A Situation Analysis of

Ecosystem Services and Poverty Linkages in Bangladesh

Moushumi Chaudhury
Senior Research Fellow, Environment Unit

Research and Evaluation Division

Table of Contents

Maps

Tables

Acknowledgements

I am extremely grateful for vital comments from Dr. Mahabub Hossain who has guided this Situation Analysis from the beginning. Without his insight and comments, this document would not have been possible. Comments received from various experts prior to and during the ESPASSA workshop held in Dhaka have also been important in developing a strong situational analysis. I am also very thankful to Mr. Kazi Faisal Bin Seraj for helping me to collect the material needed to write the situational analysis. Librarians at the Asian Development Bank, Bangladesh Institute of Development Studies, and IUCN Bangladesh Country Office have been very resourceful in locating material.

I am thankful to BRAC for supporting the development of this situational analysis that has allowed me to contribute to research, especially for the Environment Unit within the Research and Evaluation Division.

Summary

What is the relationship between ecosystem services and poverty alleviation? Finding answers to this question is vital if resources are to be used sustainably and to alleviate poverty. However, this is a question that has not received thorough attention in Bangladesh. In an attempt to understand and create linkages between ecosystem services and poverty alleviation, this Situation Analysis (SA) presents and analyzes literature that has been published in academic books and journals that could address this question.

In order to conceptualize the linkage between ecosystem services and poverty alleviation, emphasis has been placed on identifying ecosystems services. These services primarily include provisioning and regulating services. Additionally, it has also been important to identify the drivers of change that alter services. Drivers identified fall into two categories: direct and natural, and indirect and social. Keeping services and drivers in mind, the SA attempts to analyze and make linkages to the impact of drivers changes services that affect poverty, which in SA is defined through the concept of 'well-being'. This includes security, basic material for a good life, health, good social relations, and freedom of choice and action to influence decisions about services and well-being.

Five different ecosystems have been chosen to demonstrate the linkages between services, drivers, and poverty. The mangrove forest ecosystem focus primarily on the impact of shrimp farming regulating and provisioning services, as well as women's economic well-being. Although women gain financially from shrimp fry collection, such activities have increased salinity and have affected agricultural land. Inland water and floodplain ecosystem explores the impact of drivers such as, floods and riverbank erosion. Not only do these drivers destroy homes and livelihoods, but they also greatly affect human health. In an effort to control these drivers, the creation of embankments has had both negative and positive impacts, which are discussed. There are two types of wetland ecosystems that have been discussed: *haor* and *beel*. Such wetland areas provide vital provisioning and regulating services, which to some extent have been economically evaluated. These services are, however, under threat due to poor policies and overexploitation of natural resources. Agro-ecosystems primarily focus on the costs and opportunities high yielding variety (HYV) of crops brings to Bangladesh. Case studies on HYV demonstrate the paradox of needing such Green Revolution Technologies to feed large numbers of people, yet at the same time having to cope with soil and water degradation due to heavy use of chemical fertilizers and pesticides. Finally, upland and lowland forest ecosystems highlight tensions between various actors and how poor policies have drastically changed ecosystems and the ability of ethnic minorities to access services.

The SA ends by identifying future areas of research taking account of the type of literature that has not been found through a bibliometric approach. It is anticipated that attempts will be made to fill in research gaps to create sound policies that both conserve services and alleviate poverty.

1. Introduction

People are dependent upon the functioning of ecosystems to survive and improve their standards of living. The Millennium Ecosystem Assessment (MA 2005) defines ecosystems as 'a dynamic complex of plant, animal and microorganism communities and their nonliving environment interacting as a functional unit' (p.49). Ecosystem services provide provisioning services or goods, such as food, fuel, and fiber. People are also dependent upon regulating services such as climate regulation and disease control. There are also nonmaterial benefits that ecosystems provide, such as spiritual or aesthetic benefits. Alterations to the delivery of these goods and services can exacerbate poverty by degrading the level of well-being. The Millennium Ecosystem Assessment defines well-being in five ways: security (i.e. safety, secure access to resources, security from disaster), basic material for a good life (i.e. adequate livelihoods, sufficient nutritious food, shelter, access to goods), health (i.e. adequate food and nutrition, strength, feeling well, access to clean air and water), good social relations (i.e. social cohesion, mutual respect, ability to help others and express cultural value), and freedom of choice and action to influence decisions about services and well-being.

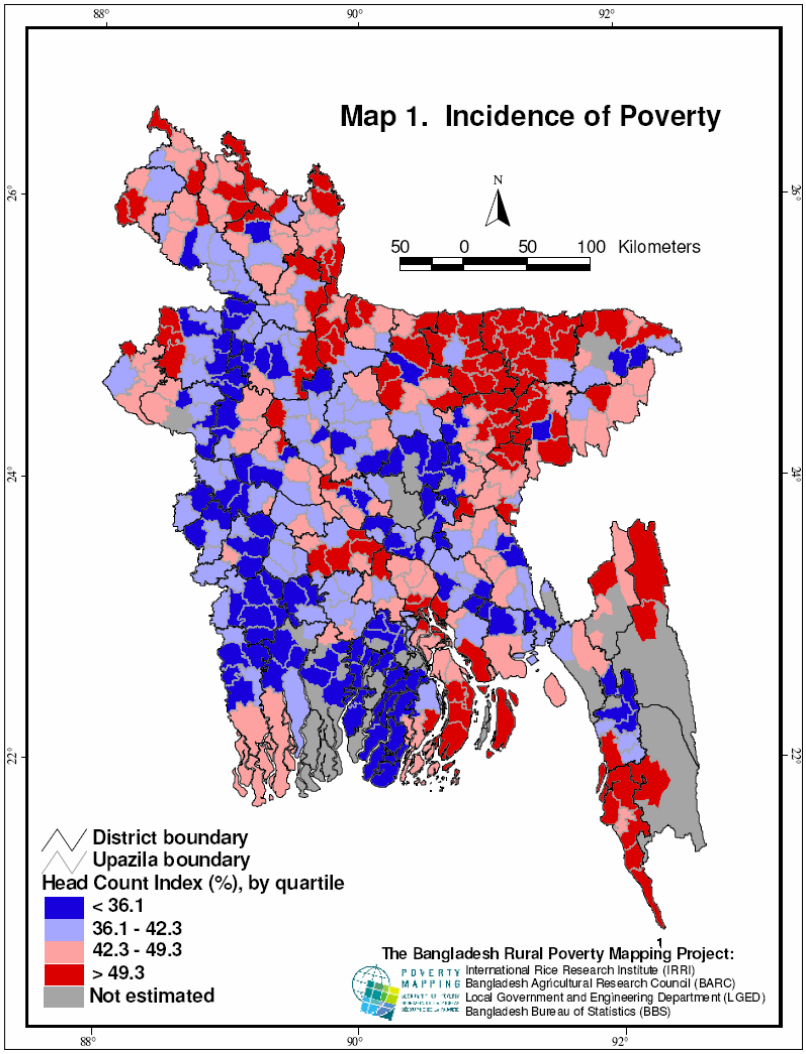
According to MA, globally 60% of all ecosystem services have been degraded or are used in an unsustainable manner affecting one or more components of well-being of many poor people. Degradation of ecosystem services is also taking place in South Asia where most poor people are dependent on a local resource base (Dasgupta 2007). The poor state of ecosystem services and its impact on poverty is major issue in South Asia. Although economic development is taking place in South Asia that can help alleviate poverty, natural resources are being used unsustainably. Degradation of services is due to several 'drivers' or factors that causes change to an aspect of an ecosystem. MA states that drivers can be natural and direct, which includes changes in local land use and cover; species introduction or removal; technology adaptation and use; external inputs; harvest and resource consumption; climate change; and natural, physical, and biological drivers. They can also be indirect and social, which includes demographic; economic; socio-political; science and technology; and cultural/religious aspects. Changes that these drivers bring not only alters ecosystems and their services, but can also worsen levels of poverty and human well-being.

This paper provides a conceptual framework in order to understand the linkages between ecosystem services and poverty alleviation, and how changes in ecosystems services affect poverty within the Bangladeshi context. This situational analysis only focuses on landscapes, which can be defined as a land surface, including coastal and/or freshwater, that provide ecosystem services. Using MA's definition of ecosystem services and well-being, literature is reviewed about Bangladesh regarding these concepts. Due to time constraints, literature that has been reviewed has been published primarily in the last 10 years. The situational analysis also includes information acquired from the Ecosystem Services and Poverty Alleviation Study in South Asia (ESPASSA) workshop that was held on 17 December 2007 at BRAC Centre. It is useful to note that urban ecosystems have not been included in the review since most people in Bangladesh live in rural areas. Since most literature reviewed does not link ecosystem services with poverty with regards to Bangladesh, an attempt is made to make this connection through analysis of the literature.

This paper is divided by ecosystems, which includes mangrove swamps located on the coast and terrestrial ecosystems, such as rivers, wetlands, agro-ecosystems, and upland and lowland forest ecosystems. This paper concludes with a section highlighting future areas of research, which may help make the connection between ecosystems services and poverty alleviation.

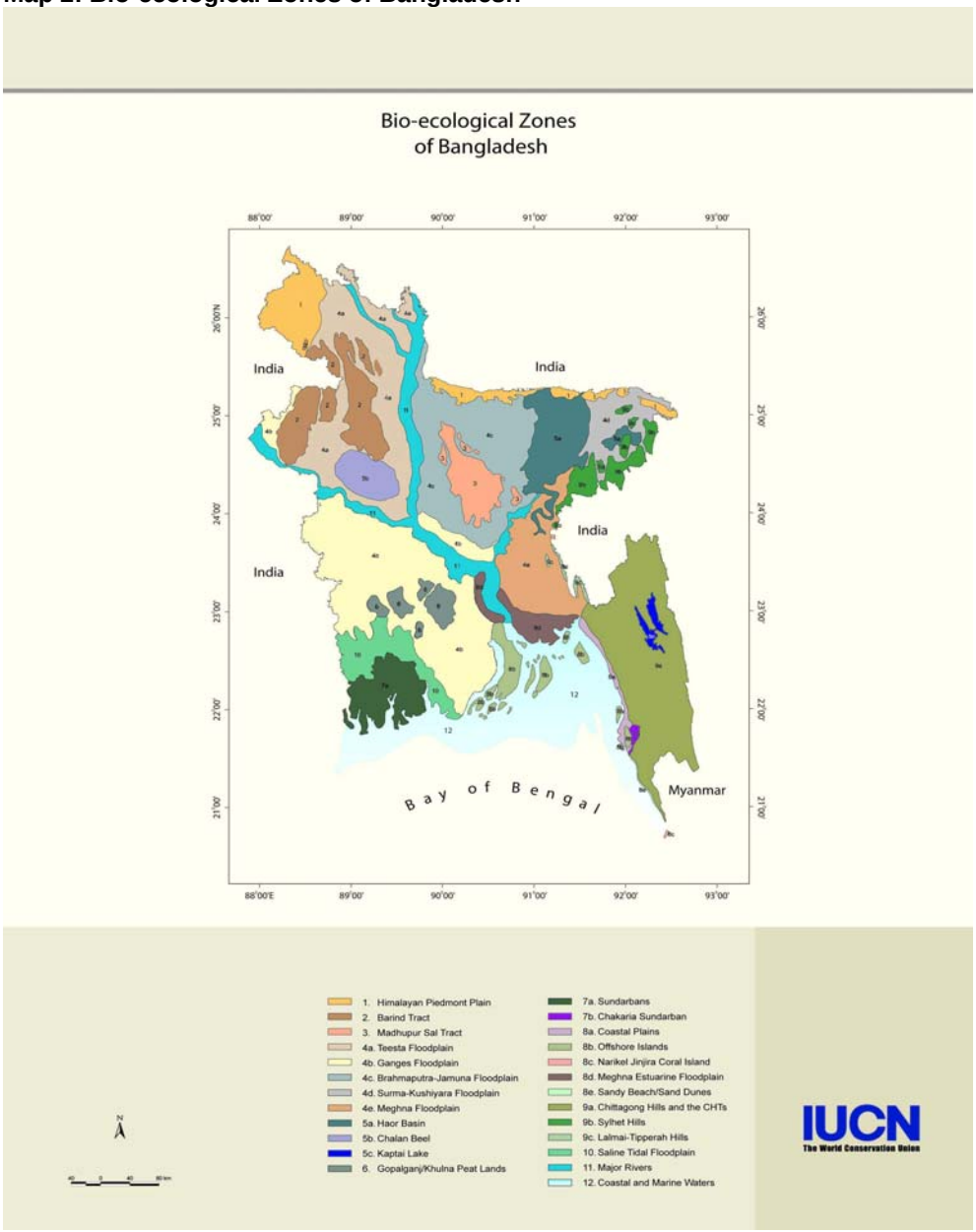
2. Conceptualizing the Ecosystem Service-Poverty Linkages in Bangladesh

Ecosystem services play a critical role in Bangladesh with regards to human well-being. It has been estimated that in 2005, 153 million people live in Bangladesh within an area of 147,570 km² (UNDP 2007/2008). Seventy-five per cent of people live in rural areas (UNDP 2007/2008) who are directly dependent on various ecosystem services. However, as this situational analysis will reveal, the ecosystem services people depend upon are being degraded in many parts of Bangladesh. Although very few publications make the connection between ecosystem services and poverty, it can be assumed, to a great extent, that almost 50% of the people who live below the national poverty line (WRI 2005). Map 1 below is a poverty map of Bangladesh.



The drivers that make these changes will now be discussed based on particular ecosystems. Bangladesh is classified into 4 physiographic regions, which include eastern and northern frontier hilly regions; great table land; flood planes of the Ganges, the Brahmaputra and the Megna river system; and the delta (BBS 2005). These classifications are further divided into various bio-ecological zones (see Map 2 below).

Map 2: Bio-ecological Zones of Bangladesh



Source: Nishat et al. 2002

In this situational analysis several agro-ecological zones will be covered, such as Madhupur Sal Tract; Ganges, Brahmaputra-Jumuna Floodplains, Haor Basin, Chalan Beel, Kaptai Lake, Sundarbans, Charkaria Sundabans, and Chittagong Hill Tracts. Table 1 provides information on the type of ecosystems that will be discussed in the situational analysis and percentage of area it covers.

Table 1: Ecosystems and Area Covered

Location	**Type of Landscape**	**% Area in Country**	**Land cover Categories**
Coastal	Mangrove swamps	4%	4%
Terrestrial	Rivers: Permanent Rivers and Streams	4%	4%
	Wetlands	30%	Estuaries and Swamps: 5% Shallow Lakes and Marshes: 1% Large Water storage reservoirs: 1% Small tanks and fish ponds: 1% Shrimp ponds: 1% Seasonally Flooded Floodplains: 21%
	Agro-ecosystems: Cropped	54%	Single cropped area = 19% Double cropped area = 28% Triple cropped area = 7%
	Upland Forest	12%	11%
	Lowland Forests		1%

Source: BBS 2005

(a) Mangroves Swamps

The coastal areas of Bangladesh are one of the most populated areas. In 2001, it was reported that 35.1 million people live in coastal areas (Islam ed. 2004). The extent of poverty in coastal areas is relatively high compared to the rest of Bangladesh. It has been estimated that 25% are poor and 24% are extremely poor (Islam ed. 2004)[1]. Most people are agricultural labourers, small farmers, fishermen, and urban poor. One type of ecosystem in coastal areas is the mangrove swamps. Sundarban and Chakaria Sundarban are the largest mangrove swamps in Bangladesh that covers 4% of forest areas in the country. Sundarbans in southwest

[1] This estimate suggests that 50% of poor people live in coastal areas of Bangladesh, which challenges WRI's estimate mentioned earlier that 50% of the *entire* country lives below the poverty line. Such differences in statistics are a major issue, which will be further discussed in this SA.

Bangladesh, offer various provisioning ecosystem services. These include wood, honey, bamboo, cane, herbs, and ornament plants. They also play a crucial role in maintaining the life cycle of economically important fish, shrimp, and crab species. They provide several regulating ecosystem services such as nutrient production, water purification, sediment trap, and shore stabilizer. One estimates states that 1/3 of the country is dependent on the Sundarbans and 3.5 million people surrounding the area are directly or indirectly dependent on this ecosystem (Hoq 2007). Another study shows that 18% of Sundarban household depend on such resources (Islam ed 2004, a).

There are many people in the Sundarbans that depend on these resources as a source of income and economic well-being. There are 20,000 woodcutters (*bawalis*) and 7,000 seasonal honey collectors (*mouals*) who depend on the Sundarbans. The revenue generated from fuelwood, for instance, can be up to US$261,775 per year. Non-timber forest products (NTFP), such as food, fibers, resins, gum, and plant and animal products used for medicinal, cosmetic, and cultural purposes, are also extracted from the Sundarbans. In total, these products contribute Tk. 1.3 billion annually to the local economy (Billah 2003). NTFPs in particular not only help alleviate poverty, but they also contribute to food security and health of the poor who do not have alternative and easy access to food and health care.

The extent to which the ecosystem services the Sundarbans provide is, however, under threat. The Sundarbans, an area covering 601,700 hectares, have been described to be in an 'irreversible' condition or 'sick' primarily due to over-extraction of resources (Islam ed. 2004). Demographic change has been a significant driver where over-harvesting beyond sustainable levels have occurred due to the combination of population pressure and the demand for resources. External inputs, such as development projects have also been key drivers in combination with poor resource management. For instance, timber needed for infrastructure purposes has led to the loss of forests as well as its value (Billah 2003; Islam ed. 2004) where the stumpage value for timber resources in the Sundarbans has fallen for all species. In-between 1991 and 1992, the stumpage value for Gewa in the Sundarbans was Tk. 90,867,000. The reduction in stumpage value had fallen to Tk. 31,702,000 by 1995 and 1996 (Billah 2003). The value placed on Gewa, is however, debatable. According to a participant from the government in the ESPASSA workshop, the value of Gewa is much higher. This has occurred due to a 'boom and bust' incidence where there was an initial high demand for poles required for rural electrification infrastructure, which then eventually led to fall in demand. The fall in value of provisioning services such as timber due to such development activities can negatively affect many poor people who use timber as house building material and for commercial purposes. This loss of timber stock and its stumpage value potentially diminishes their income earned and threatens their livelihoods.

The extent to which the southwest Sundarbans can economically benefit and provide food security is also dependent on natural drivers of change, such as cyclones, that change ecosystems. Cyclone Sidr that took place in November 2007 has not only destroyed 25% of the Sundarbans, which protects millions from tidal waves, but it has also completely destroyed 8-10% of mangrove forests. The cyclone also had devastating affects on people (Manik and Khan 2007). It killed thousands and ruined the shrimp-based economy that many poor people depended upon. It has been estimated that the shrimp farms in the cyclone-affected districts has suffered a loss of up to Tk 17.5 billion (Chowdhury 2007). Farmers will not be able to sell their shrimp because shrimp enclosures and hatcheries have been washed away. This incident demonstrates that cyclones as natural drivers can have drastic negative effects on economic well-being of people, and especially poor women who depend upon shrimp farming in coastal areas as their main source of income and nutrition.

Drivers, such as external factors in the form of infrastructure development have had a significant affect on regulating services the Sundarbans offer. Building of the Farakka Barrage has decreased the level of freshwater that reaches the Sundarbans from India and increased salinity in the coastal mangroves (Islam ed. 2004, a). Additionally, salinity is a result of illicit felling of trees and systematic over-exploitation of resources (Islam ed. 2004, a). Increased salinity can alter regulating services. This was especially evident in the Chakaria Sundarban in the Cox's Bazaar District, in southeast of the country where trees have disappeared due to high levels of salinity. In 1972, 19,390 acres were covered in forests and by 1995, the forest vanished (Gain 2002). Attempts were made recreate the forest area through afforestation, however, this was not completely successful because people are more interested in shrimp farming. This landuse change makes people in areas even more vulnerable to cyclones since coastal mangroves provided protection against storms. Although the ecosystem services provided by the coastal mangroves swamps were lost due to salinity, people took advantage of this ecosystem change and started to intensively farm shrimp in Chakaria Sundarban. This is just one example in the way in which people may adapt their livelihoods to accommodate changes in ecosystems.

The Chokoria Sundarbans is an areas of 18,500 hectares and was declared a reserve forest in 1903 (BRAC 2008). Shrimp farming as an economic activity in the Chokoria Sundarbans has increased significantly. Between 1984 and 1985, the area under shrimp farming was 64,246ha. It rose to 203,071ha between 2003 and 2004 (BBS 2005). Shrimp export revenue has grown from US$ 4 million to US$ 360 million, making it 12 times more profitable than high yielding varieties of rice (Ali 2006). Shrimp farming can contribute between 8% and 10% of total export earning (Crow and Sultana 2002). Although 81.3% of non-poor are involved in shrimp farming, it is an activity that benefits 18% of poor people (Rahman and Hassan eds. 2006). Among those involved in aquaculture in mangrove swamps are women. Thirty percent of women in coastal areas are directly or indirectly involved in small-scale fisheries, which includes shrimp farms. Women also make up 50% of workers in shrimp processing centers (Karim et al. 2006). Among women, it is the poor who are primarily involved in shrimp fry collection. In addition to being a source of income, shrimp farming contributes to their food security and offers inexpensive source of protein required to maintain good health.

Shrimp farming has positive and negative impacts on coastal mangrove swamps ecosystems. In some cases, shrimp farming has changed to improve ecosystem services. For instance, shrimp farming can reduce insect attacks in rice fields, and fish feces can contribute to organic mater that improves soil quality, which leads to increased rice production (Karim et al. 2006). In other cases, shrimp farming has had detrimental effects. Mass shrimp fry collection is a threat to the coastal ecosystem, causing damage to the nursery grounds of many species, newly planted mangroves, and reserve forests. Additionally, introduction of new species has also been detrimental to the mangrove forest ecosystem (Ali 2006; Hoq 2007). For instance many white fish are lost when collecting shrimp fry (BRAC 2008). Agro-ecosystems are being affected where coastal shrimp farming takes place in the same field/pond near a river where rice is also cultivated. Although shrimp farming and rice cultivation does not take place at the same time, encroachment of shrimp farming due to both demand for shrimp and population pressure has led to salt-water seepage, increasing salinity in soils and affecting soil fertility (Ali 2006). In some cases, influential shrimp entreprenuers have forcibly rented land from small and marginal landowners to make fish ponds to cultivate shrimp. This has gradually led to salinization of land and disappearance of (social) forests, and depletion of livestock due to disappearance of grazing land and scarcity of fodder such as rice straws (BRAC 2008). This has led to the fall in productivity of *aman* rice, for instance. Not only has productivity of this rice decreased between 1987 and 2000, but also total unemployment in agriculture has increased from 0% to 19%

among males and from 46% to 55% among females in agriculture because of salinity caused by shrimp farming between 1975 and 1999 (Hoq 2007; Karim 2006). Therefore, changes in mangrove forest ecosystems can make aman rice farmers vulnerable and threaten their income levels.

Changes in the ecosystem, such as increased salinity, especially affect poor women. Some poorer women cannot afford deep tube wells and have to travel up to 5km to collect drinking water since surface and groundwater become polluted due to salinity as a result of shrimp farming. They may also have to provide free labor in return for access to closer water sources (Crow and Sultana 2002). Such conditions affect their livelihoods because they are unable to find clean water for their homestead gardens and livestock (Karim 2006). Nutritional diversity also declines because saline water is unable to support vegetables and livestock for consumption. They may also be unable to gather livelihood resources from coastal forests, such s NTFPs, as shrimp farms expand. Therefore, changes in ecosystems greatly affect women's well-being through its impacts on their health, nutrition, workload, and livelihood strategies (Crow and Sultana 2002). Although formal and informal management mechanisms exist to sustain aquaculture in mangrove forests and minimize negative impacts, they have either been ignored or have collapsed over time (Crow and Sultana 2002).

(b) Inland Waters and Floodplains

Inland water bodies, such as rivers, are a source of freshwater upon which people and other biodiversity depend. Freshwater is essential for the functioning of many provisioning and regulating ecosystem services. Rivers provide water for production (irrigation, energy, fish[2]) and domestic use (drinking and sanitation). Freshwater is essential for human well-being. In Bangladesh there are in total 790 rivers with 1,094 million acres ft. (BRAC 2008). Surface level freshwater is ample in Bangladesh as it is located at the confluence of Jamuna (Brahmaputra), Ganga, and Megna rivers. There are, however, several drivers of change such as poor quality of water, floods, river erosion, and waterlogging which negatively impacts agricultural production, creates disinvestment in land, loss of human settlement, lack of safe drinking water, and outbreak of water borne diseases (BRAC 2008). These drivers of change will be discussed in this section.

The quality of water in various parts of Bangladesh is degrading, which affects human well-being. Buriganga, Sitalakhya, and Naryanganj are the worst affected rivers of Bangladesh. Inland freshwater ecosystems are being changed due external inputs that include development activities, such as industrial production (Alauddin and Quiggin 2007). There are 6,000 large and medium industries and 24,000 small industries within various sectors such as chemicals, tanneries, paper and pulp mills, petrochemical and fertilizer complexes, and rubber factories (Islam ed. 2004; Zahid and Ahmed 2006 cited in Alauddin and Quiggin 2007). Run-offs from these industries, especially due to the lack of clean technologies contaminate inland water sources where around 85% of wastes are directed into canals and rivers. For instance, in July 2007, Dhaka city produced 1.3 million cubic meters wastes per day but only disposed 0.12 mcm wastes per day through Pagla, the waste treatment plant. Most waste is pumped and thrown into the canals and drains towards rivers through open and covered drains. More than 85% of the waste is thrown directly into rivers (BRAC 2008). Additionally, the lack of sanitation technology is also a driver of change as it degrades water quality and changes ecosystem services when excessive human and animal waste enters rivers and lakes. Not only does this

[2] Two million tons of fish are caught from rivers of Bangladesh per year (BRAC 2008)

lower water quality that affects sources of income based on water resources, such as agriculture and fisheries, but it also affects the quality of health. Because the poor have limited access to health care services, their ability to recover from water borne diseases, due to poor water quality, is low. This significantly diminishes their health and well-being. Poor health in turn worsens economic poverty since the number of days one is able to work is reduced. This also leads the poor to purchase water, which sometimes costs more than in some developed countries. Since many cannot afford the high cost of water, they are forced to drink contaminated water (UNDP 2006). Therefore, the lack of appropriate technologies to minimize run offs and treat wastes, lowers both economic well-being and that related to health.

In addition to the indirect drivers mentioned above, there are several direct and natural drivers that change ecosystem services creating a negative impact on the poor. Studies have shown, especially in Bangladesh, that drivers of change that alter water bodies and floodplain are seasonal flooding that takes place due to increase in rainfall, especially during the monsoon. The extent to which seasonal changes that create floods are the only significant driver that changes inland water and flood plains is, however, debatable. Many claim that the driver of change is deforestation in the Himalayas that loosen soil, which eventually creates sedimentation in rivers of Bangladesh as soil is washed down during the monsoon. Sedimentation then limits the ability of inland water bodies to absorb excess water. The correlation between deforestation in the Himalayas of Nepal and flooding in Bangladesh, however, has not been proven significant (Hofer and Messerli 2006). According to Hofer and Messerli, because deforestation has not occurred on a grand scale in Nepal, it is impossible to equate deforestation in Nepal to large scale flooding in Bangladesh. Flooding occurs due to various drivers that exacerbate the impact of flooding. These drivers include La Nina phenomenon, intense rainfall in Bangladesh, above danger flow of the three major rivers, and backwater effects in the Bay of Bengal, as was the case during the 1998 floods, which will be discussed shortly. Hofer and Messerli's work suggests that drivers of change that affect inland water and floodplain ecosystems are complex and debatable.

Although debates about drivers of change exist, the impact of the drivers can be catastrophic. As a flood-prone country, approximately 34% of land submerges under water between 5 and 7 months of the year. Flooding is an environmental issue that approximately 60% of households in Bangladesh face (Rahman and Hassan eds 2006). Although rivers that flood provide regulating ecosystem services such as fertilization of fields, flushing out salts and toxins from soils and watercourses, and recharging reservoirs (Few 2003), floods as natural drivers can also be devastating. Floods as natural occurrence that alter ecosystem provisions, such as land availability and composition, tend to exacerbate poverty, and create land/homelessness through displacement, as it destroys natural resources the poor directly depend upon.

The flood in 1998 in Bangladesh, for example, is considered to be the worst in the 20th Century in terms of extent and duration. Approximately 50% of the country was submerged for 67 days (Hofer and Messerli 2006) due to flooding of Jamuna and Ganga rivers. It not only damaged 60% of the land and affected 30 million people (Hutton and Haque 2004), but it also caused 2.04 million metric tons of rice crop losses (Ninno et al. 2001). In a study by Ninno et al. (2001), a total of 24% of the anticipated agricultural production was lost. Even though the 1998 flood was devastating, markets were stable due to private sector imports of rice and wheat, as well as government supply. However, even though food was available, many poor people were unable to access them due to the loss of assets and income earning opportunities. It has been estimated that 55% of households lost assets worth Tk 6,936, which is equivalent to 16% of pre-flood total value of assets. Furthermore, day laborers were severely affected since their employment fell sharply from 19 days per month in 1997 to only 11 days per month from July to

October 1998. This has also greatly affected human well-being in terms of increasing food insecurity. Ninno et al. state that 15.6% of flood-exposed households became food insecure. Many poor also do not have access to safety nets and resources to cope with natural calamities, which further leave them vulnerable after rivers have flooded (Few 2003). Additionally, human well-being was threatened as homes were damaged or destroyed. Therefore, floods, which are direct drivers of ecosystem change greatly challenge the poor whose well-being in terms of security and income become significantly worsened.

Floods also greatly affect health and people's well-being. The flood in 1998 had a significant toll on human health as access to safe water was reduced, and toilet facilities were destroyed or damaged. In the 1998 flood, there were up to 400,000 cases of diarrhea of which 500 ended in death (Hutton and Haque 2004). Another study states that 9.6% of individuals in the sample suffered from diarrhea, and 4.7% were affected by respiratory illnesses (Ninno et al. 2001). Women and children were particularly affected. It has been estimated that 55% of children were stunted and 24% were wasted due to reduced access to food, the increased difficulties of providing proper care for children that came with disruptions in home life, and the greater exposure of children to contaminants. Women were also found to be energy deficient (Ninno et al. 2001). Most people whose health were affected by this epidemic were either 'poor' or 'very poor' with low levels of education. Floods as natural drivers of change can greatly affect the poor and deteriorate both their health and ability to recover because of their lack of assets (Kunii et al. 2002).

People have, however, developed sophisticated ways of coping and adjusting to life in floodplains that minimize the impact of their well-being. Hofer and Messeri identify that coping mechanisms can include raising their house courtyard to a certain height during the monsoon to prevent damage to their physical assets and loss of lives. People have also been planting flood-resistant plants, such as deep-water *aman* rice, jute, and sugarcane. Since flooding is part of life for many in rural Bangladesh, women, for instance, prepare portable stoves and keep firewood in stock during the wet season. Rafts from banana trees are also made for transportation from roads are submerged.

River bank erosion is also a serious problem in Bangladesh. Interestingly, many rural people consider riverbank erosion a greater problem than floods, with high repercussion on well-being. Although floods may temporarily cause severe damages as discussed above, people are able to still use the land in flood plains after floods have receded. However, lateral riverbank erosion is a more constant threat to well-being because they erode living spaces and existence base of entire families (Hofer and Messerli 2006). It has been estimated that 2,000km to 3,000km of riverbanks annually experience erosion in Bangladesh (Hutton and Haque 2004) and 31% of households in Bangladesh are susceptible to riverbank erosion (Rahman and Hassan eds 2006). River bank erosion is due to extraction of sand from riverbanks to help construct buildings (BRAC 2008). In most cases, riverbank erosion is a natural phenomenon.

River bank erosion primarily affects the poor, small landowners who live near the riverbank. It affects their well-being in terms of safety and shelter, as well as sources of livelihood (Brouwer et al. 2006). However, the impact is severest among the landless and impoverished farmers. Although some poor small landholders can rely on existing tenancy structures and resume their livelihoods, widespread erosion not only destroy their homes and land, but also their source of income and food on a large scale (Hutton and Haque 2004). Hutton and Haque demonstrates that 62% of displacees from river bank erosion, which include a large proportion of the poor who live along river banks and earn US$1-2 per day, which in many cases is not enough to buy food. Additionally, Hutton and Haque's work suggests that those who have been displaced due to

river bank erosion are also affected by mental stress because of social fragmentation and difficulties in adjusting to urban areas where they migrate to, affecting their mental well-being. Women's well-being is particularly affected when they are displaced as they become more secluded, and subordinate as social pressures to wear a *purdah* increases in their new place of refuge. Displacement in urban areas among women also causes purposelessness where in rural areas they play a critical role in household economics. Although it can be suggested that floods and river bank erosion leads to *char* formation, which is emerging land or islands in the middle of braided rivers creating land for re-settlement and agricultural production, these lands are not enough to improve peoples' well-being. Living and working conditions in *chars* are difficult since they are not connected to the mainland and are prone to acute erosion and flooding, hence leaving people vulnerable (BBS 2005).

In addition to natural drivers of change with regards to rivers, development projects as external drivers have also significantly contributed to changes in ecosystem services. For instance, the Farakka Barrage constructed by India in 1975 to divert water from the Ganges has led to droughts in lower Ganges channels within Bangladesh, as well as siltation and salinity. Such changes in regulating services have greatly affected the well-being of many people in Bangladesh due to significant losses in agriculture, fisheries, forestry, industry, navigation, and water supply amounting to US$3 billion (Rahman and Hassan eds 2006). Development planners have, however, tried to minimize the impact of floods and riverbank erosion on floodplains by creating the Flood Action Plan (FAP), 1989-1995. FAP was a consorted effort by various development organizations such as the World Bank, UNDP, and USAID, along with the government of Bangladesh (Government of Bangladesh 1995). The FAP suggested policies to promote physical solutions to flooding and riverbank erosion by promoting embankments. It also called for understanding the environmental impact that embankments could have, as well as ways in which to improve relief efforts, flood-proof villages, and share data. Policy documents such as FAP, however, are marked with controversy with regards to the feasibility of embankment projects. On the one hand, in some embankment areas they provide shelter during floods, access to roads is maintained so that transportation and trade do not become disrupted during the monsoon, and *aman* rice does not become affected. On the other hand, embankments can create a false sense of security since they can be breached and eroded leading to a sudden onrush of water that destroys infrastructure, homes and crops (Hofer and Messerli 2006). Because people feel secure with embankments, the costs of breached or eroded embankments are higher since people are not prepared for embankment failure. The question remains whether only technological feats, such as embankments, are adequate enough or whether a 'holistic' approach is the solution is still debatable.

(c) Wetlands: *Haor* and *Beel*

Wetlands are one of the most prevalent ecosystem in Bangladesh covering 35% of the country's land area. According to the first Ramsar Convention, a wetland consists of 'areas of marsh, fen, peatland, or wasteland, natural or artificial, permanent or topography, with water which is static or flowing, fresh, brackish or salt including areas of marine water' (Ramsar Convention Bureau cited in Billah 2004). This includes rivers, streams, lakes, rice fields, shrimp farms, inland flooded forests, swamps and coastal mangroves. Wetlands offer numerous regulating services. Some of the provisioning services that can be found in wetlands are water (for rice cultivation and aquaculture), grazing land, food, fiber, and medicines. Regulating functions include providing nutrients through floods, natural purification of water, and recharging of groundwater (Ratner et al. 2004). Additionally, wetlands help to store flood water, stabilize shoreline, reduce soil erosion, remove or retain nutrients, and provide food for plants and animals. They offer water transportation, preserve biodiversity, and stabilize micro-climates (Billah 2003). They are

ecologically, economically, and culturally significant.

Within wetlands of Bangladesh are unique areas of backwater swamps that significantly contribute to people's well-being. One type of backwater swamp is known as *haor* or bowl-shaped depressions located between the natural levees of rivers. Hakaluki *haor*, which is one of the largest in Bangladesh, provides ecosystem services to 190,000 people. Using bio-economic models, the World Conservation Union (IUCN) has estimated that the economic value of Hakaluki Haor is Tk 585.75 per year (IUCN 2006). Similarly, USAID (2007) has also estimated the economic value of Hail Haor, which amounts to Tk 36,990/area and Tk 454,924,600 in total returns. The provisioning resources that can be found in such haors include plants, fish, birds and other wildlife. People have also practiced indigenous methods of floating cultivation or *dhap* (also referred to as hydroponics) in wetland areas for centuries, which have provided them resources such as vegetables (Islam and Atkins 2007). Cultivation on *dhap* can lead farmers to earn up to Tk. 16,000 in one season (Islam et al. 2000). Fish (260 species) and migratory birds especially contribute to well-being in relation to health as they provide nutrition and economic well-being since many people are involved in fisheries. It has been estimated that 80% of people in rural Bangladesh depend on wetlands areas, such as *haors*, for fish and other aquatic resources (USAID 2007).

Provisioning resources, such as fish, are, however, being depleted due to several reasons. The drivers of change include overharvesting of fish, loss of habitat and connectivity, paving roads, flood embankment and water control structures that block fish migration and cause rivers to 'die'. These drivers of change also increase drainage congestion, reduces surface water due to irrigation of rice field during winter, increases water pollution due to dumping of industrial waste, deforestation and poor land management that causes siltation and filling up of wetlands, and the use of fine mesh nets (USAID 2007). Regulating services, such as flood control and storm surge protection, have also degraded due to the building of transportation and communication infrastructure that cover up wetlands (Islam et al. 2000). Additionally, poor property rights prevent poor people who depend on common property resources from accessing natural resources from *haors* since the government controls many wetland areas. The government only provides short-term leases to people which encourages maximum exploitation while excluding poor people from use of common pool resources (Islam et al. 2000). Due to the various reasons why fish stocks has depleted, it has been estimated that consumption of fish has fallen by 11% in recent years and 40% of fish are threatened (USAID 2007). In order to sustain economic well-being of people, some development interventions are helping to improve such situations. Development projects such as MACH funded by USAID have the potential to minimize overfishing by encouraging a community based natural resource management approach where a community is formed to address the negative impacts on ecosystems services while ensuring that their livelihood is sustained from fishing activities. This is being initiated by participatory planning process where rules and norms to manage aquatic resources through sanctuaries have been established (USAID 2007). There are also other NGO-led community based projects in various other haor areas (Rahman and Hassan eds. 2006).

Although development projects may have good intension, in some cases, they have degraded ecosystems due to development projects that act as negative drivers of change. This has taken place in Beel Dakatia affecting extremely poor people (Rahman 1995). A *beel* is defined as depressions and lakes that hold water permanently or seasonally in wetland areas. For instance, in order to prevent sea water during storms and floods from entering agricultural fields, which are adjacent to *beel* areas, development projects have constructed polders to drain the sea water. Such development projects have, however, been more harmful than helpful. Many polders blocked tidal flow of rivers and created siltation and waterlogging, which eventually did

not allow sea water to be drained (Choudhury et al. 2004). Ecosystem changes due to salinisation and waterlooging include loss of trees with economic value, land productivity, livestock, kitchen gardening, fisheries, biodiversity, and clean drinking water, which are all provisioning services found in agro-ecosystems. This change has led to an 'ecological crisis' and loss in livelihoods for thousands of people (Rahman 1995). This has also forced many people to migrate away and/or take up various occupations to support their families affecting their financial and social well-being, especially with the loss of social networks. Additionally, people's health has also been affected with 87% of people in the area suffered from diarrhea (Rahman 1995).

(d) Agro-ecosystems

Agriculture contributes to 23.5% of the GDP in Bangladesh and 2/3 of the population depend on agriculture as a major source of income (BBS 2005). It is the largest (manmade) ecosystem in Bangladesh covering 54% of the land. However, 50% of people are considered landless farmers and 80% have less than 2.5 acres of land. Bangladesh has the highest percentage (70%) of land under agriculture in South Asia and highest degree of intensification of agriculture (Alauddin and Quiggin 2007). One of the key drivers of change in agro-ecosystems is population growth, which is growing at the rate of 2.2% per year (UNDP 2007/2008). Although the rate of population growth has declined from 3% per year at independence in 1971 to 1.4% per year at present, the absolute number is still increasing by 2.0 million every year. This requires the production of an additional 0.5 million tons of rice every year (BRAC 2008). This led to the adoption of Green Revolution technology in Bangladesh, which included cultivating modern high yielding variety (HYV) crops. Modern varieties have now spread to two-thirds of the area under cereals.

High yielding seeds of rice may potentially reduce the amount of pesticides that contribute to ecosystem degradation, and thereby, sustain agricultural production that many people in the developing world depend upon as source of income (Garcia and Altieri 2005). Currently 61% of rice production in Bangladesh is allocated to modern varieties (Baffes and Gautum 2001 cited in Rahman (b) 2003). HYV has significantly increased food production while minimizing the area of land required for agriculture. For instance, Bangladesh was able to increase its rice production from 15,043,000 tons in 1965 to 37,383,000 tons in 2003. High production level has ensured stable food grain prices, which has reduced the incidence of poverty. For example, incidence of poverty in Bangladesh fell from 41.5% in 1990 to 31.9% in 2000 due to production of HYV (Alauddin and Quiggin 2007).

Some studies consider the impact of HYV cultivation on levels of poverty. A study by Hossain (unpublished) examines the impact of HYV on various income groups and gender (i.e. very poor, poor, and non-poor men and women). His study demonstrates that, overall, yield and income have increased regardless of the various levels of poverty and gender. However, because HYV crops require a certain level of inputs such as fertilizers and pesticides, the price of agricultural inputs have also increased for most groups. On the one hand, this has lowered most farmers' economic vulnerability across all economic positions and increased food security in most cases except for one female and poor group. On the other hand, farmers will face greater expenses due to increases in agricultural inputs, which questions the benefits of HYV crops and the adoption of Green Revolution in Bangladesh. Therefore, Hossain's study suggests that the benefits of the Green Revolution in Bangladesh are debatable.

National economic plans which act as drivers, has promoted the adoption of HYV technologies, which has led to significant decline in soil quality across all agro-ecological zones in

Bangladesh. Cultivation of HYV crops resulted in constrained penetration of crop roots, reduced water infiltration, and increased surface runoff in many parts of Bangladesh (Rasul and Thapa 2004). For instance, in 1987 the estimated crop-land quality score was 150 and by the mid-1990s, it decreased to 23 (Peterson 1987, Prescott-Allen 2001 both cited in Alauddin and Quiggin 2007). Over time, production of HYV crops have fallen and this has primarily impacted economic well-being of farmers. Real income among modern rice farmers has decreased by 18% (Rahman 2003, b). Although Rahman (b) states that the reason behind this fall is the stagnant output price and rising costs of production coupled with declining productivity, it could be suggested that the fall in income is also related to the degradation of ecosystem services, that underpins agricultural production.

In addition to declines in soil quality, HYV technologies, which require fertilizers and pesticides, have also altered ecosystems services and human well-being. Policies promoted subsidization of chemical fertilizers and pesticides, which has contributed to the deterioration of the agro-ecosystem. The government maintained the price of urea at a very low level, but allowed the private sector to import phosphate and potash and charge international prices to farmers. As a result, the farmers use too much urea and too little other fertilizers (BRAC 2008). The un-balanced use of fertilizer as external inputs into the ecosystem and direct drivers of change has contributed to the deterioration of soil fertility. Small farmers especially use fertilizers for agricultural intensification since they do not have access to large agricultural land. Excessive use, however, contributes to soil degradation and water pollution. Between 2003 and 2004, 3,364,100 tons of chemical fertilizers were used in Bangladesh (BBS 2005). Even more pesticides were used in Bangladesh. In 2004, 22,116,000 ton/kl of pesticides were used (BBS 2005). According to Rahman and Parkinson (2007), more than 65% of the total agricultural land in Bangladesh is suffering from declining soil fertility and about 85% of net area suitable for cultivation has an organic matter below the minimum requirement due to excessive use of fertilizers. The loss of agricultural land and supporting services, such as soil formation, can directly affect the poor whose main source of income comes from agricultural activities (ODI 2006). Although intensified land use provides essential source of natural resources and income for poor or small farmers who do not have access to other income earning opportunities, intense use of fertilizers and pesticides can lead to loss of vegetation, depletion of soil, and destruction of habitats (Dasmann 1988 cited in Niazi 2003) that all contribute to deterioration of regulating services, and thereby the reduction in economic well-being of farmers.

Hossain's study produces similar findings compared to the studies just reviewed on the impact of HYV on the environment but disaggregates the information based on different levels of poverty and gender. His work suggests that all groups in the study, regardless of gender and economic status have experienced loss in soil fertility due to excessive use of pesticides and fertilizers. As a result of pesticide and fertilizer use, the level of biodiversity has also fallen in terms of quantity of aquatic and land plants and animals. With an increase in the use of HYV crops, pests and diseases have also increased. The detrimental effect on the environment has increased vulnerability to attacks by pests and diseases, affecting the health of farmers in all economic groups. Despite the negative consequences, farmers are not willing to stop producing through Green Revolution technologies because financial returns are higher from cultivating HYV crops, especially since existing policies do not require farmers to pay for external costs, such as health hazards and water pollution caused by Green Revolution technologies (Rasul and Thapa 2004).

Cultivation of HYV crops have negatively affected water tables due to the increase in groundwater use to cultivate HYV crops (and diversion of inland water as discussed in the previous section). No other country in the world depends on groundwater use to the extent that

Bangladesh does. It is the most important source of water for domestic, industrial, and irrigation supplies (Islam ed. 2004). The decrease in the water table has not only reduced biodiversity due to drought, especially in the northern Rajshahi Division and western Khulna Division, but has also exacerbated impacts on the environment and livelihoods of people living in these areas. It has been reported that 30% of cultivable land has been affected by drought (Alauddin and Quiggin 2007). However, this finding does not apply in all cases. Hossain's study demonstrates that although cultivation of HYV increased vulnerability to drought, this was not the case for a very poor female and one non-poor female group because irrigation systems were installed.

Refreshing groundwater supply has been especially difficult because, flood mitigation work and the use of levy banks to protect against flooding have reduced the spread of floodwater, to replenish groundwater sources. Although Bangladesh has more surface water than many countries in the world, farmers still rely on groundwater because it is easier to access and control for irrigation. However, depletion of groundwater has led to a major environmental health issue in Bangladesh, namely arsenic poisoning. Since 1993, when high arsenic concentration was discovered, 20 million people in Bangladesh have been affected by arsenic poisoning and 70 million are at risk. The poor are especially vulnerable to arsenic poisoning because they are not able to buy expensive tube wells that dig deep into the ground. It has been estimated that 74% of poor households use arsenic contaminated water (Rahman and Hassan eds 2006). Poor women in particular are more vulnerable than men to this public health crisis because they are nutrition-poor and unable to fight the poisoning. In addition to bodily harm, women who have been affected by arsenic poisoning face social repercussions since they become 'unmarriageable' (Crow and Sultana 2002). Additionally, chemical run-off from fertilizers has also contaminated groundwater by leaching nitrate, which causes methemoglobinemia or 'blue baby syndrome' (Rasul and Thapa 2004). Therefore, external inputs, such as excessive use of fertilizers and pesticides, not only alters groundwater quality, but seriously threatens the well-being of farmers and especially women with regards to their physical and mental well-being, in addition to threatening their source of income based on agriculture in agro-ecosystems.

There are examples, however, where farmers are adopting more environmentally sensitive farming methods compared to methods involved in HYV cultivation. Many farmers in villages, such as Pyraban, rely on compost for fertilizer, for instance, and not chemical fertilizers that can cause environmental damage. This practice is especially beneficial as it saves farmers money since price of chemical fertilizer has increased in recent years (BRAC 2008). However, the extent to which using more environmentally friendly cultivation practices provide more food and income security is unclear.

(e) Upland and Lowland Forest Ecosystems

Upland and lowland forests make up 12% of all forest areas in Bangladesh. The total land area under forests in Bangladesh according to government statistics is 2.52 million hectares (BRAC 2008). Most of the public forests in upland areas (600m to 1,052m) are in the Chittagong Hill Tracks (CHT). Provisioning resources such as timber and bamboo are extremely important economic resources in CHT. The GDP from such forest resources between 2003 and 2004 amounted to Tk 56,202,000 (BBS 2005). External inputs such as development activities act as direct drivers of change in CHT. For instance, the Kaptai Dam in Rangamati District has created the Kaptai Lake, which is one of the largest man-made lakes in the world. Although Kaptai Lake has changed the local ecosystem to create a 'lake economy' and provide opportunities for aquaculture, irrigation, and generation of electricity, it has also had negative repercussions on

the local population. It has displaced 10,000 tribal families, and 8,000 families that practiced slash and burn cultivation as well as other poor people (Rahman and Hassan eds 2006).

The establishment of plantations as development activities has also had negative repercussions. Plantations have created monocultures, which have degraded forest soils to a significant extent (Adnan 2004). Deforestation to create plantations has also been another reasons why 75% of upland forest areas are susceptible to soil erosion (BBS 2005). Although most literature on upland forest plantations does not directly reflect on poverty, some work implies that the creation of plantations has further marginalized ethnic minorities from the forests they depend upon, worsening their level of poverty and economic well-being (Gain 2002). The Khyang, for example, have been one of the most affected ethnic minority communities since expansion of government land has limited their access to ecosystem services (Rahman and Hassan eds 2006) and plantations have limited availability of forest resources (Adnan 2004). Women from such ethnic communities in particular are the worst victims of forest degradation and government expansion, especially because they are the ones who gather forest resources for their families for subsistence use and for commercial purposes. Because plantations have degraded soil quality, forest resources the Khyang depend upon are diminishing. This requires the Khyang women to travel further to collect resources, which increases their time and burden of work since access to forests has declined due to nationalization (Rahman and Hassan eds 2006). The Khyang example demonstrates how development activities can negatively impact economic well-being of marginalized groups who have few assets to begin with, to contribute to their well-being.

Local land use change is also a key natural driver of change in CHT. Studies have shown that conversion of forest land into agricultural fields due to decreasing availability of agriculture land, and increases in population growth[3] and poverty have led to the loss of soil nutrients especially since soil conservation methods have not been used (Iftekhar and Hoque 2005; Islam and Weil 2000). Studies also demonstrate that *jhum* or slash and burn cultivation practiced by 'tribal' communities in CHT instead of agroforestry, is also a major reason why upland forests have degraded (Adnan 2004; Rasul and Thapa 2006; Rasul et al. 2004, Salam et al. 1999; Thapa and Rasul 2006). Although *jhum* cultivation is not an environmentally damaging practice per se because it allows for long fallow periods and regeneration of soil and vegetation, population pressures and demand for agriculture products has reduced the amount of time land lays fallow. Furthermore, because *jhum* cultivators, such as the ethnic Khyang, do not have secure land tenure due to state nationalization of land, they are unwilling to switch to more environmentally and economically better agro-forestry practices. Poor, small landholders also lack of access to credit to start up agroforestry production. Furthermore, the counter insurgency movement in CHT and conflict has left ethnic minorities landless aince their land has been taken over by over by Bengalis. This has left many minorities devoid of assets on which they depend upon for economic well-being (Adnan 2004). Therefore, poor land policies, that leaves the Khyang land-insecure, in combination with poverty, create a land use system that degrades regulating services such as soil formation and regeneration. This in turn jeopardizes the livelihoods and economic well-being of 'tribal' communities who tend to be poor and with fewer assets.

Lowland forests, such as Modhupur Tracts, share many similarities with CHT. Madhupur Forests are *sal (Shorea Robusta*) forest that offer many provisioning services in addition to hardwood used for house-building. These provisioning services mostly include non-timber forests products, such as sungrass found in the undergrowth is used to make roofs. Root foods,

[3] Population growth includes both growth in the area and also land encroachers who enter CHT from other parts of the country to search for employment (Iftekhar and Hoque 2005).

wild fruits and berries offer supplementary food to local population living in and around the forests. Additionally, medicinal plants found in such forests offer immediate treatment to various health problems (Islam 2007, b). Although lowlands forests, such as Modhupur, offer several provisioning services, they have disappeared due to heavy deforestation. The disappearance of sal forests can also be attributed to the introduction of social forestry and plantations. The introduction of pineapple and rubber plantations and other foreign species in the name of 'social forestry' has depleted forest provisioning resources and forest areas to 10% (Gain 2002; Islam 2007). These social forestry schemes were advocated by the government, with the aid of major development organizations in order to take control from local people who are viewed as 'illegal encroachers' (Islam 2007). This is, however, debatable as government sources proclaim social forestry to have had positive economic effects due to large scale production of crops while others state that social forestry has been a disaster because natural forests provide more ecosystem services, especially to the poor (BRAC 2008). This situation creates vulnerability among women and their families, as well as confrontation between ethnic minorities and plantation owners (Gain 2002; Islam 2007, b). Ethnic minorities, such as Mandis and Garos, have also not been able to access *sal* forest resources they depend upon because land conversion to plantations have reduced their access. They lost their rights to forest land when Modhupur became a reserved forest in 1955 and national park in 1961 in the name of conservation (Islam 2007). This has especially affected the well-being of women since their access to forest resources have been minimized, which in turn increases their inability to access food and medicines for their families.

Thus far, this situational analysis has provided an overview of the drivers of change with regards to mangrove swamps, rivers, wetlands, agro-ecosystems, and upland and lowland forest ecosystems. Table 2 below demonstrates the linkages between ecosystem services, goods, and types of ecosystems. The check marks indicate linkages that have been discussed in this situational analysis in relation to poverty alleviation. The cells that are shaded in gray indicate a possible linkage although no evidence based on publications has been found.

Table 2: Goods, Services, and Ecosystems

Ecosystem Service Component	Goods or Services	Mangrove Swamps	Rivers	Wetlands	Agro-ecosystems	Upland and Lowland Forests
Sustaining Services	Oxygen Production					
	Nutrient Cycling	√	√	√		
	Primary Production					
	Habitat Provision	√	√	√	√	√
	Water Cycling		√	√		
	Carbon Sequestration					
	Pollination					
Goods	Food and Drink	√	√	√	√	√
	Fibre/Construction	√		√		√
	Medicinal/Cosmetic Resources	√		√		√
	Ornamental Products	√				
	Renewable Energy Products	√	√			
	Genetic Resources	√				
Regulating Services	Filtration of Air Pollution					
	Detoxification of water and sediment	√	√	√		
	Local Climate Regulation			√		
	Erosion Control			√		

	Flood Risk Mitigation	√					
	Storm Protection	√					
	Maintenance of surface water stores	√		√			
	Groundwater Replenishment		√	√			
	Crop Pest Regulation	√					
	Human Disease Regulation						
	Shore Stabilization			√			
	Sediment Trap	√					
Cultural Services	Paleo-environmental Records						
	Archaeological Preservation						
	Recreation and Ecotourism						
	Physical health and well being						
	Spiritual and religious values						

3. Areas of Future Research

In this literature review, an attempt has been made to link ecosystem services and poverty primarily based on publications between 1997 and 2007 within the Bangladeshi context. Considering this linkage is not made explicitly in most cases, it suggests that a greater emphasis needs to be placed on understanding not only how the two concepts link, but also how the various definitions and dimensions of poverty connect to the various components of an ecosystem in a much more direct manner. Table 2 suggests that there is also room for research to examine how ecosystem services and goods link human needs as indicated by the gray cells.

Using a basic bibliometric approach Table 3 below demonstrates additional research gaps with regards to understanding direct or natural drivers of change that affect ecosystem services and poverty.

Table 3: Articles Relating to Direct / Natural Ecosystem Drivers

Direct / Natural Driver	Ecosystem	Author	Total Number of Publications
Local land use and cover and harvest and resource consumption (i.e. shrimp, NTFP, timber, agricultural products)	(a) Mangrove Swamps	Ali (2006), Billah (2003), Hoq (2007), Islam ed. (2004)	4
	(b) Upland and Lowland Forests	Adnan 2004, Gain (2002), Iftekhar and Hoque (2005), Islam and Weil (2000), Rasul and Thapa (2006), Rasul et al. (2004), Salem et al. (1999), Thapa and Rasul (2006)	8
Species introduction or removal	(a) Mangrove Swamps	Ali (2006)	1
	(b) Upland and Lowland Forests	Gain (2002)	1
Technology adaptation and use (i.e. Green Revolution)	Rivers	Alauddin and Quiggin (2007), Baffes and Gautum (2001), Dasmann (1988), Garcia and Altieri (2005), Hofer and Messerli (2006), Niazi (2003), Hossain (unpublished), Peterson (1987), Prescott-Allen (2001), Rahman (1995, b), Rahman (2003, c), Rahman and Parkinson (2007), Rasul and Thapa (2004)	13
External inputs (i.e. development projects, industries)	(a) Mangrove Swamps	Billah (2003), Islam ed. (2004)	2
	(b) Rivers	Choudhury et al. (2004), Islam ed. (2004), Rahman (1995,a), Rahman and Hassan eds. (2006), Zahid and Ahmed (2006)	5
	(c) Wetlands	USAID (2007)	1
	(c) Upland and Lowland Forests	Adnan 2004, Gain (2002)	2
Natural, physical, or biological (i.e. cyclones, floods)	(a) Mangrove Swamps	Chowdhury (2007), Manik and Khan (2007)	2
	(b) Rivers	Few (2003), Hutton and Haque (2004), Kunii et al. (2002) , Ninno et al. (2001), Rahman and Hassan eds. (2006)	5

Table 4 shows that major gaps exist on examining the introduction of species. This is based on the fact that only one publication has been cited on mangrove swamps, and one publication on upland and lowland forest ecosystems in this situational analysis review. Other areas where greater attention should be paid are external inputs (particularly in mangrove swamp areas) and impact of natural drivers on mangrove swamps. Table 4 below demonstrates gaps in research with regards to indirect or social drivers of change.

Table 4: Articles Relating to Indirect / Social Ecosystem Drivers

Indirect / Social	Ecosystem	Author	Number of Publications
Demographic	(a) Upland and Lowland Forests	Iftekhar and Hoque (2005)	1
	(b) Mangrove Swamps	Ali (2006), Billah (2003), Islam ed. (2004)	3
Economic (general)		Billah (2003), Crow and Sultana (2002), Hoq (2007), Islam ed. (2004), Karim et al. (2004)	5
Socio-political	Wetlands	Islam et al. (2000)	1
Science and technology			0
Cultural / Religious			0

Table 5 shows that there are gaps in understanding indirect or social drivers in many cases. No publications were cited on cultural/religious and indirect science and technology drivers, and only 1 publication was cited under socio-political drivers. These are areas that deserve greater attention. Table 5 also reveals that great emphasis should be placed on understand upland and lowland forests ecosystems in relation to how demographic changes affects ecosystem services and human well-being considering only one article has been cited.

The ESPASSA workshop also identified several areas for future research, which are listed below in Table 5.

Table 5: Additional Knowledge Gaps

Ecosystem	Knowledge Gaps
Mangrove Swamps	Statistics about forest area and ecological accounting cannot be agreed upon. The type of statistics that should be used needs to be examined.
Agro-ecosystems	The potentials of using hydroponics to reduce impact on land for food production
	Potentials of crop diversification to enhance food security
	Impact of changing socio-economic conditions of marginal farmers who own 10 decimals of land and their natural resources over time its impact on the supply of food and how they indirectly affect poor people through prices
	Impact of rising prices on the supply of food and how they indirectly affect poor people
	How farmers' rights, and genetically modified organisms may reduce poverty.
Upland and Lowland Forests	The question of whether destruction of natural forests to implement social forestry and plantations (of foreign species) for larger production will alleviate poverty should be examined. It should also be investigated if natural forests provide greater ecosystem services compared to social forestry.
	There is a need to assess the political economy of Chittagong Hill Tracts
In General	Need scientific understanding of various ecosystem services, particularly focusing on changes in chemical composition, sediment loads, and microclimate information to know what should be conserved and used for poverty alleviation.
	Research is required on the political economy of natural resources to understand markets and potential for employment generation
	Impact of biofeuls on food prices and poverty as well as the state of energy reserves in relation to poverty alleviation.

In addition to research gaps identified based in Tables 4, 5, and 6, there are additional research gaps that should be emphasized. For instance, most of the literature reviewed depicts a doomsday scenario where ecosystem degradation not only leads to poverty, but that the poor are trapped in a vicious cycle where they degrade the ecosystem services they depend upon because of the lack of alternatives. In general, the literature reviewed suggests that due to human activities, the carrying capacity of ecosystems is lost. This scenario is, however, too simplistic. The literature reviewed does not address issues of ecosystem resilience whereby certain ecosystems have the ability to regenerate. Placing an emphasis on understanding ecological resilience may help fill the gap on species introduction and removal. The doomsday

scenario that the literature review depicts also suggests that people are incapable and powerless in terms of protecting the ecosystem services they depend upon. Therefore, research needs to be conducted that addresses how poor communities have developed (indigenous) mechanisms to protect ecosystem services and minimize risk and vulnerability when ecosystem services change. Although literature on *dhap* or hydroponics and flooding examine indigenous mechanisms (Hofer and Messerli 2006; Islam and Atkins 2007; Islam et al. 2000), no direct connection is made between protecting ecosystem services and poverty alleviation, and therefore, there is room for research in this area. Attempts should also be made to understand community-based institutions and governance to examine both cultural and socio-political aspects that can help protect ecosystems. Such work has only just begun in Tanguar Haor (Kabir and Amin 2007) and Hail Haor (USAID 2007). Understanding natural and human resilience offers positive stories that can be learned and possibly applied as policy solutions.

Attempts should also be made to further understand the relationship between actors and the politics of power between them that influences the types of social drivers that alter peoples' well-being. Although the example of the Khyang demonstrated changes in property rights and hinted at the power dynamics, between ethnic minorities and government officials (Gain 2002; Rahman and Hassen 2006), there is no in-depth analysis on social relationships and governance over ecosystem services that could explain why some social drivers have a bigger impact than others. Furthermore, the role of women and gender relationships are largely unexplored. Although women are mentioned with regards to their subsistence and commercial activities in forests and mangrove swamps (Karim et al 2006), how gender, power, and property rights relate to one another are not examined by any of the literature in any depth except for Crow and Sultana's work (2002) to understand how ecosystem services are managed between men and women to reduce poverty. Filling these gaps would shed light on social well-being, which includes social cohesion, mutual respect, and ability to help others. Conducting such research will help assess the extent to which politics of power keep some people in poverty and alleviate poverty for others.

With regards to methodology, one that has been under-used in Bangladesh is environmental accounting or valuation. Although it is difficult to place value onto ecosystems because of the problems of defining and valuing ecosystem goods and services, placing monetary value on ecosystem services and the effects of human activity on the ability of the ecosystem to provide services, is one way to monetarily understand the relationship between ecosystem services and poverty. Valuation of ecosystem services in Bangladesh has hardly been conducted except for a few cases. In addition to Billah's work, the economic value of some haors has been estimated. For instance, Hakaluki *haor*, which is one of the largest wetlands in Bangladesh, provides ecosystem services to 190,000 people. Using bio-economic models, it has been estimated that the economic value of Hakaluki Haor is Tk 585.75 per year (IUCN 2006). Similarly, USAID (2007) has also estimated the economic value of Hail Haor, which amounts to Tk 36,990/area and Tk 454,924,600 in total returns. Although it is difficult to place an economic value on ecosystem services because they are complex public goods, valuation helps policy makers to make decisions with regards to ecosystem management (Duraiappah 2006). Therefore, attempts should be made to not only gather scientific data, but also translate it into helpful economic models so that planners are able to better control the impact of development activities. This is especially important since development activities are the most significant drivers of change as this situational analysis has demonstrated.

Last but not least, efforts need to be made to conduct research on policies made by governments, donor agencies, and other influential actors. Most ecosystem service degradation

and impacts on human well-being have taken place due to non-existing or poor policy implementation that have failed to protect ecosystems and people who depend upon them. Understanding policy gaps through researching policies will help to not only identify areas where policies need to be made, but also where they need to be rectified. Work in this aspect has begun to take place in Bangladeshi. For instance, Islam and Khan (2007) have used remote sensing and policy analysis to highlight discrepancies in government policies regarding forests in lowland forests. Their work suggests that faulty policies are the major cause of deforestation in Bangladesh. If similar approach is used to analyze policies in relation to mangrove swamps, rivers, wetlands, agro-ecosystems, and upland and lowland forests, it would minimize mismanagement of provision and regulating ecosystem services, which have direct links to human well-being as this situational analysis has demonstrated.

Ecosystems, ecosystems services and the linkage to poverty with reference to Bhutan

Introduction to Bhutan:

Bhutan lies amongst the most rugged mountain terrains in the world, as most of the country is situated on the Himalayan ranges. The land rises from an elevation of about 160 m in the south to more than 7,000 meters above sea level in the north; hence the variations in climate are correspondingly extreme too. Southern Bhutan is generally hot and humid, while the northern parts of Bhutan in the high Himalayas are under perpetual snow. The climate is dominated by the monsoon with a dry winter season and high precipitation during June-September. Rainfall, in particular, can differ within relatively short distances due to rain shadow effects. Influenced by topography, elevation and rainfall pattern, Bhutan has a wide variety of climatic conditions between valleys and within valleys depending on altitude and consequently a wide diversity in vegetation and farming systems. High rainfall, steep slopes, and poor parent material are characteristics for the agricultural soils of Bhutan and thus soil fertility is a major constraint.

Gross National Happiness (GNH) is the major driving force for the country's development. It states that development should not be pursued only on the basis of economic growth but also encompass emotional and spiritual well being of the people is the basis for Bhutan's development. Thus maintenance of cultural heritage as well as the conservation of the environment is key to the achievement of this goal.

A few key points on development in Bhutan:

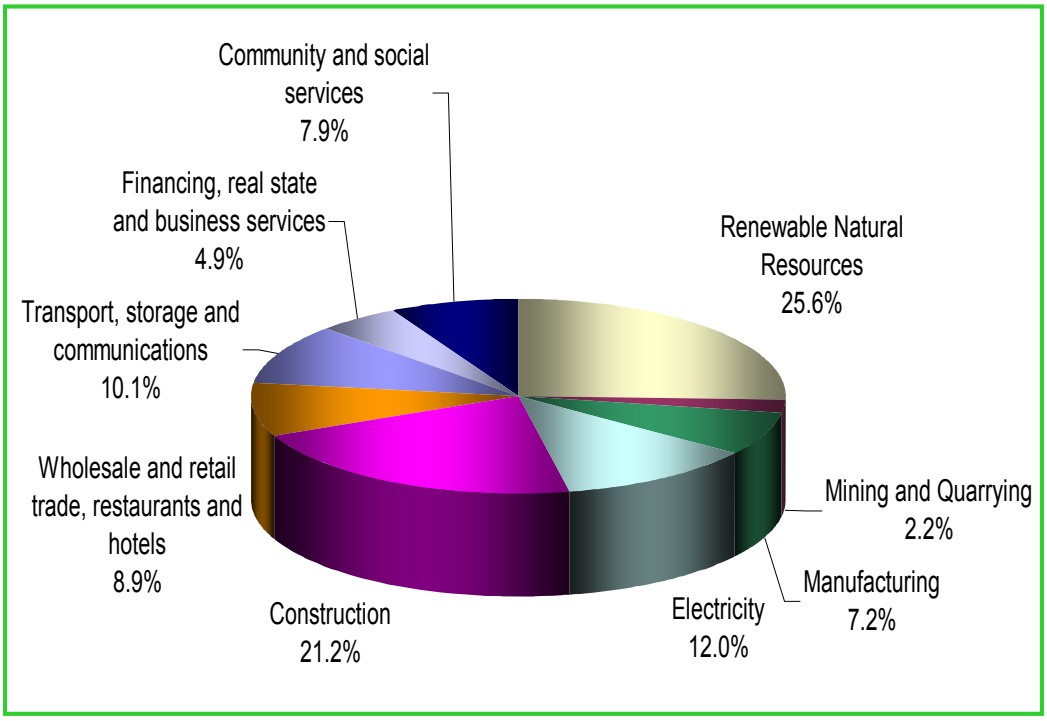
The Population Census conducted in 2005 reported the country's population at 634,982 with a growth rate of 1.3%. Urban population is rapidly increasing as a product of development with all the features representative of a growing economy. Economic growth is largely stable and the main drivers of the economic growth are Renewable Natural Resources (RNR), Hydropower and tourism.

Approximately 70 percent of the population resides in rural areas with agriculture as the main source of income. Agriculture therefore is the main economy, contributing to 24.7% of the GDP (Statistical Yearbook of Bhutan, 2005).

Hydropower is a top revenue earning sector, driving growth, with electricity generation exports in 2005 of 16233.66 MU.(statistical yearbook 2006) With the commissioning of the mega power projects like Tala hydropower project, along side existing power projects like chukha and kurichu, the power generation of the country will keep steadily increasing.

Tourism more than doubled in the last decade with earnings increasing from USD 5.8 m. to USD18.5m. It is one of the primary earners of foreign exchange. Tourism is based on the principle of low impact high value. Bhutan's healthy ecosystems with it's conservation of its natural heritage and environment are a vital draw for tourist arrivals.

Bhutan's industrial development is still in infancy with most license holders being of cottage industries and small and medium size establishments. Large scale industries are constrained by the terrain and lack of manpower.



Source: Annual Report, Royal Monetary Authority of Bhutan, 2006

Ecosystems and ecosystem services in Bhutan

A brief study into the various facets of ecosystems services with relevance to Bhutan.

1. Land/forest ecosystems:

Paradox of Land abundance and land scarcity:

According to the RNR Statistics 2000, out of the total land area of 40,076 square km, only 311,098 ha or 7.8 % is agricultural land.[4] The area suitable for agricultural production is limited by the steep and rugged terrain, altitude, and the high priority given to maintaining forest cover. Dry land accounts for the largest area of agricultural land, followed by *tseri*/*pangshing* or shifting cultivation. C*hhuzhing* or wet land, used primarily for rice cultivation, accounts for around one percent of total land cover and orchards account for less than one percent. Almost four percent of the country is used for *tsamdrok* or pasture.

Forestry laws stipulate that farmlands left fallow for over 12 years or with a significant growth of trees are to be reverted back to forest and hence pass under government jurisdiction. Around 80% of the agricultural land lost was used for shifting cultivation. This reduces the amount of agricultural land available for cultivation of food crops and undermines sustainability of farming systems on fragile lands since with the fear of losing control over their lands, farmers reduce

fallow periods. In addition, despite laws restricting land conversion or changes in the use of farm lands, especially with respect to new constructions on farm lands, farm land is being lost to urban development. With the gradual inclusion of areas around towns under the urban category, farm lands around urban areas are being constructed on. Governmental preference for flat lands has inevitably led to the acquisition of prime wetlands for urban development. Between 1996 and 2001 about 630 acres of wetland were lost to non-agricultural development activities such as town planning, roads and other facilities (FAO, 2005).

The density of population in Bhutan is low considering the entire territory (16 hab/km2- NEC) but very high when we consider the land that is suitable for development; if we take the cultivated area as a proxy for the latter then density jumps to 470 hab/km2, which is much higher than India (328) and in the Netherlands (395).

Little less than 40,000 ha of land have access to some form of irrigation, i.e. 98% spring or river diversion 2 % pumping; for 94 % they are small schemes and for 6% large (for Bhutanese standards).

Agricultural production: key crops are rice, cereals, roots and fruits. Fruits for export include mainly apple and mandarin.

Environmental sustainability of this sector

Environmental sustainability is a key to Gross National Happiness and longer-term food security.

Although rural-urban migration has helped to alleviate land pressure in rural areas to some extent, population pressure has also led to fragmentation of land holdings and an increase in the number of economically marginal farms.[5]

A preliminary assessment made by the MoA in 1998 indicated that there is potential to increase agricultural land by 78,432 ha or 2 % of the total land area if forested and other areas with slopes less than 50 % and altitude below 3200 meters above sea level is considered. Policy and legislative reforms are required so as to ensure that sufficient land is available to meet food production targets. In addition, existing laws that forbid the conversion of agricultural land to non-agricultural uses needs to be enforced.

Livestock /forests/mining

Cattle are owned by 90% of households of the country. Cattle dominate the temperate and sub tropical region. In the northern colder regions yaks are the livestock of the community. Livestock provides butter, cheese, meat, manure and power for the farmer and has contributed to 21% of the agricultural GDP in 1996. Grazing is usually done in forests and traditional grazing lands, but overgrazing is becoming a growing concern.
Forest cover is estimated at 72.2 % including scrub forest with a large percentage of the forested area being broadleafed and conifer. Demand for wood is very high at over 700000 m3 demand per year while harvesting is less than 300000 m3 per year. Bhutan is one of the highest per capita users of fuelwood and demand is driven by both this consumption and the booming construction occurring in the country. The gap is accentuated given that the government is committed to 60% forest cover as a matter of national policy.

[5] *Renewable Natural Resources Ninth Five-Year Plan*

Land degradation is a concern in challenging terrain of Bhutan with over 32000 ha degraded and over 95000 ha affected by landslides and soil erosion.
Mining is still small scale and limited to a few areas with approximately 600 ha being mined.

Pressures in the sector

The agricultural sector faces constraints primarily due to the nature of the terrain. Farm Labour shortage, both skills and workers are in short supply or too much competing with mandatory free-labour contributions are also factors that contribute to the difficulties in this sector. Land for the agricultural sector cannot be increased easily as access to forest limited or forbidden. Tsheri (shifting cultivation) has been banned Bhutan's success at maintaining it's forests also means that wildlife are in abundance in near proximity to human habitation and thus wild animals generate crop and cattle damages. Local markets are limited and transport of goods is very costly (time, money). Conversion of wet land/forests to other land use types mainly for development

Forest fires 400 annually affecting 35000+ha from 1995 to 2005 and degradation of land also affects the viability of some forested areas. Illegal logging is also a problem in some areas. Livestock are increasingly under pressure due to regulations on land and grazing as well as the expansion of urban settings. The expansion of mining industries etc. is hampered by a lack of data vis-s-vis geological mapping as only a relatively small percentage of the country has been surveyed.

Response

Bhutan has witnessed a steady growth rate of 6 percent per annum since the mid 1980s, resulting in the enhancement of the per capita income. Nevertheless, Bhutan remains a Least Developed Country with a large number of people living on less than a dollar a day primarily in rural areas. The government has also formulated a policy to modernize the agriculture sector including implementation of various donor supported projects and programs in different regions of the country. Research on crop varieties, extension and manpower development programs in various fields such as horticulture, potatoes and market infrastructure development are making a positive impact on the farming systems.

The government is promoting the production of cash crops that has seasonal advantage over other crops in the neighboring countries. The RNR policy is geared towards transforming the agriculture sector from subsistence farming to a market oriented commercial farming

Efforts are also being made to in the forest sector with reafforestation improving degraded areas and the establishment of Community forests and Private Forest to help management of forested areas. Forest Management Units also involve the community to ensure that stakeholders have participation in the management of resources.

RNR branches of the government also reach out to farming communities with research and development as well as implementation of innovative techniques and much needed know how. Sustainable land management projects contribute to the sustainability of this sector.

2. Water

Water abundance and water scarcity: Bhutan is endowed with high rainfall and water resources per capita are among the highest in the world, however the physical access to permanent water is limited and sometimes impossible, creating water scarcity pockets during most time of the dry period from October till May. Due to the topography, the options for storage, diversion and channeling infrastructure are constrained. This situation is not a peculiarity of Bhutan but common to the Hindu Kush Himalayas as identified by ICIMOD: "Scarcity amidst Plenty: the looming Water Crisis in the Mountains".

Bhutan is blessed with rich water resources of good quality. Water related deaths are still low – only 44 related deaths in 2005 (NEC). Per capita mean annual flow availability is 109000 m3. Consumption demand 420 m3 and demand for hydropower 6700 million m3.

Hydropower is engine of development being the highest revenue earner for the country and there are four power generating projects at present – Chukha Hydropower Corporation, Kurichu Hydropower Corporation, Basochu Hydropower Corporation, and Tala Hydroelectric Project Authority.

Pressures

Glacial Lake Outburst Floods are a grave threat to the sustainability of the hydropower sector. There are 24 potentially dangerous glacial lakes and Bhutan has suffered 3 outbursts in last 50 years. Global warming and glacial retreats are impacting the economic use of the water resources.

While Bhutan does have abundant water supplies there are local shortages due to population growth. Other factors contributing to this short supply are the difficult terrain, constrained water tapping, poor maintenance of water storage and distribution.

Dependence on rains for cultivation and lack of irrigation facilities are also constraints that could have a huge negative impact on the agricultural sector.

Response

The resources in the water sector do exist and thus management of the resources is key to the effective use of the resource. The government is making efforts via improved access and sanitation. Regulation of chemical discharge and Sewage management in cities is becoming of importance as Bhutan undertakes economic development with all its resultant growth trends.
Monitoring glacial lakes and Maintenance of natural habitat will contribute to the sustainability of the use of water resources. However, as with all natural factors the efforts Bhutan makes can be impacted by the transboundary nature of the environment.

3. Air

State and pressures

With development Bhutan has seen an immense rise in the use and ownership of vehicles with vehicle population growing at 9% from 2000 to 2005. (NEC). The Green House Gas Inventory in 2000 estimated that approximately 19% of the total CO2 emissions came from road transport.

Industries contributed 58% of emissions. 12% of emissions came from domestic use. Domestic use of fuelwood is for lighting, cooking and heating. Bhutan has one of the highest per capita uses of wood in the world at 1.27 tons per annum. Population growth along with growing urbanization is also placing pressure on the air environment. Forest fires which are both caused by human action and helped along by the changes to the environment also affect the atmosphere. While ambient air monitoring has shown that the particulate matter present is not high there were over a million hospital referrals for respiratory disease in 2003-5.

Response

The government has been actively encouraging the use of clean technology such as electricity from hydropower and solar power. Rural electrification is planned and being carried out extensively. Tax free import of clean energy cooking implements is allowed.
In addition vehicular emissions are monitored with the enforcement of emission standards. Transboundary air pollution is starting to be monitored.

4. **Biodiversity**

Bhutan has been designated as a biological hot spot and is known for the richness of its natural environment which has been protected by government policy and enlightened leadership. Bhutan has recorded vascular plants numbering 5603, 616 birds, 198 mammals. From these recorded species globally threatened species found in the country are 14 bird and 26 mammals. Protected areas are over 28.3% of total area.
Total planned protection area: 4 national parks, 4 wildlife sanctuaries and 1 strict nature reserve. 7 of these protected areas are operational as of now.

Pressures

Illicit harvesting of forests for timber and fuelwood threaten the richness of the forest system and the biodiversity habitat within the systems. Poaching in border areas and interiors also threaten the survival of some species especially endangered species. The maintenance of the sanctity of protected areas also depends on the support of the community which is threatened by the negative aspects of human wildlife contact especially for neighboring farm areas. Human wildlife conflict is a prevalent concern among farmers bordering protected areas- e.g damage by wild boars over 100m ngultrums.

Overgrazing causes pressure to the forest systems and affects the sustainability of the areas. Population pressure also leads to the encroachment of forest and protected areas.

Response

Agrobiodiversity conservation programs e.g gene bank which ensures some measure of protection to the biodiversity of Bhutan. Establishment of protected areas also ensures that the habitat of species is maintained. Awareness efforts along with compensation packages to affected farmers leads to greater co-operation of the communities living in or near the protected areas. Efforts are also being made to develop more sustainable methods of grazing.

Population and Poverty: The growing urban ecosystem
Poverty and population

Population density is 16 per km^2 when considering total land area but increases to 200 per km2 when considering only arable/land with human settlements and jumps to 470 when considering arable land only.

Bhutan's population is representative of a developing economy with a skewed population distribution with 45% of population under 20. Urban population is 31%. This is concentrated in two major towns and 3 smaller towns. (major -20,000 -70000+ i.e. thimphu and phuntsholing, Minor 5000-10000) 40% of the urban population resides in thimphu alone. One effect is growing impact on environment for e.g. Solid waste generation under 50MT a day in larger towns and the urban managers are starting to have great difficulty managing the solid waste being generated.

Poverty is also something of a new concept in Bhutan. Previously there was little research on this field as abject poverty was thought not to exist. There is also no specific agency committed to tackle this issue separately as development issues were driven to improve the lives of the least fortunate. However, with growing awareness of the current pace of development as well as considering other countries practices of analyzing/measuring poverty efforts have been made to define and research poverty in Bhutan.

The National Statistical Bureau has defined the food poverty line at Nu. 403.79 per capita per month and the overall poverty line (non food allowance) at Nu. 740.36 per capita per month. 31.7% of the population is under this overall poverty line. (Poverty Analysis report 2004 –NSB)

Pressures

The Urban population grew by is increasing at a rapid pace - 21% in the 2002-2007time period. This can be attributed not only to the population growth but also the growing trend of rural urban migration. So while 97% of poor still reside in rural areas, population trends are placing a greater stress on the urban environment mainly due to lack of infrastructure and space. Urban poor face the pressures of lack of /limited living space, lack of skills and job security.
The rural poor are hampered by their lack of access to the market, limited agrarian land, lack of irrigation, dependence on rains and threatened food security.

Response

Shifting from basic food production to cash crops provides farmers with monetary alternatives. Low interest schemes as well as improved methods of cultivation improve the aspects of a farmer. The government has also successfully regulated the harvesting of high value cash crops like cordyceps to benefit only the marginalized farmer. In this particular scheme the government both regulates the harvesting as well as the marketing of the product ensuring thus the sustainability of production: as well as assuring the farmer of competitive market prices.
The development of low cost housing as well as improving job skills among the disadvantaged are a few methods used to alleviate the pressures faced by the urban poor. The adoption of employment rules also protects the interests of the disadvantaged. However, like any developing country these responses are blunted by the corresponding growth in the pressures.

Regional variations and changes over time. Data issues.

Given that research development in Bhutan is still a recent phenomenon time series data is very poor. The wide range of natural systems along with the difficult terrain makes for challenging research. Comparative studies and research can only be taken along limited lines. Data management in Bhutan is not very efficient and baseline data is often missing or incomplete.

Transboundary concerns

No man is an island and though Bhutan strives to be environmentally sound we are affected by the environmental actions of the rest of the world. Climate change will have adverse impacts on Bhutan's goal of sustainable development in the form of agricultural production declines as well effects on our natural resources. The GHG inventory has shown that Bhutan's emissions were relatively small. However, Bhutan is still subject to the impact of climate change as can be witnessed in the GLOF. In 1994 a GLOF in Lunana (northern highland) seriously damaged the lower valleys in Punakha. In recent years too there have been signs of unusual changes in climate. A rare dry spell with no snowfall was experienced in 1998 winter and this lead to higher incidences of forests fires. There was a freak snowfall in july 1999 in north Bhutan and Flash floods have also claimed lives in 2000. Heavy rains also affect water supplies which are struggling to meet demand especially in urban settings.

Possible Difficulties

Climate change could adversely affect the fragile mountain ecosystems badly affecting biodiversity with the possible extinction of some species. Warming will also affect low income rural farmers dependant on traditional practices most adversely. Cropping practices and production if unable to adapt could be threatened. An increase in rain patterns increases soil erosion increases the threat of flooding/landslides and affects sustainable water management. Increased rains and siltation also affects the hydropower industry and economy. GLOF affect both the hydropower industry and life and livelihood downstream .

Responses

To mitigate the possible effects of climate change and transboundary issues Bhutan continues to follow in the path of sustainable development while supporting international measures aimed at conserving our natural environment. Regular glacial monitoring is being undertaken. Community awareness and involvement is being encouraged. Proper land use planning and water use planning is being undertaken.

Country level policy making and ecosystems

Governance structure
The constitutional head is His Majesty. There are the three branches of government- executive, legislative and judiciary.
The Executive has10 ministries are headed by the ten ministers who comprise the cabinet headed by the prime minister. The country is divided into 20 districts with the chief administrator being the governor (dzongda). The district is sub divided into smaller blocks (geogs) headed by the gup. At the block level the geog yargye tshogchung (committee) deliberates on matters and at the district level the dzongkhag yargye tshochung is the assisting committee to the governor. Both committees consist of people's representatives and government officials. Planning and implementation is inclusive of the people especially with the 10^{th} five year plan.

The first Five Year Plan for the country started in 1961 and is now entering the 10th Five Year Plan period. However, with the decentralization policy of the country the planning follows a bottom up approach. Geog or sub-district plans are prepared by the Gups or the geog administrator (elected post) and discussed at the Geog Yargey Tshogchung. All geog plans are submitted to the district level for the second stage and then finally to the line ministries. The line ministries put it together to be submitted to the Planning Commission who in turn compiles it at the national level for implementation. However, with regards to any development activities that require environmental clearance then the process has to go to the NEC after the plan has been approved. An Environmental clearance is required before implementation begins.

The face of the government in Bhutan is set to change with the country's move towards 'democracy', but it is widely anticipated that the country will continue to hold true to the development philosophy of GNH as set forward by the 4th King.

The ultimate goal of Bhutan's development policy is towards achieving Gross National Happiness (GNH). This unique development philosophy has several aspects to it, including the four main pillars:

- Socio-economic development
- Good Governance
- Environmental Conservation
- Preservation of culture and tradition

Bhutan has cautiously followed the "middle path" balancing economic development with environmental conservation. Bhutan continues to pursue a holistic development approach placing people at the center of development to ensure all plans; programs and economic reforms create an enabling environment to the people to achieve economic prosperity and happiness.

Agriculture Development Policy

Within the broad framework of the national development strategy, the specific policy objectives are:

- The sustainable development of arable agriculture, animal husbandry and forestry.
- Improvement of income, living and nutritional standards of the rural population.
- Environmental conservation, emphasizing an integrated crop/livestock/forestry system's development.
- To intensify the integrated approach towards achieving at least 70% self-sufficiency in food grains.
- To maintain at least 60% of the country's area under forest cover.
- To develop and promote high value low volume cash crops that offer comparative advantages over other crops.

Major available studies and their nature

Middle path – the path to sustainable development
Bhutan 2020- the vison for the development of Bhutan.
Initial National Communication under the United Nations Framework Convention on Climate Change.
Statistical hand book for Bhutan 2006
State of the environment 2001
Poverty Analysis report 2004

References

Adnan, S. (2004) *Migration, Land Alienation, and Ethnic Conflict: Causes of Poverty in the Chittagong Hill Tracts of Bangladesh*. Dhaka: Research & Advisory Services.

Alauddin, M. and J. Quiggin (2007) 'Agricultural intensification, irrigation and the environment in South Asia: Issues and policy options' in *Ecological Economics*, doi:10.1016/j.ecolecon.2007.06.004

Ali, A.M.S. (2006) 'Rice to Shrimp: Land use/land cover changes and soil degradation in Southwestern Bangladesh' in *Land Use Policy* 23: 421-435.

Baffes, J., M. Gautam (2001) 'Assessing the sustainability of rice production growth in Bangladesh' in *Food Policy* 26: 515–542.

Bangladesh Bureau of Statistics (2005) *Compendium of Environment Statistics of Bangladesh*. Dhaka: BBS.

Bangladesh Rural Advancement Committee (2008) Ecosystem Services and Poverty Alleviation Study in South Asia Bangladesh Workshop Report. Unpublished.

Billah, A.H.M.M (2003) *Green Accounting: Tropical Experience*. Dhaka: Palok Publishers.

Brouwer, R., S. Aftab, and L. Brander (2006). Socio-economic vulnerability and adaptation to environmental risk: A case study of climate change and flooding in Bangladesh. *PREM Working Paper* 06/01.

Choudhury, N.Y., A. Paul, and B.K. Paul (2004) 'Impact of coastal embankment on the flash flood in Bangladesh: a case study' in *Applied Geography* 24: 241-258.

Chowdhury, S.A. (2007) 'Shrimp sector faces Tk 250 cr loss' in *The Daily Star*, 23 November 2007, 17 (305).

Chowdhury, Q. I., M. Haque, and S.I. Chowdhury (2001) Overview of an Amazing Ecosystem in Q.I. Chowdhury (ed) *State of Sundarbans. Dhaka*: Forum of Environmental Journalists of Bangladesh.

Crow, B. and F. Sultana (2002) 'Gender, Class, and Access to Water: Three Cases in a Poor and Crowded Delta' in *Society & Natural Resources* 15 (8): 709-724.

Dasgupta, P. (2007) 'Nature and the Economy' in *Journal of Applied Ecology* 44: 475-487.

Dasmann, R. F. (1988) 'Towards a biosphere consciousness' in D.Worster (ed.) *The ends of the earth: Perspectives on modern environmental history*. Cambridge: Cambridge University Press.

Duraiappah, A.K. (2006) *Markets for Ecosystem Services: A Potential Tool for Multilateral Environmental Agreements*. Winniepeg: International Institute for Sustainable Development. Available from: http://www.iisd.org

Few, R. (2003) 'Flooding, vulnerability and coping strategies: local responses to a global threat' in *Progress in Development Studies* 3 (1): 43-58.

Gain, P. (2002) *The Last Frontier of Bangladesh*. Dhaka: Society for Environment and Human Development.

Garcia, M.A., and M.A. Altieri (2005) 'Transgenic Crops: Implications for Biodiversity and Sustainable Agriculture' in *Bulletin of Science Technology Society* 25: 335.

Government of Bangladesh (1995) *Flood Action Plan.* Dhaka: Government of Bangladesh.

Hofer, T. and B. Messerli (2006) *Floods in Bangladesh: History, Dynamics and Rethinking the Role of the Himalayas*. Tokyo: United Nations University Press.

Hoq, M.E. (2007) 'Analysis of fisheries exploitation and management practices in the Sundarbans mangrove ecosystem, Bangladesh' in *Ocean and Coastal Management* 50: 411-427.

Hossain, M. Unpublished work on the impact of Green Revolution in Bangladesh.

Hutton, D. and C.E. Haque (2004) 'Human Vulnerability, Dislocation, and Human Settlement: Adaptation Process of River-bank Erosion Erosion-induced Displacees in Bangladesh' in *Disasters* 28 (1): 41-62.

Iftekhar, M.S. and A.K.F. Hoque (2005) 'Causes of forest encroachment: An analysis of Bangladesh' in *GeoJournal* 62: 95-106.

Islam, K.R. and R. R. Weil (2000) 'Land Use Effects on Soil Quality in Tropical Forest Ecosystems of Bangladesh' in *Agriculture Ecosystems & Environment* 79: 9-16.

Islam, M.R. (ed) (2004,a) *Where Land Meets the Sea: A Profile of Coastal Zone of Bangladesh*. Dhaka: The University Press Limited.

Islam, S. T., S.D. Shamsuddin, and F. Jamal (1999-2000) 'The Common Property Resources of Bangladesh: Its Use, Abuse and Potentials' in *The Jahangirnagar Review* 23-24: 77-95.

Islam, S. T. (2007, b) 'Deforestation in Bangladesh' in *Geography Review* 20 (4): 2-5.

Islam, T. and P. Atkins (2007) 'Indigenous floating cultivation: a sustainable agricultural practice in the wetlands of Bangladesh' in *Development in Practice* 17 (1): 130-136.

Kabir, M. H. and S. M. N. and Amin (2007) *Tanguar Haor: A Diversified Freshwater Wetland*. Dhaka: Academic Press and Publishers Library.

Karim, M., M. Ahmed, R.K. Talukder, M.A. Taslim, and H.Z. Rahman (2006) Policy Working Paper:
Dynamic Agribusiness-focused Aquaculture for Poverty Reduction and Economic Growth in Bangladesh. *WorldFish Center Discussion Series No. 1.*

Karim, M.R. (2006) 'Brackish-Water Shrimp Cultivation Threatens Permanent Damage to Coastal Agriculture in Bangladesh' in C.T. Hoanh, T.P. Tuong, J.W. Gowing and B. Hardy (eds.) *Environment and Livelihoods in Tropical Coastal Zones.* Available from: http://www.iwmi.cgiar.org

Kunii, O., S. Nakamura, R. Abdur, and S. Wakai (2002) 'The impact on health and risk factors of the diarrhea epidemics in the 1998 Bangladesh floods' in *Public Health* 116: 68-74.

Manik, J. A. and S. Khan (2007) 'Big blow to the Sundarbans' in *The Daily Star*, 20 November 2007, 17 (302).

Millennium Ecosystem Assessment (2005) *Ecosystem and Human Well-Being Synthesis*. Island Press: Washington, DC.

Niazi, T. (2003) 'Land Tenure, Land Use, and Land Degradation: A Case for Sustainable Development in Pakistan' in *The Journal of Environment and Development* 12(3): 275-294.

Nishat, A., S.M. Huq, B. Imamul., P. Shuvashish, A.A.H.M Reza, and M.A.S. Khan (eds.) (2002) *Bio-ecological Zones of Bangladesh*. IUCN Bangladesh Country Office. Dhaka, Bangladesh.

Ninno, C, P.A. Dorosh, L.C. Smith, D.K. Roy (2001) The 1998 Floods in Bangladesh: Disaster Impacts, Household Coping Strategies, and Response. *International Food Policy Research Institute Research Report 122*. Washington, DC: IFPRI.

Overseas Development Institute (2006). *Sourcebook for the Environment*. London:ODI.

Peterson, W. (1987) International Land Quality Indexes, Staff Paper P87-10. Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, Minnesota.

Prescott-Allen, R. (2001) *The Wellbeing of Nations: A Country-by- Country of Index of Quality of Life and the Environment*. Island Press, Washington, D.C.

Rahman, A. (1995,a) *Beel Dakatia: The Environmental Consequences of a Development Disaster*. Dhaka: University Press Limited.

Rahman, A. and M. Hassan (eds.) (2006) *People's Report 2004-2005 Bangladesh Environment*. Dhaka: Unnayan Shamannay.

Rahman, A. and D. Mallick (2007) 'Poverty Reduction and Natural Resources Conservation Linkages: Access of the Poor to Natural Resources - Constraints, Potentials and Possibilities in Bangladesh', Keynote Paper at The Workshop on Sustainable Natural Resources Management (unpublished). Dhaka, April 2007.

Rahman, H.Z. (1995, b) Ecological Reserves and Expenditure-Saving Scope for the Poor in H.Z. Rahman and M. Hossain (eds) *Rethinking Rural Poverty: Bangladesh as a Case Study*. New Delhi: Sage Publications India Pvt Ltd.

Rahman, Z. and R.J. Parkinson (2007) Productivity and soil fertility relationships in rice production systems in Bangladesh' in *Agricultural Systems* 92: 318-333.

Rahman, Z. (2003, c) 'Profit efficiency among Bangladeshi rice farmers' in *Food Policy* 28: 487-503.

Rasul, G. and G.B. Thapa (2004) 'Sustainability of ecological and conventional agricultural systems in Bangladesh: an assessment based on environmental, economic and social perspectives' in *Agricultural Systems* 79: 327-351.

Rasul, G. and G.B. Thapa (2006) 'Financial and economic suitability of agroforestry as an alternative to shifting cultivation: The case of the Chittagong Hill Tracks, Bangladesh' in *Agricultural Systems* 91: 29-50.

Rasul, G., G.B. Thapa, and M.A. Zoebisch (2004) 'Determinants of land use changes in the Chittagong Hilltracks of Bangladesh' in *Applied Geography* 24: 217-240.

Ratner, B.D., D.T. Ha, M. Kosal, A. Nissapa, and S. Chanphengxay (2004) Undervalued and Overlooked: Sustaining Rural Livelihoods Through Better Governance of Wetlands. *World Fish Center Studies and Reviews* No. 28. Available from: http://www.worldfishcenter.org

Salam, M.A., T. Noguchi, and M. Koike (1999) 'The causes of forest cover loss in the hill forests of Bangladesh' in *GeoJournal* 47: 539-549.

Thapa, G.B. and G. Rasul (2006) 'Implication of changing national policies on land use on the Chittagong Hilltracks of Bangladesh' in *Journal of Environmental Management* 81: 441-453.

UNDP (2006) *Human Development Report 2006 Beyond Scarcity: Power, poverty, and the global water crisis*. UNDP 2006.

UNDP (2007/2008). Human Development Report Statistics. Available from: http://hdrstats.undp.org/countries/data_sheets/cty_ds_BGD.html

USAID (2007) *Restoring Wetlands through Improved Governance: Community Based Co-Management in Bangladesh, The MACH Experience*. Technical Paper 1.

World Conservation Union (IUCN) (2006) *Final Report: Natural Resource Economic Evaluation of Hakaluki Haor.* Prepared and submitted by The World Conservation Union Bangladesh Office in association with Center for Natural Resource Studies for Ministry of Environment and Forests.

World Conservation Union (IUCN) (2002) *Bio-ecological Zones of Bangladesh*. Dhaka: IUCN Bangladesh Country Office.

World Resources Institute (WRI) in collaboration with United Nations Development Programme, United Nations Environment Programme, and World Bank (2005). *World Resources 2005: The Wealth of the Poor—Managing Ecosystems to Fight Poverty.* WRI: Washington, DC.

Zahid, A., and S.R. Ahmed (2006) 'Groundwater resources development in Bangladesh: contribution to Irrigation for food security and constraints to sustainability' in B.R. Sharma, K. Villholth, and K.D. Sharma (eds.) *Groundwater Research and Management: Integrating Science into Management Decisions*. Colombo: International Water Management Institute.

ESPA Situation Analysis for India

Arabinda Mishra, Rucha Ghate, P K Joshi, Neeraj Khera, Surender Kumar,
Susmita Sahu, Navarun Varma

1. Country profile: physiography, climate and socio-economic characteristics

India, with a total geographical area of about 329 million hectares, is situated to the north of the equator. It lies between $8^0$04' and $37^0$06' N latitude and $68^0$07' and $97^0$25' E longitude. It is bounded by the Indian Ocean in the south, the Arabian sea in the west, the Bay of Bengal in the east and the Himalayas in the north. The country's total geographical area covers only 2.4% of the world's total area but supports around 16.7% of the world's human population and around 18% of the world's livestock population (GoI, 2001). India's total land area is about 297.3 million hectares, of which 169.6 million hectares is cropland.

The country's mainland comprises four broad geographical areas: the Northern Mountains which has the great Himalayas, the vast Indo-Gangetic plains, the Southern (Deccan) Peninsula bounded by the Western and Eastern Ghats, and fourthly, the coastal plains and islands. About 69% of the total geographical area come under the dryland (arid, semi-arid and dry sub-humid) category as per the Thornthwaite classification. The country is divided into 10 biogeographic zones (Table-1).

India is primarily a tropical country but due to great altitudinal variations, almost all climatic conditions from hot deserts to cold deserts exist. There are four seasons: (i) winter (December-February), (ii) summer (March-June), (iii) south-west monsoon (June-September), and (iv) post monsoon (October-November). The south-west monsoon is the principal rainy season for almost the entire country and contributes almost 80 per cent of the precipitation. The retreating or north-east monsoon (October-February) yields substantial amount of rainfall in the areas south of 15^0 latitude, namely Tamil Nadu and adjoining coastal Andhra Pradesh. Cyclonic storms are common in the east coast during this period. Annual average frequency of such storms is about 2.

The distribution of south-west monsoon rainfall varies significantly – from over 2500mm in the western coast and extreme northeastern sector to within 25-50 mm in the extreme tips of the peninsular region. Most of central India receives rainfall of over 1000 mm and in the northern plains the rainfall varies between 500-750 mm. Similarly, in terms of the number of rainy days (rainfall > 2.5 mm per day from 8.30 AM to next day 8.30 AM), the range is from 100-125 days in the west coast and N.E. states to 10-20 rainy days in the Western Rajasthan, Kachchh and Saurashtra regions. More than 50 rainy days are observed to the east of 79^0 E longitude and parts of east M.P. Orissa coast and Gangetic West Bengal experience more than 75 rainy days. Interior Deccan Plateau has 40-50 rainy days.

The mean annual temperature variations are not as significant as those of the rainfall. However, MAT varies from 10 to 28^0C. The mean summer and winter temperatures show significant variation in the northern sectors (< 10^0C); the southern sectors however, show <5^0C variation in mean summer and mean winter temperature.

The total population of India is 1,027,015,247 persons comprising of 531,277,078 males and 495,738,169 females as per the census of March 2001. India added about 181 million persons during 1991-2001, which is more than the estimated population of Brazil, the fifth most populous country in the world. The population of the country rose by 21.34 % during 1991-2001. The sex ratio (i.e., number of females per thousand males) of population was 933, rising from 927 as at the 1991 Census. Total literacy rate was returned as 65.38%.

2. Poverty in India

Poverty can be defined as a state of individual or section of people unable to satisfy the basic needs of life. Being a very controversial term, different countries have varied definition and approaches to measure it. As per the Planning Commission in India, poverty line in rural area is drawn with an intake of 2400 calories in rural areas and 2100 calories in urban area. The Planning Commission has estimated that 27.5% of the population is living below the poverty line (2004-2005) which was 51.3% (in 1977-78) and 36 % (1993-1994). Despite significant economic progress, still 25% of the national population earns less then 0.40 USD per day. As per the report of National Commission of Enterprises in the Unorganised Sector (NCEUS), 77% of Indians live less than Rs. 20 per day. In addition to this, India has very high rate of malnutrition among the children under the age of three.

The poverty in terms of income or the consumption do not expresses the true picture of the destitutions. Apart from this, poverty can also be looked from different dimension viz., UNDP's Human development index (including health, access to nutrition and water, life expectancy, eduction etc); social exclusion, marginalisation etc. These all in one way or other are linked with the ecosystem health or ecosystem health may define the human well being. The unaccounted services which one or in combination of ecosystems provides are means for adequate nourishment, avoid diseases, clean and safe (air, water, shelter) and many other socio-cultural activities.

The majority of India's poor continue to be located in rural areas despite a declining trend in official income-based poverty estimates. State-wise, nearly 72% of India's poor and half of her population are located in the following six states: Uttar Pradesh (including Uttaranchal), Bihar (including Jharkhand), Madhya Pradesh (including Chhatisgarh), Maharashtra, West Bengal and Orissa (Table-2).

As per the official data on BPL population for the year 1993-94, seven states – Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Maharashtra, Assam and West Bengal – had a poverty ratio (% of population in poverty) in excess of the all-India average for rural areas (37.2%). Not only is the distribution of poverty spatially uneven in India, but also the gap in terms of poverty incidence between the poor and the affluent states in the country is growing over time (IBRD, 2000).

This spatial variation in incidence and depth of income poverty is the outcome of a highly uneven performance by the states of India in reducing poverty over time. The factors identified as having contributed to poverty reduction include favourable initial conditions of human and physical resource development as well as equitable access to physical and human infrastructure (Datt and Ravallion, 1996; Ravallion and Datt, 1996),

Datta and Sharma (2000) have used the 1993-94 NSS estimates to identify the spatial incidence of the rural 'very poor' with incomes three-fourths of the poverty line or less. The six regions identified by them as having high incidence of the 'very poor' are South Western Madhya Pradesh, Southern Uttar Pradesh, Southern Orissa, Inland Central Maharashtra, Southern Bihar, Northern Bihar, and Central Uttar Pradesh.

Another dimension of poverty is its duration and an early study in the Indian context (Gaiha, 1989) found that chronic or extended duration poverty is highest in case of 'casual agricultural labourers' among the different occupational categories of the country's rural population. This is corroborated in later studies (Bhalla, 2000). The defining characteristic of the chronically poor, according to Gaiha (1989), is 'not so much low per capita income/expenditure in any year as low variation in it (in absolute terms) over time'. Chronic rural poverty in the semi-arid region of India has been attributed to the negligible/inferior resource endowments of the poor that restrict their ability to augment income (Singh and

Binswanger, 1993). Increasing prices of essentials accompanied by sticky wages would also serve to restrict incomes of the chronically poor. The country study for India by the IBRD (2000) provides evidence to show that the real rate of growth of daily wages for rural unskilled male agricultural labourers came down from 4.6% in the 1980s to 2.4% in the 1990s and links this slowdown to, among other things, the productivity decline in agriculture.

3. Ecosystem trends in India, ecosystem services and economic valuation

Forests

Champion and Seth (1968) have recognised 16 major forest types comprising 221 minor types in India. Of these, the tropical moist deciduous forest forms the major percentage (37%) of forest cover in India. Tropical dry deciduous forest forms 28.6% and the remaining ones are scattered in minor proportions.

The role of India's forests in the national economy and in ecology is emphasized in the National Forest Policy 1988, which focuses on ensuring environmental stability, restoring the ecological balance, and preserving the remaining forests. Since 1987, the forest cover of the country is being assessed biennially by the Forest Survey of India (FSI) using remote sensing technology. Results of the past seven years assessments are given in Table 9. The recent forest cover assessment of the country has been estimated to be 678,333 sq.km., which is 20.64% of the geographic area of the country. The dense forest, open forest and mangrove constitute 11.48%, 7.76% and 0.15% of geographic area respectively. Scrub and non-forest are the other classes in the scheme of classification.

Forests are associated with ecosystem services such as soil protection, water augmentation (recharging groundwater), flood control/regulation, carbon sequestration, and nutrient cycling. Manoharan (2000) provides a review of a large number of valuation studies that throw considerable light on the magnitude of intangible benefits or ecosystem services accruing from India's forests. More recently, a study by Kumar et al (2006) looks at three important ecological services provided by India's forests – prevention of soil erosion, augmentation of groundwater, and flood control – and presents state-wise estimates of the benefits derived from these services in physical as well as monetary terms. Based on data generated from representative experiments in different parts of India, the total soil loss prevented by 42 mha of dense forest in 2001 for the country as a whole is estimated to be around 515 million tonnes which comes down to 482 million tonnes in 2003 with a decline in the dense forest cover in the country to 39 mha during this period. The authors estimate the total major nutrient loss which Indian forests prevent and, following the replacement cost approach, derive the economic value of nutrient loss in soil erosion prevented by dense forest to be around 50,000 million rupees.

Regarding groundwater recharge, the above study uses hydrological balance methods to calculate the additional recharge facilitated by dense forests. For the years 2001 and 2003, the differential water recharge due to dense forests is estimated to be 4417 and 4128 million m3, respectively, and the corresponding money value estimates are 1325 and 1239 million rupees.

The third ecological service considered by Kumar et al is the generally acknowledged flood control function of forests. While the overall impact of forests on flood management depends on various factors such as the type of forest, intensity and duration of rainfall, and general topography of the area, a thumb rule is that the forest (dense) area is a critical determinant of flood intensity and frequency. According to the authors' estimates, decrease in each hectare of dense forest in the country is estimated to increase the value of flood damages by 8125.75 rupees per annum.

Grassland

The grassland vegetation of India is largely secondary. Sehima-Dichanthium cover occupies the largest area of the country, covering the semi-arid tract of Maharashtra, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu. Dichanthium-Cenchrus-Lasiurus cover is found in the semi-arid and arid regions comprising the western portion of Gujarat, western Uttar Pradesh, Haryana and Punjab. Phragmites-Saccharum-Imperata type of grass cover is dominant in the Gangetic Plains, the Assam Valley and extends westwards in the plains of Punjab.

One of the largest extant grassland of the country is the sewan (Lasiurus sindicus) grassland in Jaisalmer (Rajasthan) which is 170 km long and 25 to 35 km wide. An important grassland is Banni in Kutch district. Most of the original forests and grasslands have disappeared in the Gangetic Plains owing to population pressure, except in isolated pockets in the terai. In Punjab, Haryana and western Uttar Pradesh, improved irrigation facilities have led to the grasslands being replaced by extensive crop fields. Geevan et al (2005) report that in the Kutch district of Gujarat, grazing and the invasion of the exotic mesquite *prosopis juliflora* native to South and Central Americas have severely degraded the grassland ecosystems.

Grasslands are important from the ecological point of view for their important role in maintaining biodiversity. The Gujarat Wildlife Protected Area network, for instance, covers more than 450 sq km area of grasslands and support many rare and endangered birds, such as Great Indian Bustrad, Houbara Bustard and Lesser Florican; mammals such as Indian Gazelle (Chinkara), Wolf, Fox, Desert Cat, Caracal, and reptiles, such as Spiny Tailed Lizard. The level plains of Punjab and Haryana were some of the chief strongholds of blackbuck in India and the largest reported herd of 10,000 animals was seen in a grassland in Hissar district in Haryana. The livelihoods of a significantly large population of pastoral and agro-pastoral communities in the arid/ semi-arid regions depend on the pasturelands and free grazing livestock.

Desert

The arid and semi arid zones in India are spread over eight states but 90 percent of the hot desert is located in the north western part of the country (Table 12). Of this, 62 percent is located in the state of Rajasthan. The Great Indian Desert, or the thar is situated on the eastern most fringe of the Saharan-Rajasthan plain. This desert is by the far the most populated one in the world; the human population being 75 per km^2 as compared to 3-5 in other deserts. Indian Thar desert extends about 2.34 million sq. km covering parts of Rajasthan, Gujarat, South-Western Punjab, Haryana, and Karnataka. A large number of population and livestock are dependent on this desert. The soil of the land is fertile full of dormant seeds of various species and with a little precipitation it blooms with a wide range of vegetation, and attracts animals and birds.

Marginal land cultivation in the Thar desert have increased from 32 per cent in 1960s to 52 per cent in 1990s leading to further desertification (Singh, 1998). The construction of the Indira Gandhi Canal in 1952 has converted the desert ecosystem in the command area of the canal into an evergreen forest ecosystem (Sinha, 1993). Thar desert holds a big potential for development into a rangeland: the highly nutritive fodder grasses Lasiurus sindicus, Cenchrus ciliaris, C. setigerus and Cymbopogon jwarancusa are well adapted to the Thar desert environment (Sinha et al 1997).

Wetlands

India has a very rich diversity of inland and coastal wetland habitats. The lakes of Himalayan highlands and the wetlands of Kashmir valley are sources of major rivers. In the Western India in arid and semi arid areas are vast saline expanses and brackish water

lakes. In the east and northeast are vast areas of floodplains of the Ganges and Brahmaputra and a number of lakes, marshes, and swamps. In South India, innumerable tanks and reservoirs occur. The backwaters of Kerala (locally known as *Kayals*) are among the richest ecosystems, providing breeding ground for fishes, shrimps, prawns, zooplankton, and other aquatic fauna.

The first survey of wetland areas in India was undertaken by the Department of Science and Technology in 1976 and this gave a figure of 39,045 sq.km area and a total of 1193 wetlands (572 natural, 542 human-made, 7 having both habitat types, and the rest unclassified). Majority of the wetlands are freshwater (938) and small (over 690 had area<100ha). Some 418 of the wetlands were used for irrigation purposes, 369 sites for fishing, 90 for fish culture, 161 for grazing, 30 for waste disposal and 19 for reed gathering (*ref*). A more recent survey by the MoEF (1990) puts the area under wetlands about 4.1 million ha (1.5 million ha natural and 2.6 million ha human-made), excluding paddy fields and mangroves. This is still considered to be a conservative estimate because of the exclusion of smaller water bodies, rivers and canals.

Coastal wetlands

India has a coastline of about 7515 km (GoI, 2001) distributed among nine states and her offshore islands. The mainland coast is divided into two parts, West Coast and East Coast, which are markedly different in their geo-morphology. The West Coast is generally exposed with heavy surf and rocky shores and headlands. The East Coast is generally shelving with beaches, lagoons, deltas and marshes. It is also relatively low lying with extensive alluvial plains and deltas. The country enjoys sovereign rights over the living and non-living resources in an Exclusive Economic Zone (EEZ) of over 2 million sq.km.

Nearly 50% (420 million according to 1991 census) of the country's population resides in the nine coastal states and the population density in coastal areas is much more than the national average. Apart from fisheries, the coastal population has other occupations like agriculture with marginal farmers having paddy and coconut plantations. There are a few coastal areas under the coastal saline paddy fields (called as *Khazan*s in Goa, *Gajjani*s in Karnataka and *Chemmen* in Kerala), which are now being converted into aquaculture farms. The major activities being carried out along the west coast include industrial expansions, intensive aquaculture, wetland reclamation due to population expansion, beach tourism activities etc. Industrial activities and their discharges cause serious problems to biodiversity and the environment. This has clogged the waterways and also reduced the fishery resources of the region. On the east coast, in Andhra Pradesh alone, various kinds of wetlands have been converted for shrimp aquaculture, which grew exponentially from around 8,000 hectares in 1991-92 to about 53,000 hectares in 1994-95 (Vivekanandan and Kurien, 1998).

The coastal zone of India is endowed with a multitude of ecosystems such as estuaries, lagoons, mangroves, backwaters, salt marshes, rocky coasts, sandy beaches, seagrass meadows and coral reefs. In terms of area tidal/mud flats have the greatest spread among these ecosystems (Table-13), whereas, estuaries, mangroves and coral reefs have high ecological as well as economic values. Seagrass meadows occur along the east and West Coast and Andaman and Nicobar Islands. In some locations along the Indian coast, estuaries form backwaters that stretch over vast areas (e.g. Cochin backwater in Kerala). There are 17 noteworthy lagoons (8 on the east and 9 on the west) along the Indian coasts. Two lagoons, namely Chilka and Pulicat on the East Coast, are the important wetlands as far as biodiversity is concerned.

Mangroves

Mangroves are salt tolerant forest ecosystems found mainly in tropical and sub-tropical inter tidal coastal regions near river mouths. They are basically tidal forests providing all four types of services of ecosystems mentioned by MA[6].

India has 2.7% of the world's mangroves. Out of India's total area under the mangroves, about 57% are found on the East Coast, 23% on the West Coast and remaining 20% on the Andaman and Nicobar islands. There are three types of mangroves in India viz., deltaic (on the east coast), backwater-esturine (on the west coast) and insular categories (in Andaman and Nicobar islands). Coral reefs occur as fringing reefs in the Gulf of Mannar, the Gulf of Kutchh, Andaman and Nicobar Islands, and as atoll reefs in Lakshadweep.
Table 11 shows that the mangroves in India cover an area of 4481 square km as of the year 2001. The area under mangroves has remained more than 4000 square km since 1987 and has increased marginally. Out of 9 coastal states, West Bengal and Gujarat possess more than half of the total area under mangroves.

The world's largest mangrove forest, the Sunderbans, is located at the apex of the Bay of Bengal and is presently spread over an area of 25,000 sq. km. in India and Bangladesh, out of which the Indian part consists of 9,630 sq.km. (Chopra et al, 2006). Out of the 9,630 sq. km., 4,264 sq. km. has reserve forest status comprising of 2,195 sq. km. of wetland/mangroves and 2,069 sq. km. of tidal river. The remaining 5,366 sq. km. is reclaimed area used to form human settlements.

Progressive reclamation of the Sunderbans over the last 150 years has resulted in the loss of substantial masses of mangrove forest and several faunal species, especially along the northern limits. Bhattacharyya (1998) reports that the turn of this (last) century, the Sunderbans has lost some of its remarkable wild fauna such as Javan Rhinos (Rhinoceros saundicus), wild buffalos, swamp deers and marsh crocodiles. Likewise, tigers, estuarine crocodiles and many species of turtles and terrapins were pushed to the brink of extinction mainly because of deterioration and destruction of their habitats along with indiscriminate hunting.

According to Chopra et al (2006), a multiplicity of causes has turned the Sunderbans into an extremely fragile and vulnerable ecosystem. Sea ingress has been a natural feature of the Sunderbans area over the past three to four hundred years and the rate is predicted to rise in the future. Land is an extremely scarce resource in the region. The study combines remote sensing data for the period 1986-2004 with soico-economic data from field surveys in eight blocks of the Indian state of West Bengal to identify the economic drivers of land use conversions from mangrove forests to aquaculture as well as from paddy land to aquaculture. The analysis suggests that the net relative land productivity and population density drives both kinds of land conversions. In addition, relative labour productivity is the other driving force behind the conversion from mangroves to aquaculture. It is estimated that annually for every 1 percent fall in relative labour productivity ratio, there will be 0.40

[6] The provisioning services provided by them include fuel wood and charcoal, timber for construction of boats and houses, mangroves seeds, which are used as vegetables, a variety of fish and fodder for cattle. Also rural households use them for medicines to treat chicken pox and injuries. Wood, fodder and fish are also important sources of income for the coastal households over and above their domestic uses. The regulatory services of mangroves include the protection of coastal agricultural lands from the seawater ingress, control of wind and storm surge from cyclones, purification of waters, and climate regulation through carbon sequestration. The supporting services include the development of therapeutic, preventive and clinical medicines, promotion of growth of corals, and the protection of bio-diversity of coastal waters consisting of a large variety of microorganisms. The mangroves are also the source of cultural services such as eco-tourism, education and research. (Hirway and Goswami, 2004).

percent of land conversion from mangroves to aquaculture. Similarly, annually 0.55 percent of mangrove land goes to aquaculture in response to 1 percent increase in population density.

One of the most prominent ecological services of mangroves is their protection of inland residents from storms and cyclones. A study by Das (2007) gives a methodology to capture the storm protection value of mangroves in coastal Orissa. In the Indian subcontinent, the annual frequency of cyclones crossing the east coast of the country is very high compared to the west coast, and on the east coast it is highest for the coast of Orissa. Along with the high frequency of cyclones, coastal Orissa also has a high vulnerability index on account of high population density and high storm surge vulnerability. The methodology applied by Das (2007) uses an estimated damage function along with a cyclone probability function and locational parameters. The loss of one km of mangroves increases the expected damage to properties by Rs 40.27 per capita. If there are 5000 people living in a panchayat, the value of a km of mangroves to that panchayat is estimated to be Rs 2,01,332.

A study by Hirway and Goswami (2004) provides a detailed analysis of dependence of poor rural households on mangroves in Gujarat. Gujarat state has about 20 percent of total mangrove forests in India. It spreads over an area of 911 square km over 1650 km coast line of the state. Hirway and Goswami use the primary data collected for a sample of 400 households belonging to 9 coastal villages. This study finds that fodder and fuel wood are the most important provisioning services for rural households from the mangroves. It finds that about 50 percent of the households living in the selected coastal villages own animals and about 82 percent of these use mangroves as fodder. It also finds that about 24.2 percent of households in coastal Gujarat use mangroves for fuel wood while about 10 percent of them use it for construction.

One hectare of mangroves yields as high as Rs. 23860 worth of fodder every year in Gujarat. The rural households in coastal Gujarat harvests annually Rs. 827.64 million worth of fodder from the mangroves. Survey data shows that each household on the average extracts 257.6 kgs of fuel wood annually from mangroves the market value of which is Rs. 515.2. All the households in coastal Gujarat get Rs. 44.88 million worth of fuel wood per year from mangroves. In some areas of Gujarat, the value of timber extracted from mangroves is as high as Rs. 577 per hectare in a year.

The value of all varieties of fish local to mangroves harvested by fishermen is estimated as Rs. 8000 per hectare of mangroves in a year. The total estimated value of fish harvested annually is Rs. 728.8 million. The total annual benefits are estimated as Rs160305 million. The benefits of fodder and a variety of fish local to mangroves constitute 52 and 46 percent of total benefits respectively.

The regulating services identified in the Hirway and Goswami case study include on shore and off shore fisheries (fish, shrimp, prawns, crabs etc.), protection to agriculture from winds, cyclones, salinity etc., protection to life, property infrastructure etc to coastal settlements, promoting biodiversity in coastal and marine ecosystems and improving quality by coastal waters and ground water. The total annual benefits from the regulatory services are estimated as Rs. 557.3 million. This study also provides estimates of carbon sequestration and the control of soil erosion by mangroves in Gujarat.

The Rann of Kutchh (Gujarat) is a unique coastal ecosystem in which during the monsoon the entire 19,300 sq.km. area of the Rann gets submerged under knee-deep waters but dries out after the rainy season to form a saline desert. The influx of tidal and rainwater during monsoon into the Rann results in the formation of huge but shallow lakes, forming a hybrid environment of inland and coastal wetlands and persisting for 3-4 months.

Freshwater ecosystems

Freshwater ecosystems include both lentic (still waters) and lotic (flowing waters) habitats and may be natural or human-made. While the rivers and streams of India suffer from pollution impacts and obstruction to flow, the most important pressure on lentic bodies like ponds, lakes, floodplain marshes, etc is in the form of encroachment and reclamation.
Tanks, the traditional irrigation commons, are situated in many parts of India to capture monsoon runoff in arid and semi-arid areas. As one of the oldest man-made ecosystem, the tank system consists of water spread areas, physically constructed structures namely bund, slices, surplus weirs and water flow structures like feeder canal and surplus courses, wetlands, flora and fauna and inland fishes.

The genesis of the freshwater wetlands of Assam, locally called *beels*, is attributed to the wandering habits of the rivers, when in their way of straightening courses, abandon some of their meander curves. Apart from this they may be also the outcome of tectonic movement, Assam being situated in one of the most vulnerable zones for seismic activity (the major earthquakes took place in 1869 and 1950 – both measured beyond 8M in Richter scale). A total area of 101,232 hectares of Assam is covered by 3513 wetlands. This is close to 4% of the total floodplain area and 1.3% of the total area of the state. The natural wetlands have been officially classified under 4 categories: lake or pond, oxbow lake or cut-off meander, waterlogged areas, and swamp or marsh. The lakes/ponds occupy an area of 15494 hectares and number 690; there are 861 oxbow lakes/cut-off meanders covering 15461 hectares; the waterlogged areas number 1126 and occupy 23436 hectares (dry season satellite data); and the swamps/marshes cover an area of 43434 hectares and number 712.

These wetlands exist not without purpose; they control flood intensity by sharing extra load of water that exceeds run off capacity of the river during high monsoon or supply water to rivers by way of seepage during lean time. *Beel*s are biodiversity hotspots and act as livelihood source for the indigenous communities living in these areas. Fishing is the main activity in the *beel*s. *Beel*s are very rich in nutrients and have a great production potential. The local people farm rice and vegetables in the catchment areas of the *beel*s during the post-monsoon season.

The construction of embankments along the entire length of the river Bramhaputra and its tributaries has also reduced the periodic flushing by monsoon floods. The final onslaught on the wetlands has been from human activities such as buffalo and cattle rearing, agriculture and horticulture and overfishing. The resulting change in biodiversity has implications for the food security and livelihood of the population that depends on the beels.

Biodiversity

The services provided by healthy, biodiversity-rich ecosystems are the foundation for human well-being. However, out of the 24 ecosystem services assessed by the Millennium Ecosystem Assessment (2005), 15 are in decline. These include the provision of fresh water, marine fishery production, the number and quality of places of spiritual and religious value, the ability of the atmosphere to cleanse itself of pollutants, natural hazard regulation, pollination, and the capacity of agricultural ecosystems to provide pest control. There are a number of species which are on the verge of extinction, along with genetic erosion within many of the surviving species. In a scenario, when the population growth is enormous, a major part of the population depends on natural resources, and rapid urbanization and industrialization is taking place in many countries in South Asia, this unprecedented biodiversity loss poses a significant barrier to achieving the United Nations Millennium Development Goals (MDGs) like poverty alleviation and ensuring environmental sustainability.

Realizing the need to conserve biodiversity for sustaining development, several global biodiversity agreements have come into existence in the past few decades. Six major global

conventions focusing on biodiversity issues are the Convention on Biological Diversity (CBD), the Convention on Conservation of Migratory Species (CMS), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the International Treaty on Plant Genetic Resources for Food and Agriculture, the Ramsar Convention on Wetlands and the World Heritage Convention (WHC). Apart from these, the United Nations Convention on the Law of the Sea provides the overall legal framework for ocean activities, United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Convention to Combat Desertification (UNCCD) are conventions on climate change and desertification that are intrinsically related to biodiversity. Recently, triggered by the unprecedented loss of biodiversity and emerging appreciation of the urgency with which the issue need to be addressed, Heads of States, at the Conference of Parties of the CBD in the year 2002, committed "to achieve, by 2010, a significant reduction of the current rate of biodiversity loss at the global, regional and national level, as a contribution to poverty alleviation and to the benefit of all life on Earth" with the aim of reaching this objective by 2010. This commitment is known as the biodiversity 2010 target.

There are several indicators being currently used, to look into the changes in the status of biodiversity and the response measures (see: CBD headline indicators, Global Biodiversity Outlook 2006, Forest Resources Assessment by FAO, European Environment Agency, SEBI2010, Countdown 2010, 2010 Biodiversity indicators partnership), ranging from *number of threatened species* (indicator for the state and trend of biodiversity) to *area under protection* (indicator for policy response to changing state and declining trend of biodiversity). Based on the existing set of indicators and the conceptual knowledge on the interlinkages between poverty and biodiversity, we discuss the status of biodiversity in South Asia with the help of following indicators. Information for some of these indicators (in *italics*) has been compiled in table 14a (state and trend indicators) and 14b (response indicators):
State and trend indicators:

1. *Number of threatened and extinct species; data deficient species,* indicating the need to facilitate basic biodiversity research in the country.
2. *Average annual change in forest area* indicating the habitat change
3. *Human population living in and around protected areas* indicating the dependence on biodiversity for subsistence needs.
4. *Value of export in the Non-timber forest products (NTFPs*) indicating the contribution of biodiversity to the national economy.
5. *Magnitude of illegal trade in wild plants and animals* indicating the diversion of resources of subsistence value to forest dependent communities. [Many rural households in developing countries depend heavily on wildlife resources, both plants and animals, for subsistence purposes and income generation. For some wildlife species and products, however, a significant segment of products traded are ultimately destined for foreign markets. The general direction of wildlife trade flows is from (poor and biodiversity rich) developing countries to developed countries (IIED and TRAFFIC, 2002). There is thus a need to document the interlinkages between the illegal wildlife trade and its impact on the livelihoods of people who are dependent on these resources]

   Response indicators:

   1. *Party to biodiversity conventions* indicating the political will and policy adaptiveness of the country
   2. *Area under protection*, including *terrestrial* as well as marine area, indicating the tangible response of the national government to the declining habitat. However, the effectiveness with which the protected areas are being managed is an equally crucial issue.

3. *Status (number of Ramsar sites, area under Ramsar sites) of wetlands*, indicating how far the wetlands, which are extremely important for biodiversity conservation and for the well-being of human communities, are being wisely used in the country.
4. *Status of World heritage sites*, indicating the efforts that the country is making towards conserving the sites of global importance that contributes immensely to the national and local economy through tourism and scientific value.
5. Funds allocated to biodiversity conservation programs in the country, indicating the resources being diverted for conserving biodiversity directly through conservation programmes and indirectly through eliminating perverse subsidies.

Protected areas

Protected areas are created with the objective of preserving as samples of interdependent ecological gene-pool combination and gene bank capital. This in turn helps in protecting the ecological and food security of the country. There are 597 protected areas (95 National Parks, 500 Wildlife Sanctuaries and two Conservations Reserves) in India covering 1, 54,772 sq km. or 4.74% of the country's geographical area. However, 40% of these protected areas are exposed to traditional livestock grazing, fodder extraction, timber extraction, and non timber forest produce collection. In another survey, 67 per cent of national parks and 83 per cent of wildlife sanctuaries surveyed reported grazing.

As per estimates about 4 million people are residing inside protected areas mainly because of inability and reluctance of state governments to settle their rights and relocate them. More than 45% of protected areas have public thoroughfare which further dissects the area into smaller parts and affects their viability. Increasing human and livestock population are a major pressure on viability and health of protected areas. Although special attention is being given to the regeneration of degraded forest areas and lands adjoining forest areas, national parks, sanctuaries and other protected areas as well as ecologically fragile areas, it is inadequate. The report of National Forest Commission (2006) highlights that established protected areas are ecologically small and incomplete biomes surrounded by human habitation, which in most cases are adversely exploiting these areas. The Wildlife Institute of India suggests that India should have 870 National Parks and Sanctuaries spreading over 5.74% of geographical land of the country.

18 sites are most seriously threatened 27 are moderately threatened, 44 are marginally threatened, while 4 are not threatened. IUCN's (1990) report on "Threatened protected areas of the world" indicates five protected areas of India as endangered which includes the Gulf of Kutchch Marine National Park (Gujarat state).

4. Impacts of ecosystem changes

The Himalayas cover only 18 per cent of geographical area of India yet has more than 50 per cent of forest and 40 per cent of the species endemic to Indian sub continent. The hill agricultural system in the region is dependent on the pastures and forests for supply of biomass energy and the flow of energy from pastures to arable land is mediated through existing cattle population. A number of studies have focused on land use changes in the region and the consequent socio-economic and ecological impacts. Tiwari (2000), for instance, looks at the Kumaon Himalayan region, which has 28.7% of the geographical area under forest of which around 4% has more than 60% of crown cover. The area under cultivation in the Kumaon area has increased at the rate of 1.5% and cattle population at the rate of 0.2% per year and this puts a lot of pressure on the carrying capacity of the land. There has been a shift in agriculture from crop farming to more profitable vegetable farming, and floriculture resulting in diminished fodder production and simultaneously there has been increased cattle stock for more commercial production of milk. The increased pressure of

livestock on pastures and forests has resulted in destruction of young vegetation, degraded forest and huge soil loss. Developmental activities such as road building has also resulted in loss of forest, destabilisation of mountain slopes, destruction of wildlife, disruption of drainage and production of huge amount of debris.

Surface run-off and accelerated erosion in the Himalayan mountains have been linked to more frequent floods in the Indus river basin in the last 25 years as compared to previous 65 years (Tejwani, 1990). Each year landslides (5-10 landslides per km.) produce 550 cu. M. of debris and rock falls and cause 24 X 10 cu M of sediments to slide down the mountains causing massive destruction of vegetation, wild life, choking mountain streams and causing floods in the plains. The beds of Terai rivers are rising at the rate of 15-30 cm annually due to siltation (CSE, 1991) and studies also indicate that 2400 tonnes of silt are now being transported to Bangladesh every year because of large scale deforestation in Himalayas (Tejwani, 1990). This trend would result in a loss of a third of the arable land within 20 years at the rate of 5ha/min.

In the Ganga sub-basin[7], the anthropogenic demand on the river waters is huge. In India, for instance, around 43 per cent of the country's population (2001 census) belongs to the sub-basin's catchment area, with a density of over 1000 people per sq km. The demand for irrigation waters in the region is huge and growing, owing to the predominantly agrarian nature of the sub-basin's economy. The Ganga and its tributaries, particularly the Yamuna, carry huge pollution loads that come from domestic as well as industrial sources. Increasing urbanization has led to huge additional demands on the rivers to meet the domestic as well as non-domestic water needs of a rapidly growing urban population.

National strategies for use of ecosystem services do not make explicit provisions for the ecosystem needs. In the case of the Ganga river system, for instance, the river is an important fish migration route and plays an important role in contributing to salinity control in the Bay of Bengal. Similarly, biodiversity degradation in the Sunderbans – the largest single-patch mangrove forest in the world – has been conclusively linked to reduced upstream inflows. Some of the services that river water infrastructure seek to provide (such as flood control) are often received naturally as ecosystem flows in a more cost-efficient and equitable way (Emerton and Bos, 2004).

Existing user communities are also affected when new demands for a resource emerge following the degradation or depletion of substitute resources.

5. The climate change factor

Climate change and the potential for the monsoon to become more volatile have major implications for growing economies like India. India's economy and societal infrastructures are dependent on the significant stability of the monsoon, which may again imply the high vulnerability to small changes in monsoon rainfall. A glaring example is the failure of the monsoon rains during the month of July in 2002, resulting in a seasonal rainfall deficit of 19% and causing profound loss of agricultural production with a drop of over 3% in India's GDP. Neither the prolonged break in the monsoon, nor the seasonal deficit was predicted. In

[7] The river Ganga runs over 2500 kms through four countries – China (Tibet), Nepal, India and Bangladesh – and forms one of the most populous as well as poverty-stricken river basins of the world. Along its length, large tributaries enter into the Ganga from both north and south, significantly affecting its flow and course. The total basin area of the Ganga is about 1,093,400 sq kms, of which 79 per cent is spread over eleven Indian states, 13 per cent falls in Nepal, and both Bangladesh and China have 4 per cent each (Pun, 2004).

the future, the pressures of an increasing population will bring additional stresses on society and the environment, with implications for water resources, health and food security. In order to ensure food security, the food production must keep pace with the population explosion. Much of the extra production will need to come from rain-fed agriculture that comprises from the farm lands which are again extremely vulnerable to climate variability and change (Challinor et al., 2007).

Rainfall in the Indian monsoon season occurs from June to September, accounts for about 70% of annual rainfall and exhibits decadal variability. Observational studies have shown that the impact of El Niño is more severe during the below-normal epochs, while the impact of La Niña is more severe during the above-normal epochs. Such modulation of ENSO impacts by the decadal monsoon variability was also observed in the rainfall regimes over Southeast Asia (IPCC, 2007). Seeing the importance of El-Nino on the monsoon, several projections have been made as to whether it will become stronger and/or more frequent. The Hadley Centre model (HadCM3) which includes the influence of El Nino on the monsoon, suggest that changes in the level of interannual variability, as a fraction of the seasonal mean, will be small. However, when viewed in the context of the overall increase in monsoon rainfall, this equates to changes of up to 14% in the standard deviation of total rainfall, with the implication that floods could become more extreme, but droughts remain just as likely (Turner et al. 2006). Furthermore, these new model results suggest that the recent observed weakening of the influence of El Nino on the monsoon is likely to be due to natural, interdecadal variability in the climate system. This interdecadal variability will itself introduce uncertainties in the projections of monsoon behavior in the coming decades (Turner et al. 2006).

The general consensus amongst climate models is that the mean summer rainfall for All India will increase slightly, by about 10% by the end of the century, largely because of the warmer Indian Ocean and the fact that warmer air can hold more water. This increase in rainfall will not necessarily be accompanied by stronger monsoon winds. There are, however, likely to be much larger regional variations across India, with indications that the northern states will see much of that increase, although these changes are considerably more uncertain. As part of the more intense hydrological cycle, some models indicate that the intensity of heavy rainfall events may increase whilst the number of rainy days may decrease. This suggests changes in the temporal characteristics of the water cycle which could have profound effects on agriculture and management of water resources (Challinor et al., 2007).

The evidence to date suggests that the changes in water and temperature will have serious consequences for agriculture. The impact of less rainy days and increased intensity of rainfall events is to reduce the amount of water available for crop growth, since more water is likely to be lost to runoff and drainage. This in turn leads to a reduction in crop yield. Changes in the active/break cycles of the monsoon will also lead to reduced yield if a break occurs at a time when water availability is critical for the crop (Challinor et al., 2004). Changes in both the mean and the variability of temperature will also affect crop yield. Critical temperatures, above which damage to crops increases rapidly, are likely to be exceeded more frequently; also the expected increases in seasonally-averaged temperature often hasten the maturity of a crop. These changes could reduce mean crop yields at the end of this century by up to 70% (Challinor et al. 2006).

Himalayan glaciers are reported to be among the fastest retreating in the world due to the effects of global warming, which may eventually mean reduced water availability in the glacier-dependent rivers in China, India and Nepal. The recently released Working Group II report of the IPCC (IPCC, 2007) has identified four implications of global warming and glacier retreat in the Himalayas: first, in the short run, more water will be available for the perennial rivers, which may generate positive effects in dry season; secondly, chances of

glacial lake outburst floods (GLOFs) may increase putting downstream communities and river infrastructure at higher risk; thirdly, in the long run, dry season flows may reduce; and, fourthly, higher silt loads may result from the increased dry season flows in the short run, which can drastically reduce the lifespan of downstream reservoirs. Unfortunately, the relationship between climate change and glacial retreat, although generally confirmed by scientists, is not yet understood well enough by policy makers to result in effective and well-coordinated response strategies.

6. ESPA links in different ecosystems of India: a review of case studies

Changes in the flows of ecosystem services have varying implications for the well-beings of people differently situated across space and over time. At the outset, we need an analytical framework that is able to accommodate such variability.
A review of the large body of literature that has emerged on the poverty-environment link lends a basis to the following assertions:

a. That, though the rural population depend significantly on a variety of natural resources (biodiversity) and ecosystem services as a direct source of livelihood, they do have varying degrees of access to other forms of productive capital, which may be having high complementarities with natural capital or are largely substitutable.
b. That, a trinity of institutions – state, market and civil society – determine the choices that people make regarding the use of these different forms of capital in different technological combinations with natural capital, leading to changes in the flows of environmental services over a period of time.
c. That, poverty trends can be understood in terms of changes in the asset base and its composition for the rural poor in different spatial contexts distinguished by changes in the flow of environmental services.

Studies by Jodha (1986, 1992), Chopra et al (1990), Reddy and Chakravarty (1999), among others, provide enough evidence to conclude that ecosystems contribute significantly towards poverty alleviation. In a pioneering study in the Indian context, Jodha (1986) found a negative relationship between the total income of the household and the share of total environmental income in it, thus leading to the conclusion that poorer households are more resource dependent than the rich. His study found income from the commons comprising between 9 and 26 percent of the total incomes of poor households, and between 1 and 4 percent of the incomes of rich households. Reddy and Chakravarty's (1999) analysis of the data collected from rural households located in the foothills of the Kumaon Himalayas shows a significant increase in the incidence of poverty when income from forestry is set to zero.

A number of micro-level case studies point to the high and varied nature of dependence of poor communities on the provisioning services of ecosystems. To give an example, Ghate et al's (2003) study of a small tribal community in a Maharashtrian village reports that with a per capita forest availability of 2.7 ha, villagers use more than 55 species as non-timber forest products (NTFP) for different purposes like fish poison (*Gardenia Turgida, Cleistanthus Colllinus*), dyes (*Buttea Monosperma, Nysctanthus Arbor-tristis*), oil (*Madhuca longifolia, Pongamia pinnata*), medicine soaps (*Ventilago denticulate*), cotton (*Bombax ceiba, Gossypium hirsutum*), food supplements (*Cassia occidentalis, Madhuca longifolia, Trapa natans, Buchnarea lanzan*), implements (*Soyminda febrifuga, Terminalia alata, Tectona grandi, Terminalia alata),* and major source of cash income (*Madhuca longifolia, Diospyros melanoxylon, Bambusa arundinacea)*.

The effectiveness of environmental income in reducing rural income inequality in India is however disputed. According to Jodha's (1990) estimates, the inclusion of CPR income in

total household incomes reduces the extent of rural income inequalities as indicated by lower values of the Gini coefficient. In contrast, Kumar's (2002) social cost-benefit analysis of the Joint Forest Management (JFM) institution in the Jharkhand region of central India uses the data on actual rates of extraction of forest products by different classes of participating households and concludes that under present JFM arrangements the non-poor are likely to gain more from the forest at the expense of the poor. Kerr's (2002) study of watershed development projects sponsored by different donor agencies in 70 villages in Maharashtra reports that, despite a common focus on poverty alleviation, the projects most successful in achieving conservation and productivity benefits also had strong evidence of skewed distribution of benefits toward larger landholders. The study concludes that donor driven projects may fall to 'elite capture' and become unsustainable. Interventions that lead to restrictive use have different impacts on the poor and the very poor, men and women, children and adults, communities with varying occupations.

The ability of the rural poor to sustain their livelihoods is believed to be constrained due to adverse environmental conditions – high ecological vulnerability and low resource productivity – and limited access to land and other natural resources (UNCHS, 1996; World Bank, 2002). Further, as per the 1997 UNDP Human Development Report, poverty is worse in drier zones than it is in wetter zones. India's dryland regions include 125 districts spread over 12 states that are officially identified as drought prone areas or DPAP districts and 32 of these have a high or very high incidence of poverty (NIRD, 2000). Compared to the regions more favourably endowed with natural resources, such as the forested regions of central and eastern India, the incidence of poverty is generally lower in the drought-prone dryland regions (Mehta and Shah, 2006). However, the other dimensions of poverty are very much evident in the latter regions: livelihood security is low on account of high instability in crop production and there are significant social costs on account of large-scale inter-state migration.

Land reforms aimed at increasing tenurial security or at redistributing land have been central to poverty reduction policy in India (Besley et al, 2004). In their comparative analysis of the incidence of chronic poverty in the drought prone and forested regions of India, Mehta and Shah (2006) attribute poverty reduction in the former to relatively higher land productivity made possible by factors such as favourable land relations, larger landholding size, commercialization of agriculture, migration to industrially developed regions, and state's support in terms of drought relief and public works programme. India's agricultural intensification is credited with a major positive impact on forestry sector by easing pressure on marginal lands, on which most forest occurs (**WB ??).

Watershed development has emerged as a key approach to rural development in rainfed and drought-prone areas of the country (Farrington et al, 1999; Kerr, 2002). Grewal et al (2001) cite successful conservation and productivity outcomes of the World Bank aided Integrated Watershed Development Project, which was launched in 1990 for seven years to treat 2,30,000 ha contiguous area of four Northern states i.e. Haryana, Himachal Pradesh, Jammu and Kashmir, and Punjab called the Shivaliks. The project had a single window system of providing goods and services by complete integration of soil and water conservation, forestry, rain fed agriculture, horticulture and live stock components through a unified implementing agency.

In contrast to the situation in the dryland regions, the higher incidence of poverty in the forested regions of the country is viewed by Mehta and Shah (2006) primarily as a problem of entitlement failure. For the rural poor, access to a variety of natural resources is critical for sustaining livelihood because they provide them with diversification options as environmental conditions change (Koziell and Saunders, 2001).

In the Anaikatty region of the southern Western Ghats in India, land-use in forest peripheries is characterized by low productivity and extended fallows. Land alienation, soil degradation, drought, wild animal attacks, and declining access to forests have debilitated the livelihood base of a tribal community known as *Irulas*. Purushothaman's (2005) study seeks to identify alternate land-use and management strategies to strengthen and diversify the livelihood options that are confronted by these extremely poor marginal farmers. Benefit-cost analysis in combination with stakeholder discussions reveal that alternative land-use strategies such as millet-based dry-farming along with the adoption of soil conservation or growth of perennials on field bunds are economically efficient relative to current dry-farming and that these enjoy acceptance among farmers. Adoption of such systems would result in a nearly 300 percent increase in the annual income from their land. Other economically superior alternative land-uses are not acceptable to farmers, indicating the care with which tribal development policies need to be made.

A need assessment study (Ghate, 2005) of the forest-dependent tribal people in three central Indian states reports significant seasonal migration in over three-fourth of the 29 villages surveyed. Most importantly, the 'push' factors rather than the 'pull' factors were found to be operational in all cases. This reflects negatively on the state efforts to create rural employment and implies that rural development and livelihood programmes have not been successful in improving the quality of life in villages. These factors are almost uniform for all the three states. Shortage of agricultural employment providing income for just one season of the year is the main factor, while others are all consequences of it. These include debt burden, crop failure, lack of insurance and credit back up. As a special case, migration from one of the villages in Orissa is a result of ineffective rehabilitation by the government agency, which has rendered the villagers worse off than before. Minor pull factors like higher wage rates for unskilled jobs and demonstration effect of higher economic strata do operate in some of the places, but proportionately small in number and magnitude.

Coping strategies such as migration often have a feedback effect on ecosystem management and ecosystem health. A case study by Godbole and Sarnaik (2004) illustrates this point with reference to sacred groves. Sacred groves are traditional institutions responsible for conservation of culture and valuable biodiversity at regional as well as local level. Conservation of rare and endangered plants, providing habitats for birds and animals, maintaining regeneration potential of plants, maintaining moisture in soil are some of the functions of the forest patches preserved by communities for generations as sacred groves. Sacred groves are complicated resource structures and management and ownership patterns are different in various regions. The traditional institutions that managed the ecosystem (though at smaller scale) efficiently for generations, is under threat due to the migration of younger generation to towns and cities. Resultantly, there are many changes in the management of these commons, which has directly affected the ecosystem functions. The changes include – reduced use of sacred groves for collective decision making, maintenance of temple and superceded protection of vegetation and water sources within groves, grazing which was banned earlier, is allowed in many groves, and there is general neglect due to dearth of younger persons in the village to undertake care taking activities.

Experience of the World Bank in forest sector projects in India shows that states with more open fiscal and institutional reforms (e.g. Andhra Pradesh) enjoy more success in reaping benefits from the projects (World Bank, 2006). According to the report cited, the Bank projects have proved to have potential for alleviating poverty by building the grassroot capacity for forest protection and regeneration in the communities adjacent to the forests. The same report recognizes that interdepartmental coordination is weak at national and state levels, and sustainability strategy, production strategies, and marketing issues are given inadequate attention. The current strategy of substituting funds received from donors for state and central funds and lack of coordination between the donors are proving ineffective in reaping benefits in the forestry sector.

A study by Ghate et al (2006) attempts to understand the relationship between market proximity, NTFP dependence, and forest condition, and to assess how this relationship is mediated by the presence of strong or weak local forest institutions. The study finds a clear relationship between the degree of proximity to the market, and NTFP dependence. Lack of conectivty to local markets results in low off-farm and off-forest livelihood options. With high dependence due to low alternatives, and weak forest-governance institution, there is further deterioration of forest. This impacts income from forest over a period of time.

Opportunities to reduce poverty through effective ecosystem management are often constrained due to deeply entrenched policy and institutional barriers. For example, according to the present system of management of the *beels* of Assam, both the Revenue department and the Assam Fisheries Department Corporation (AFDC) lease out the beels for a period of five years at a time. This system allows rich middlepersons to obtain the leases. The lesse hires fishers to do the fishing. In most cases fishers of foreign origin are employed at very low wages or on a share-harvest basis. The marketing of the fish is totally controlled by the lessee. Fishers are not allowed to sell their share in the market. They have to sell it back to the lessee at a low price fixed by the lessee. This system of management does not allow the local fishing communities to have a role in the management paradigm. But historically the beels were once the common property of the community and conservation ethics were followed. Owing to the poor economic scenario, the fishers are under pressure to increase their income and easily fall prey to the lessee's interests. As the lease period is fixed, the lessee maximizes income by catching the entire stock of fish from the beel. To achieve this, the water level is often reduced by pumping it out. Under such a management system all existing provisions for protection and conservation of the fish biota becomes meaningless.

Developmental interventions by the state, seeking to bring rural and marginalized communities into the mainstream growth process, often have a perverse impact by unleashing forces that tend to weaken kinship bonds, traditional customs and norms of behaviour. Market arrangements, inherent to the mainstream growth process, favour social stratification and the dissolution of ethnic bonds and customs (Seeland, 1991). Along with social stratification, economic heterogeneity arises from the uneven income distributional effects of developmental interventions. Inequalities in economic status within the community increase due to, among other things, (i) uneven distribution of knowledge and skills required for new employment opportunities created through the development process; (ii) disproportionately greater benefits to larger farmers from measures leading to increased agricultural productivity; (iii) and inter-sector differences in factor productivity and per capita income in a dualistic economy (Kant, 2000). To these, one may add the inequities and deprivation that occur due to loss of capital (physical, human and natural) arising from development induced involuntary displacement (Cernea, 2000).

Unanticipated environmental consequences of development projects have been a great source of misery for local communities all over the world and the Ganga sub-basin gives many such instances that are well documented. Thus, for instance, constructing embankments as a measure to moderate the adverse impacts of flood has put large areas in the basin region in a semi-permanent waterlogged state, seriously affecting human health and agriculture (Bandyopadhya, 2002). Constructions of upstream projects create downstream environmental hazards leading to loss of livelihood for quite a large chunk of population in downstream localities. These environmental hardships are reflected in many ways such as increased uncertainties in the water availability in the dry seasons to irrigate the agricultural lands, increased salinity of ground water, destruction of forests, adverse impacts on riverine species, disruption in the navigational system of the country etc. Policymaking on natural resources management very often displays an ignorance of

important ecosystem linkages. The following case study illustrates this point[8]. In the village Aghapur, located on the fringe of Keoldeo National Park in Rajasthan, grazing and livestock rearing was the main occupation of the 300 households with on an average 40-45 buffaloes. The cattle used to graze in the national park area till 1955. Grazing was community monitored. The area is famous for a number of bird species including Siberian cranes. The grazing of cattle resulted in trampling of grass, making it ideal for laying of eggs. The main user groups in and around the forest are primary users – chara samuh (fodder group), lakadi samuh (wood group), van uaj samuh (NTFP group), machailmar samuh (fishermen), mitti samuh (soil group), krishi samuh (cultivators); secondary user group – shikari samuh (hunters). The declaration of the National Park led to a total ban on grazing, which resulted in loss of livelihood for the grazers and also decreased the number of migratory birds. Since the grazing was banned the grass started growing unobstructed which harmed the birds' feathers while landing on water surface. Also, in the absence of trodden grass, the birds lost the ideal breeding ground. Loss of livelihood also resulted in illicit activities.

The problem of entitlement failure is the starkest in case of people living in protected areas and communities displaced on account of development projects. Silori (2007) examines the perception of the Bhotiya tribal community on the use and conservation of natural resources in Nanda Devi Biosphere Reserve (NDBR), north-western Himalaya in India with an objective of identifying the bottlenecks in the sustainable management of forest resources of NDBR through people's participation. Despite, 85% of the respondents supporting the concept of conservation of forest resources, management decisions such as ban on mountaineering activities by creation of the Nanda Devi National Park (NDNP) in 1982 and NDBR in 1988, developed negative attitude among local people towards NDBR management, mainly because of restricted access to the forest resources for their livelihood. Promotion of some alternative income generating activities to reduce the dependence on natural resources was responded positively by the local people.

Guha and Ghosh (2007) examine the contribution of tourism towards improving the livelihoods of local people in a remote island village of the Indian Sundarbans. The Sundarban Tiger Reserve is a major tourism destination and a small number of local people participate in the tourism sector as vendors, boatmen and guides. No village household subsists entirely on tourism-based income since such jobs are seasonal. A majority of the local service providers operate with very little or no capital investment. Yet households participating in tourism-related activity are better off than those who do not. Tourism participants spend 19% more on food and 38% more on non-food items relative to other villagers. Earnings from tourism appear to at least partially finance year-long consumption. Tourism may also have a conservation effect in that the proportion of forest dependent households is significantly lower among tourism dependent households. There is, however, little evidence of any percolation of tourism-related income to non-participating households through intra-village transactions. The study proposes a carefully crafted policy for promoting nature-based tourism with more room for local participation.

Conflict in multiple user groups can lead to loss of livelihoods as the following case study[9] illustrates. Kanwar lake – nest for plethora of floral and faunal diversities, especially of birds, is located in Begusarai district of Bihar. The lake was created by meandering of river Burhi Gundak. It is an ox-bow lake. It drains into Bhuti Gandak through a man-made canal, is spread over an area of about 18,290 acres, surrounded by 16 villages (population 50,000) dominated by sahnis (mallahas) fishermen community. This community has depended on Kanwar lake for its livelihood for long time. The other dominant community is that of raiyots

[8] Source:http://ces.iisc.ernet.in/PBR/PBR%20of%20Rajasthan%20Executive%20Summary.pdf
[9] Source: Srivastava D.S., Biodiversity Conservation Prioratization Project, Bihar State, Nature Conservation Society, Daltonganj, 1997.

(cultivators). These communities are in conflict because of conflicting use of water and land. While raiyots want the water from the lake to be drained for irrigating their agricultural fields, the fishing community wants the water to stay for cultivating fish. Another user group is that of traditional bird catchers, which capture birds belonging to 106 local bird species and 59 migratory species. After the creation of Kanwar Lake Bird Sanctuary in 1989, the bird capturing business has almost stopped. But fishing, though illegal, is reportedly going on to some extent. Due to total ban on bird capturing and decreasing in fishing weed growth in the water is experienced. This is because earlier the bird catchers and fishermen used to clear weeds from around the lake area. In the absence of an alternative mechanism to clear long weeds forming a dense jungle that has overtaken water surface. This is neither favoring fish nor the migratory birds.

7. Geospatial tools for mapping poverty-ecosystem links

Forest Cover and Poverty – Indian Scenario

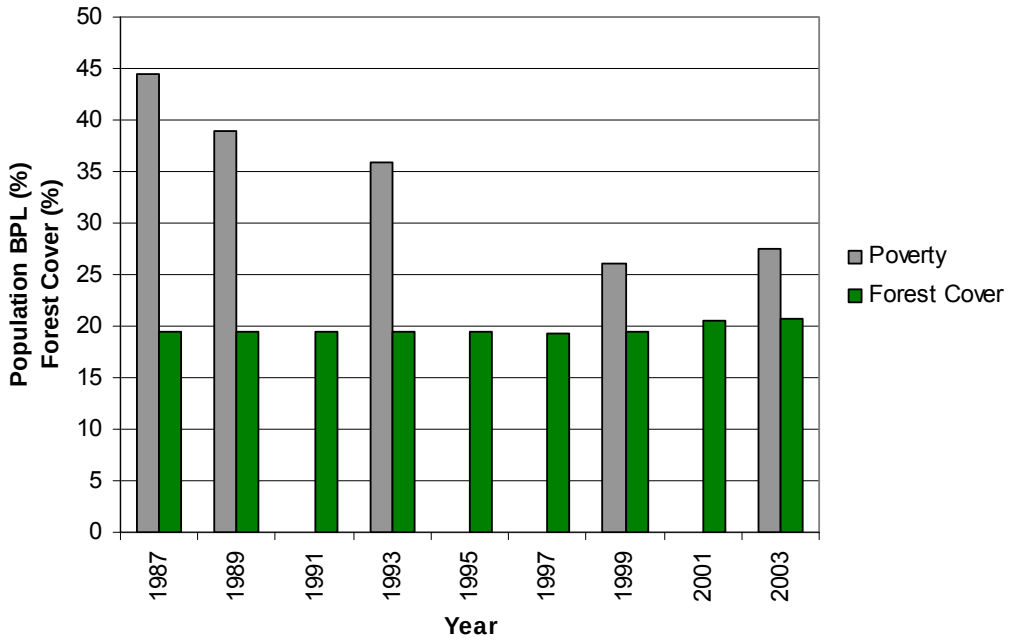


Fig.1 Temporal distribution of Poverty (%) and Forest Cover (%) in India.
(NB: Forest Cover as per SRF, FSI)

The poverty distribution in India co-incidently is linked with the distribution of ecosystems and their health in the country. All the states which host relatively good amount of the forest cover are either the hilly states like Tripura, Sikkim, Mizoram, Meghalaya, Manipur Arunanchal Pradesh or the states in which composition of population below poverty line is relatively higher (e.g. Madhya Pradesh, Jharkhand, Chattisgarh, Orissa, Nagaland and Andaman and Nicobar). It is not surprising that the hilly states with high forest cover (as mentioned above) also contribute substantially towards the population below poverty line.

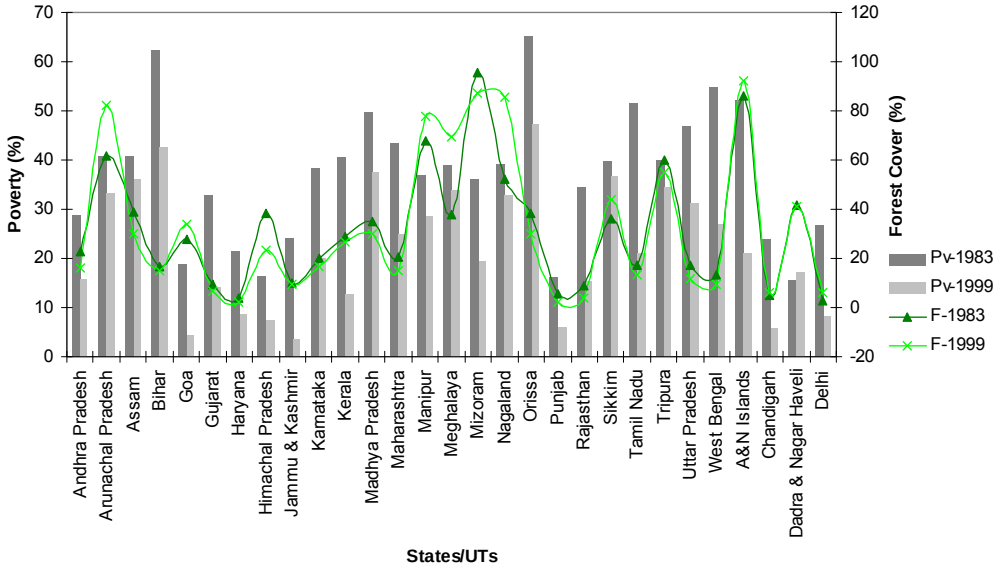


Fig.2 Distribution of Poverty (%) and Forest Cover (%) in different states of India for the year 1983 and 1999.

(NB: Pv – Poverty, Population BPL database, F – Forest Cover, SFR, FSI; SFR 1987 has used satellite data of 1983)

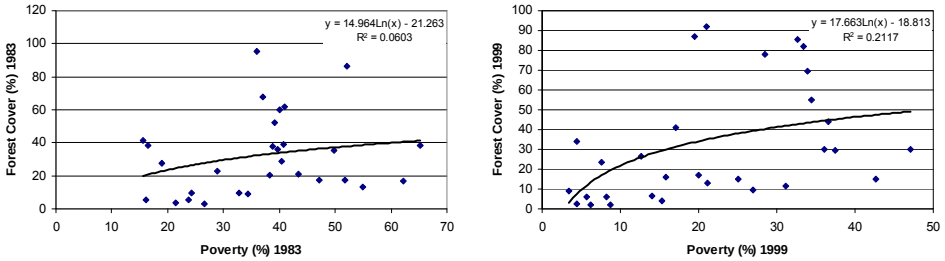


Fig.3 Scatter plot of Poverty (%) and Forest Cover (%) in different states in India for the year 1983 and 1999
(NB: Pv – Poverty, Population BPL database, F – Forest Cover, SFR, FSI)

Assessing Vulnerability – India (O'Brien et al., 2004)

The vulnerability in the ecosystems is understood as a function of biophysical, socio-economic and affluence. The biophysical indicators used in the profile consisted of soil conditions (quality and depth) and ground water availability. These indicators are selected based on the assumption that areas with more productive soil and more groundwater availability for agriculture will be more adaptable to adverse climatic conditions and better able to compete and utilize the opportunities of trade. Indicators for soil quality include the depth of the soil cover and severity of soil degradation, while indicators of groundwater availability are based on estimates of the total amount of replenishable groundwater available annually.

Socioeconomic factors consisted of levels of human and social capital, and the presence or lack of alternative economic activities. Levels of human and social capital provide basic indicators of the economic endowments of the district and of the capacity for the

communities in a district to engage in collective economic and social activities. Human capital was represented by adult literacy rates, while social capital was measured by degree of gender equity in a district. The presence of alternative economic activities provides an indicator of the ability of farmers in a district to shift to other economic activities in response to reduced agricultural income resulting from adverse climatic conditions such as drought. Presence of alternate economic activities is measured by the percentage of the district workforce that is employed in agriculture and by the percentage of landless laborers in the agricultural workforce.

Technological factors consisted of the availability of irrigation and quality of infrastructure. Quality of infrastructure is measured using the Infrastructure Development Index of the Centre for Monitoring of Indian Economy (CMIE, 2000). The CMIE index is published as a single composite index number for each district, and provides availability of facilities for transport energy, irrigation, banking, communication, education, and health.

Biophysical vulnerability has a bearing on the distribution of the forest ecosystems. The entire central India, eastern coast and Western Ghats have a very low biophysical vulnerability and good amount of dense and diverse forest cover types. The gangetic plains are exception to this, but these hold a great potential to the agro- ecosystems and functions. The western Himalayas and parts of the northeastern India, owning to their topography have high biophysical vulnerability. Here in, the importance of preserving these ecosystems becomes very important not only in terms of service providers but also for the sustenance of themselves. The Deccan Plateu, the Peninsular India and semi-arid eco-regions have emerged as the most vulnerable ecosystems. The said climate change along with the human disturbance is the most vital events to affects the ecosystems functions of these areas.

Social vulnerability has an interspersed affects due to data integration and fuzziness along the district borders. However, the social vulnerability is minimum in the areas with the wide forested ecosystems. Again the parts of central India, semi-arid ecosystems and Peninsular India are the most vulnerable in terms of the social dimensions. The parts of gangetic plains are also accounted in the highest and high category of social vulnerability. The degraded ecosystems viz., wetlands, desert, grasslands etc. are in the sensitive state of changes and functioning. The Technological vulnerability and/or affluence are very high in the areas having low biophysical vulnerability. These areas have a degree of high social vulnerability also. Though these areas are with wealth of natural resources viz., forest cover, minerals, fertile land etc., these are very sensitive to the technological changes taking place. This need to be studied in detail and accordingly protection, preservation and conservation activities should be worked out.

Dimensions and Indicators of Vulnerability Index

Vulnerability Index	Dimension	Indicator	Dimension Index
Biophysical	Soil Quality	Depth of soil cover	Soil quality index
		Soil degradation severity	
	Ground water availability	Replenishable ground water available for future use (cu m)	Ground water Scarcity Index
Social	Agricultural dependency	Percentage of district workers employed in agriculture	Agricultural Dependency Index
	Vulnerability of agricultural workforce	Percentage of landless laborers in agricultural workforce	Landlessness Index
	Human capital	Adult literacy rate (>7 years)	Education Index *[100–index value]*
	Female disadvantage	"Missing girls" i.e., less than 48.5% girls in 0-6 population	Female Disadvantage Index *[100-index value]*
	Female literacy and child survival chances	Female literacy rate	Female Literacy and Child Survival Index *[100 – index value]*
Technological	Vulnerability to rainfall variability	Irrigation rate	Irrigation Index
	Infrastructure development	Composite index of infrastructure development	Infrastructure Development Index

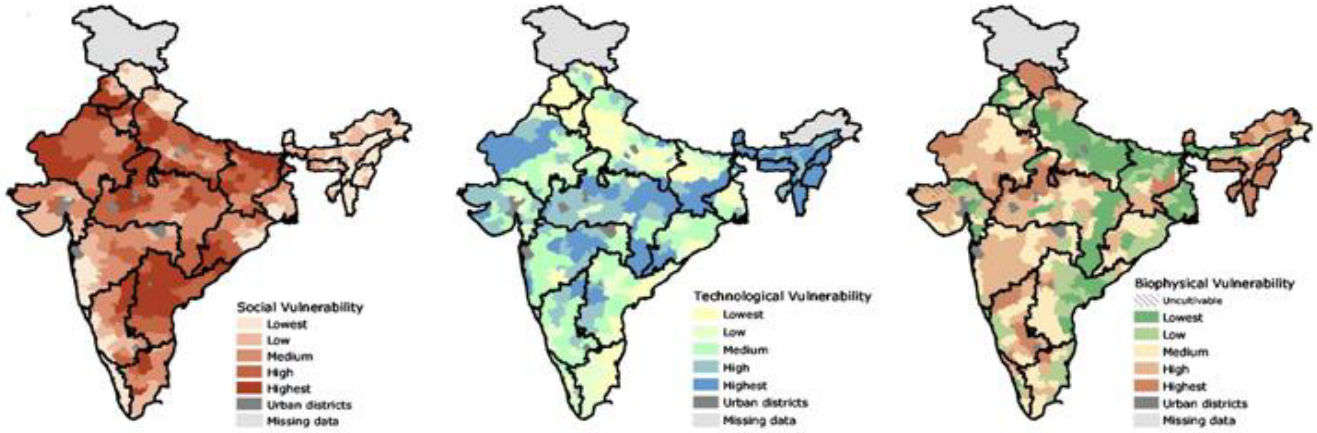


Fig. Vulnerability map of India (a) Social (b) Technological (c) Biophysical (Source: TERI Unpublished)

Forest Ecosystems vis-à-vis demographic indices (Joshi *et al.*, 2006)

Forest types are mapped in an exercise using multi-temporal IRS Wide Field Sensor (WiFS) data over the period of 1998 to 1999. The generated database identifies 35 cover classes with a description of 22 vegetation cover including 14 forest cover types from 188 m spatial resolution WiFS data.

While relating the demographic indicators with the distribution of forest ecosystems, it could be inferred that literacy has no linkage; the marginal population tends to be linked with the distribution of terrestrial forest ecosystems in parts of central India, northeast Himalaya (specifically in Arunanchal Pradesh) and parts of western Himalaya and Gujarat; and a clear linkage could be established with the distribution of tribal population. The tribal population in India is known to be distributed in the parts of central highlands, Chotanagpur plateau, north east Himalaya, higher ridges of western Himalayan ecoregion and selected patches of Western Ghats and western coast. These communities are the most vulnerable to any change in these ecosystems. Incidentally these form the major proportion of the population below poverty line.

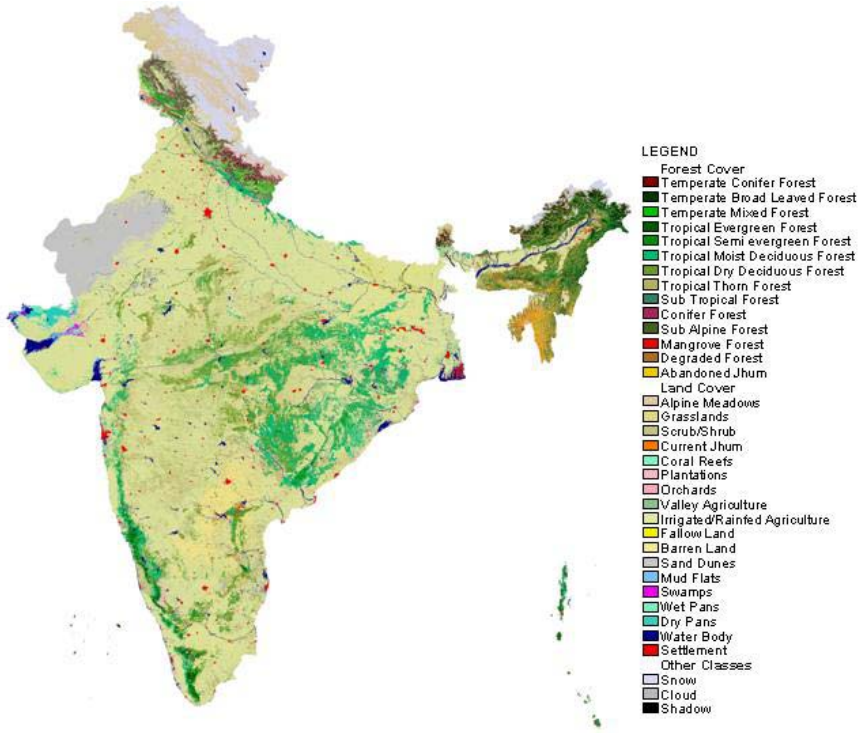


Fig. Vegetation cover type/land use map of India (Vegetation/Land Cover from IRS-1C WiFS data, Drainage from one time NIR band, Settlements from Defence Meteorological Satellite Program (DMPS) data Accuracy 86%) (Source: *Joshi et al.*, 2006)

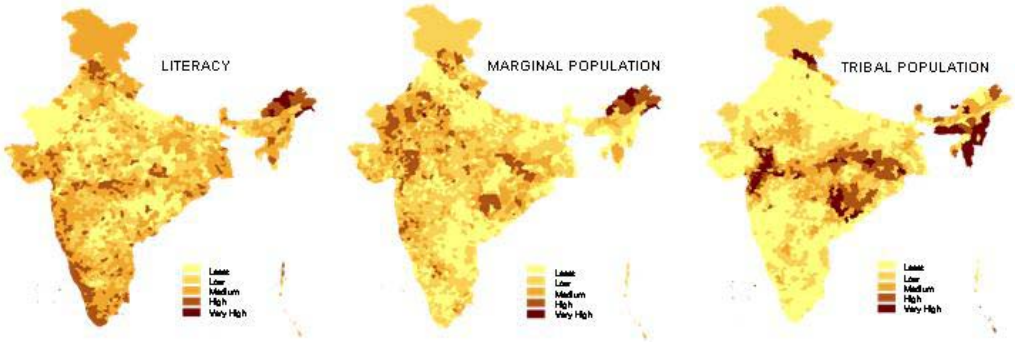


Fig. Demographic Indices of India (a) Literacy (b) Marginal population (c) Tribal population

Biological Richness

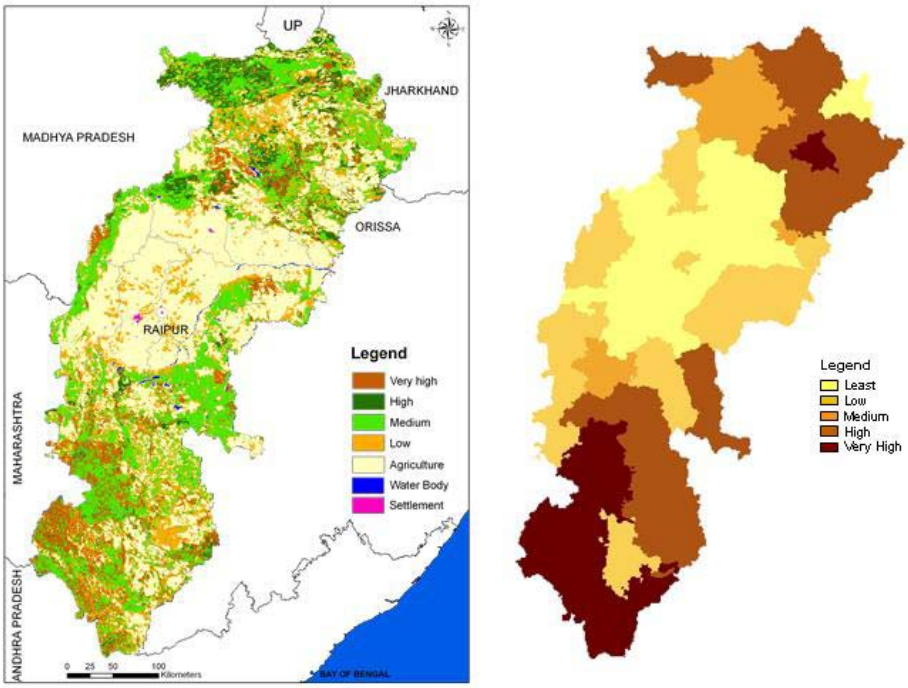


Fig. Biological richness map and Tribal population distribution map of Chattisgarh (Source: Joshi *et al*., unpublished)

While visualizing the distribution of tribal population and zones of biological richness, it is very easy to make out that the places with higher tribal population are having higher biological richness. This is attributed to their linkages with these ecosystems, dependency for the day today activities and other socio-cultural importance. Needless, to mention that alteration in the health and functioning of these ecosystems will hamper the lifestyles of these very communities within the close vicinity of these natural landscapes. Undoubtedly, these are the ones having maximum contribution to the population below poverty line.

References

Challinor, A., Slingo. J., Turner, A., and Wheeler, T. 2007. Indian monsoon: contribution to the stern review.

Hirway, I. and S. Goswami. 2004. "Valuation of mangroves in Gujarat". Centre For Development Alternatives, Ahmedabad.

Chopra, K., G. K. Kadekodi and M. N. Murty, 1990. Participatory development: people and common property resources, SAGE Publications.

Godbole A. and J. Sarnaik, 2004. "Enhancing Ecosystem services of commons by participatory conservation and development approach", paper presented at IASCP, 2004.

Kumar, P., S. Sanyal, R. Sinha and P. Sukhdev, 2006. 'Accounting for the ecological services of India's forests: soil conservation, water augmentation, and flood prevention', Monograph 7, Green Accounting for Indian States and Union Territories Project, TERI Press, New Delhi.

Farrington, J., C. Turton and A. J. James (Eds.), 1999. 'Participatory watershed development: challenges for the twenty-first century', New Delhi: Oxford University Press.

Chopra, K., N. A. Khan and P. Kumar, 2006, 'Identifying the economic drivers of land use change in mangrove ecosystems: a case study of the India Sunderbans'. Paper presented in the workshop on Trade, Environment and Rural Poverty, 18-19 August 2006, Institute of Economic Growth, New Delhi.

Turner, A. G., Inness P. M.and Slingo, J. M. 2006: The effect of doubled CO2 and model basic state biases on the monsoon-ENSO system. Part A: Mean response and interannual variability. Q. J. R. Met. S., submitted.

Challinor, A. J., Wheeler, T. R., Slingo, J. M., Craufurd P. Q. and Grimes, D. I. F. (2004). Design and optimisation of a large-area process-based model for annual crops. Agricultural and Forest Meteorology, 124, (1-2) 99-120.

Challinor, A. J., Wheeler, T. R., Craufurd, P. Q. , Ferro, C. A. T. and Stephenson, D. B. (2006).Adaptation of crops to climate change through genotypic responses to mean and extreme temperatures. Agriculture, Ecosystems and Environment, In press.

Trenberth, K.E. and Jones, P.D., 2007. Observations: Surface and atmospheric changes. Chapter3. IPCC 4th assessment report.

Manoharan, T. R. 2000. 'Natural resource accounting: economic valuation of intangible benefits of forests', RIS Discussion Paper 04/2000, New Delhi: Research and Information System for the Non-aligned and other Developing Countries.
Haripriya, G.S., 2001. 'A framework for assessing carbon flow in Indian wood products', Environment, Development and Sustainability, 3(3): 229-251.

Ghate R., Alka Chaturvedi, and Deepshikha Mehra (2003) 'Bio-Diverse Economic Dependence Of Indigenous Population: A Study From Gadchiroli District Of Maharashtra State', Paper presented at the Third Biennial Conference of the Indian Society for Ecological Economics (INSEE), to be held at the Indian Institute of Management, Kolkata, 18-20 December).

Bhattacharyya, S. 1998. Sunderban – Dying a slow death. The Hindu, Survey of the Environment - 98, 89 – 94.

Geevan C.P., Arun M. Dixit and C.S. Silori (2005) "Dynamics of resource economics of open access grasslands –Kutch district (Gujarat)" in Nirmal Sengupta and Jayant

Bandopadhyay (Ed.s) *Biodiversity and Quality of Life* Macmillan, New Delhi.
World Bank (2002); 'Linking poverty reduction and environmental management: policy challenges and opportunities', July 2002, The World Bank: Washington DC.

Sinha, Rajiv K., Sonu Bhatia and Ritu Vishnoi (1997), "Desertification control and rangeland management in the Thar desert of India" in Proceedings from an International Workshop in Iceland. Rala Report no. 200. Agricultural Research Institute, Reykjavik, Iceland, < http://www.rala.is/rade/rade-Sinha.PDF >

Singh, H.P. (1998), "Sustainable development of the Indian desert: the relevance of the farming systems approach" *Journal of Arid Environments* 39:279-84.

Grewal S.S., A.S. Dogra, and T.C.Jain. 2001. "*Poverty Alleviation and Resource Conservation Through Integrated Watershed Management in a Fragile Foot-Hill Ecosystem",* in "Sustaining the Global Farm (edt.) D.E. Stott, R.H. Mohtar and G.C. Steinhardt.

Tiwari, PC (2000), "Land-use changes in Himalaya and their impact on the plains ecosystem: need for sustainable land use" Land *Use Policy* 17: 101-11.

Semwal et al (2004), "Patterns and ecological implications of agricultural land-use changes: a case study from Central Himalaya, India", *Agriculture, Ecosystems and Environment* 102: 81-92.

Chandrasekhar et al (2007), "Ecological implications of traditional livestock husbandry and associated land use practices: A case study from the trans-Himalaya, India" *Journal of Arid Environments* 69: 299-314.

Kerr J. 2002. "Watershed Development, Environmental Services, and poverty alleviation in India", *World Development* Vol. 30, No.8, pp.1387-1400.

Ghate R., Deepshikha Mehra, and Harini Nagendra (2006) Alternative income opportunities and dependence on non-timber forest products, Report No. 01-06, Feb, SHODH: The Institute for Research and Development).
Ghate, R., 2005. "Need Assessment Of Forest Dependent People: Tribal Belts Of Three States Of Central India", Report No. 2-05, SHODH: The Institute for Research and Development, Nagpur

Purushothaman. S., 2005. Land-use Strategies, Economic Options and Stakeholder Preferences: A Study of Tribal Communities in Forest Peripheries

Silori, C. S., 2007. Perception of local people towards conservation of forest resources in Nanda Devi Biosphere Reserve, north-western Himalaya, India, Biodivers Conserv 16:211–222

Guha, I. and S. Ghosh, 2007. Does Tourism Contribute to Local Livelihoods? A Case Study of Tourism, Poverty and Conservation in the Indian Sundarbans, SANDEE Working Paper No. 26-07.

CMIE (2000). Profiles of districts. Center for Monitoring Indian Economy, Mumbai.

Hill, M.J., Braten, R., Veitch, S.M., Lees, B.G. and Sharma, S. (2005). Multi-criteria decision analysis in spatial decision support: the ASSESS analytic hierarchy process and the role of quantitative methods and spatially explicit analysis. *Environmental Modeling & Software* **20**:955-976.

Joshi, P.K., Dash, P.P., Kumar, M. and Roy, P.S. (Unpublished). Biodiversity characterization using geospatial tools.

Joshi, P.K., Roy, P.S., Singh, S., Agarwal, S. and Yadav, D. (2006). Vegetation cover mapping in India using multi-temporal IRS Wide Field Sensor (WiFS) data. *Remote Sensing of Environment* **103**: 190–202.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., Javed, A., Bhadwal, S., Barg, S., Nygaard, L., and West, J. (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change* **14**: 303–313

Tiwari, P.C. and Joshi, P.K. (2005). Resource utilization pattern and its impact on the biodiversity in the lake region of district Nainital, Kumaon Himalaya using remote sensing and geographical Information system. *Final Technical Report*. Indian Space Research Organsiation, DOS GoI, Banglore. pp.103.

Walker, P.A. and Young, M.D. (1997). Using integrated economic and ecological information to improve government policy. *International Journal of Geographical Information Science* **7**:619–632.

Yu, Haiying, Joshi, P.K. and Das, K.K. (2006). Forest Cover Dynamics and Eco-environmental Vulnerability Analysis in Birahi Ganga Sub-watershed using Geospatial Approach. *Project Report*. Centre for Space Science and Technology Education in Asia and the Pacific, Dehradun.

IUCN (2003) IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 pp.

Millennium Ecosystem Assessment (MA) (2005). Ecosystem and Human Well-Being: Synthesis. Washington, D.C: MA.

FAO, 2003 Nepal Agricultural Policy and Strategies for Poverty Alleviation and Food Security Nep/99/023: Sppd Report Food and Agriculture Organization of the United Nations, United Nations Development Programme Kathmandu, Nepal

EDWARDS, D.M. 1996. Non-timber forest products from Nepal:Aspect of the trade in medicinal and aromatic plants.FORESC Monograph 1/96, Forest Research and Survey Centre, Ministry of Forests and Soil Conservation, Kathmandu

IIED and TRAFFIC, 2002. Making a Killing or Making a Living? Wildlife trade, trade controls and rural livelihoods. Biodiversity and Livelihoods Issues No.6.

Abdul Latif and Zabta Khan Shinwari. SUSTAINABLE MARKET DEVELOPMENT FOR NON TIMBER FOREST PRODUCTS IN PAKISTAN. Kohat University of Science & Technology, Kohat Pakistan. (http://www.siu.edu/~ebl/leaflets/latif.htm) website accessed on March 17, 2008

Table 1. Biogeographic zones of India

Biogeographic Zone	Biotic Province	Total Area (Sq. Km.)
Trans-Himalayan	Upper Regions	186200
Himalayan	North-West Himalayans	69000
	West Himalayas	72000
	Central Himalayas	123000
	East Himalayas	83000
Desert	Kutch	45000
	Thar	180000
	Ladakh (cold)	NA
Semi-Arid	Central India	107600
	Gujarat-Rajwara	400400
Western Ghats	Malabar Coast	59700
	Western Ghat Mountains	99300
Deccan Peninsula	Deccan South Plateau	378000
	Central Plateau	341000
	Eastern Plateau	198000
	Chhota Nagpur	217000
	Central Highlands	287000
Gangetic Plain	Upper Gangetic Plain	206400
	Lower Gangetic Plain	153000
North-East India	Brahmaputra Valley	65200
	North-Eastern Hills	106200
Islands	Andaman Islands	6397
	Nicobar Islands	1930
	Lakshadweep Islands	180
Coasts	West Coast	6500
	East Coast	6500

Table 2. High poverty states of India

State	% of India's poor in 1999-2000	% of population in 2001
Uttar Pradesh (including Uttaranchal)	20.4	17
Bihar (including Jharkhand)	16.4	10.7
Madhya Pradesh (including Chhatisgarh)	11.5	7.9
Maharashtra	8.8	9.4
West Bengal	8.2	7.8
Orissa	6.5	3.6
Total	71.8	56.4

Source: Mehta and Shah (2006)

Table 3. Trends in poverty ratios according to $1 a day definition: 1981-2001

Regions		**Poverty Rate (%)**			**Annual Change**	
		1981	**1990**	**2001**	**1981-90**	**1990-01**
Bangladesh		26.2	35.2	32.8	3.34	-0.64
Bhutan		-	-	36.3*	-	-
India		53	40.6	35.5	-2.92	-1.22
The Maldives		-	-	1.0**	-	-
Nepal		41.9	53.2	27.3	2.69	-5.88
Pakistan		56.4	47.8	12	-1.82	-11.81
Sri Lanka		18.2	3.8	1.8	-15.97	-6.57
South Asia		51.5	41.3	31.3	-2.42	-2.49
East Asia and the Pacific		57.7	29.6	14.9	-7.15	-6.05
Latin America and the Caribbean		9.7	11.3	9.5	1.71	-1.56
Middle East and North Africa		5.1	2.3	2.4	-8.47	0.39
Sub-Saharan Africa		41.6	44.6	46.9	0.78	0.46
World		40.4	27.9	21.1	-4.03	-2.51

***Source**:www.worldbank.org/research/povmonitor as cited in SAARC 2006*
** For the year 2000 as per RPP 2005 Bhutan Country Report*
*** For the year 2004 as per RPP The Maldives Country Data*

Table 4. Trends in the incidence of Population below the National Poverty Line (%), 1980-2004

Country		% of Population Below Poverty Line				Annual Change		
		1980	1990	2000	2004	1980-90	1990-00	2000-04
Bangladesh	DCI	73	47.5	44.3	40.9	-4.2	-0.8	-1.9
	CBN		58.8	49.8		-1.5		
Bhutan				36.3	31.7			-1.5
India		44.5	36	26.1		-2.1	-3.2	
Nepal		36.2 (1997)	40.0 (1989)	38	30.8	0.84(1977-89)	-0.47 (1989-00)	-5.1
Pakistan		29.1 (1987)	26.1	34.4(2001)	23.9(2005)	-3.56	2.89	-6.1
Sri Lanka		30.9* (1985)	26.1 (1990-91)	22.7(2002)		-3.32	-1.16	

***Source**:RPP 2005 country reports; * SAARC RPP 2004*
***Note**: Sri Lanka - Excluding Northern and Eastern Provinces*
Estimates for 1991-92 and 200 in Bangladesh are based on CBN method and those for other years on DCI method

Table 5. Proportion of the Population below the Minimum level of Dietary Energy Consuption

Country	Earlier Year		Latest Year	
	Year	% of Undernourished Population	Year	% of Undernourished Population
Bangladesh	1991	35	2001	30
Bhutan				
India	1991	25	2001	21
Nepal	1991	20	2001	17
Pakistan	1991	24	2001	20
Sri Lanka	1991	28	2001	22
South Asia*	1990-92	25	200-02	22

Sources: United Nations 2005. A Future Within Reach.
http://unstats.un.org/unsd/mi/mi_worldregn.asp
*South Asia also includes Afghanistan and Iran

Table 6. Prevalence of under-nourishment among children below 5 years of age

Country			% of Malnourished Children			
			1985-86	**1990**	**2000**	**2004**
Bangladesh	Stunting (height for age): Severe				18.3	16.9
	Moderate to Severe		69	66	44.7	43
	Wasting (weight for age): Severe				1.1	1.3
	Moderate to Severe		15	15	10.3	12.8
	Underweight (weight for age): Severe				12.9	12.8
	Moderate to Severe		72	67	47.7	47.5
Bhutan						
India				25		21
Nepal			49.0 (1979-81)	19.0 (1990-92)	19.0 (1998-00)	
Pakistan				40	41.5	37
Sri Lanka	Stunting (height for age, 3-59 months			23.8(1993)	13.5	
	Wasting (weight for age,3-59 months			15.5(1993)	14	
	Underweight (weight for age, 3-59 months)			37.7(1993)	29.4	

Table 7. Trends in Human Development Indices, SAARC Countries and Other Regions: 1980 to 2003

Country/Region	1980	1990	2000	2003
Bangladesh	0.364	0.419	0.506	0.52
	(n.a.)	(135)	(145)	(139)
Bhutan	n.a.	n.a.	n.a.	0.538
	(n.a.)	(147)	(145)	(134)
India	0.438	0.513	0.577	0.602
	(n.a.)	(121)	(124)	(127)
Nepal	0.333	0.423	0.499	0.526
	(n.a.)	(140)	(142)	(136)
Pakistan	0.386	0.462	n.a.	0.527
	(n.a.)	(120)	(138)	(135)
Sri Lanka	0.649	0.705	n.a.	0.751
	(n.a.)	(76)	(89)	(93)
South Asia*				0.628
East Asia and the Pacific				0.768
Latin America and the Caribbean				0.797
Sub-Saharan Africa				0.515
High-income OECD countries				0.911
World				0.741

Source: Human Development Reports 1999, 2002.2005 UNDP.
Notes: 1. Figures in brackets are country ranks.
2. Table 2 in the UNDP report.
3. n.a. means not available. Where the rank was available but the accompanying index is not given in the 2005 Report, the ranks for 1980, 1990 and 2000 are not strictly comparable to those for 2003.
*4.*South Asia also includes Afghanistan and Iran.*

Table 8. Major forest types found in India

Forest type	Sub-Type	Area (in mha)	%	Occurrence in States/Union Territories
Tropical	Tropical Wet Evergreen Forest	4.5	5.8	Arunanchal Pradesh, Assam, Karnataka, Kerala, Mizoram, Manipur, Nagaland, Tamil Nadu, Sikkim, Andaman & Nicobar Islands, Goa
	Semi-Ever-Green Forest	1.9	2.5	Assam, Karnataka, Kerala, Maharastra, Nagaland, Orrisa, Tamil Nadu, Andaman & Nicobar Islands, Goa
	Moist Deciduous Forest	23.3	30.3	Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharastra, Manipur, Meghalaya, Mizoram, Tripura, Nagaland, Orrisa, Tamil Nadu, Uttar Pradesh, West Bengal, Andaman & Nicobar Islands, Goa, Dadra & Nagar Haveli
	Littoral Swamp Forest	0.7	0.9	Andhra Pradesh,Gujarat, Orrisa, Tamil Nadu,West Bengal, Andaman & Nicobar Islands
Sub-Tropical	Dry Deciduous Forest	29.4	38.2	Andhra Pradesh, Bihar, Gujarat, Himachal Pradesh, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharastra,J&K, Orrisa, Punjab, Rajhasthan, Tamil Nadu, Uttar Pradesh,
	Thorn Forest	5.2	6.7	Andhra Pradesh, Gujarat, Himachal Pradesh, Haryana, Karnataka, Madhya Pradesh, Maharastra, Punjab, Rajhasthan, Tamil Nadu, Uttar Pradesh,
	Dry Evergreen Forest	0.1	0.1	Andhra Pradesh, Tamil Nadu
	Subtropical Broadleaved Hill Forest	0.3	0.4	Assam, Meghalaya
	Subtropical Pine Forest	3.7	5	Arunanchal Pradesh, Himachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Uttar Pradesh, Haryana, Punjab
	Subtropical Dry Evergreen Forest	0.2	0.2	Himachal Pradesh, J&K
J&K, Himachal Pradesh	Montane Wet Temperate Forest	1.6	2	Arunanchal Pradesh, Karnataka, Manipur, Nagaland, Tamil Nadu, Sikkim
	Himalayan Moist Temperate Forest	2.6	3.4	Himachal Pradesh, J&K, Uttar Pradesh
	Himalayan Dry Temperate Forest	0.2	0.2	

Alpine	Sub Alpine Forest	3.3	4.3	J&K, Uttar Pradesh
	Moist Alpine Scrub			
	Dry Alpine Scrub			

Source: GoI, 2001, India: National Action Programme to Combat Desertification, Volume 1, Status of Desertification, Ministry of Environment & Forests, Government of India, New Delhi.

Table 9. Forest cover estimates from 1987 to 2003

Assessment	Year	Data period	Resolution of Sensors	Forest Cover (sqkm)	% of geographic area
First	1987	1981-83	80	640,819	19.49
Second	1989	1985-87	30	638,804	19.43
Third	1991	1987-89	30	639,364	19.45
Fourth	1993	1989-91	30	639,386	19.45
Fifth	1995	1991-93	36.25	638,879	19.43
Sixth	1997	1993-95	36.25	633,397	19.27
Seventh	1999	1996-98	23.25	637,293	19.39
	2001			675,538	20.55
	2003			678,333	20.64

Source: FSI, 2005

Table 10. Forest cover as per 1999 assessment

Class	Area in sq km	% of Geographic area
Dense forest	377,358	11.48
Open forest	255,064	7.76
Mangroves	4,871	0.15
Sub-total	637,293	19.39
Scrub	51,896	1.58
Non-forest	2,598,074	79.03
Total	3,287,263	100.00

Table 11. State wise Mangrove cover (in km^2) in India

States	**Estimated**	**SAC**	**FSI**				
	by states	1992	1991	1993	1995	1997	1999
Andaman & Nicobar	1190	771	971	966	966	966	966
Andhra Pradesh	200	372	399	378	383	383	397
Goa	200	6	3	3	3	5	5
Gujarat	260	991	397	419	689	991	1031
Karnataka	60	127	-	-	2	3	3
Maharastra	330	–	113	155	155	124	108
Orissa	150	187	195	195	195	211	215
Tamil Nadu	150	30	47	21	21	21	21
West Bengal	4200	1619	2119	2119	2119	2123	2125
Total	6740	4123	4244	4256	4533	4827	4871

Table 12. State wise area of the arid zone in India (after Krishnan, 1977).

State Area under	Area under arid zone	Percent area
Rajasthan	1,96,150	62
Gujarat	62,180	19
Punjab	14,510	5
Haryana	12,840	4
Maharashtra	1,290	0.4
Karnataka	8,570	3
Andhra Pradesh	21,550	7
Jammu & Kashmir	70,300	--
Total Area	3,17,090	--

Table 13. Area of India's coastal ecosystems

Ecosystem type	Area (km2)
Estuaries	1540
Lagoons	1564
Creeks	192
Backwater	171
Tidal/Mud flat	23621
Coral reefs	2330
Mangroves	3401
Sandy beaches/bars/spits	4210
Rocky coasts	177
Salt marshes	1698
Salt pans	655
Aquaculture ponds	769
Other vegetation	1391

Source: ***

Table 14a. Data on state and trend indicators of biodiversity in five countries of South Asia

Indicator		Data/Details				
		Bangladesh	**Bhutan**	**India**	**Nepal**	**Pakistan**
Status of Animal species**	Threatened species†	**89**	**41**	**313**	**72**	**78**
	Extinct	**0**	**0**	**1**	**0**	**0**
	Data Deficient[+]	**13**	**1**	**124**	**9**	**19**
Status of plant species**	Threatened species†	**12**	**7**	**247**	**7**	**2**
	Extinct	**0**	**0**	**7**	**0**	**0**
	Data Deficient[+]	**0**	**1**	**18**	**1**	**3**
Average annual change in Forest Area (%)[@]		-0.1	0.4	0.4	-1.6	-1.6
Dependence on NTFPs	**Revenue from NTFPs**			**US $100 million****	US $ 8.6 Million***	
	Number of people dependent on NTFPs			**100 million****		**34%[++]**

* This includes 25 birds, 1 freshwater fishes, 6 reptiles, 20 mammals (Source: Third NBSAP submitted to CBD)

[+]extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate (Source: IUCN red list, 2001).

**** FAO, 2003** *******Edwards, 1996 ++ Latif and Shinwari

Table 14b. Data on response indicators of biodiversity in five countries of South Asia:

		Bangladesh	**Bhutan**	**India**	**Nepal**	**Pakistan**
Party to conventions	**CBD**	**X**	**X**	**x**	**x**	**x**
	CMS	**X**	**-**	**x**	**-**	**x**
	CITES	**X**	**X**	**x**	**x**	**X**
	Ramsar	**X**	**-**	**x**	**x**	**X**
	WHC	**X**	**X**	**x**	**x**	**x**
	ITPGR	**X**	**X**	**x**	**x**	**x**
Percentage of land area under protection#	**Asia average=5.74 %**	**1.3%**	26.4 %	5.12%	17.4%	9.1 %
Status of wetlands (Number and area of Ramsar sites)	Number of sites	2	**0**	8	1	16
	Total area	6,05,500 ha	**0**	1,94,521 ha	17,500 ha	2,83,952 ha
Word heritage sites* (Natural or mixed natural and cultural)		**1**	**0**	**5**	**2**	**0**

*** UNEP-WCMC** @ FAO (Food and Agriculture Organization). 2006. Global Forest Resources Assessment 2005. Rome

 # UNEP-WCMC World Database on Protected Areas **** IUCN red list** † Threatened species are those listed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU).

ECOSYSTEM SERVICES AND POVERTY ALLEVIATION IN NEPAL: A SITUATION ANALYSIS

Project sponsors

NERC, ESRC, DFID-UK

Consortium Partners

TERI UNIVERSITY AND TERI, INDIA

UNIVERSITY OF LIVERPOOL, UK

IUCN, ASIA

SDPI, PAKISTAN

BRAC, BANGLADESH

December 2007

Deleted: ¶
¶
¶

Ecosystem Services and Poverty Alleviation Study in South Asia (ESPASSA): Nepal Situation Analysis

1. Introduction

Nepal is a small land-locked country which lies along the southern slopes of the Himalaya Mountains. The country has a land area of 147, 180km^2, being 800km from east to west, and varying from 144km to 240km north to south, between longitudes 80°–88°E and latitudes 26°–31°N (Abbington, 1992). Over 70% of the country is covered by mountains of varying altitude. Nepal's landscapes have been broadly divided into three main categories based on diversity at different altitude: Terai and Siwalik Hills (below 1,000m), Mid-hills (1,000-3,000m), and highlands (above 3,000m). The total forest area in the country is around 4.27 million hectares (representing about 29 % of total land area), 1.56 million hectares (10.6 %) of shrubland and degraded forest, 1.75 million hectares (12 %) of grassland, 3.0 million hectares (21 %) of farmland, about 1.0 million hectares (7 %) of uncultivated inclusions (NBAP, 2000). Ethnic and linguistic divisions tend to follow the same pattern, with the Tibeto-Burman speaking, largely Buddhist groups mainly in the mountains, the Nepali speaking Hindu groups in the Mid-hills and the Indo-Aryan Hindu groups, mainly speaking Maithili and Bhojpuri, in the south. The country has a population of 23.2 million (2001 census): 48.5% population lives in the Terai, 44.2% in the Mid-hills and 7.3% in the mountains.

Terai and Siwalik Hills (below 1,000m)

The Terai region has approximately 18% of Nepal's most fertile land, and is a northern extension of the Gangetic Plains of India. The topography of the area is flat, and the soils are generally very fertile, consisting of alluvial deposits carried down in the rivers from the hills and mountains to the north. This zone ranges from 25–32km in width. The climate of the Terai is subtropical, with the natural seasons being determined by the monsoon rains which affect the entire Indian subcontinent.

The biological diversity contained in the Terai and Siwalik Hills (lowlands) ecosystems are of international importance both in view of the number of globally threatened species of wildlife and flora as well as the diversity of ecosystems contained within the area (Nepal Biodiversity Year Book, 2006). The Terai and Siwalik hills contain the richest habitat with tall grasslands interspersed with riverine and hardwood Sal forest (*Shorea robusta*), tropical deciduous riverine forest, and tropical evergreen forest. Due to heavy population pressure, the ecosystem in the Terai is under increasing stress, resulting in degradation of forest resources. There has been severe overexploitation of natural Sal woodland leading to its degradation and consequent loss. Sal forests have suffered greatly from lopping and felling of trees by local villagers in eastern and central Nepal, but there are still good stands of tall trees in western Nepal (NYB, 2006). While the Terai ecosystems are well represented by a wider network of national park and reserves, coverage of the Siwalik hill ecosystems in these protected areas is still not representative (Maskey, 1996). Out of 23 ecosystems described by Dobremez in the lowlands, 15 are included in the current protected areas of Nepal (NYB, 2006).

Mid-hills (1,000-3,000m)

The hill region is a diverse area with ridges and valleys and constitutes about 48% of the total area. The climate is classified as warm temperate, as low to Mid- hills (1300–2500m) are encountered in this region. Above this, between 2500 and 4500m one can find cool-temperate climate. The Mid-hills have the greatest ecosystem diversity as well as species diversity in Nepal. This is due to the great variety of terrain and the occurrence of subtropical

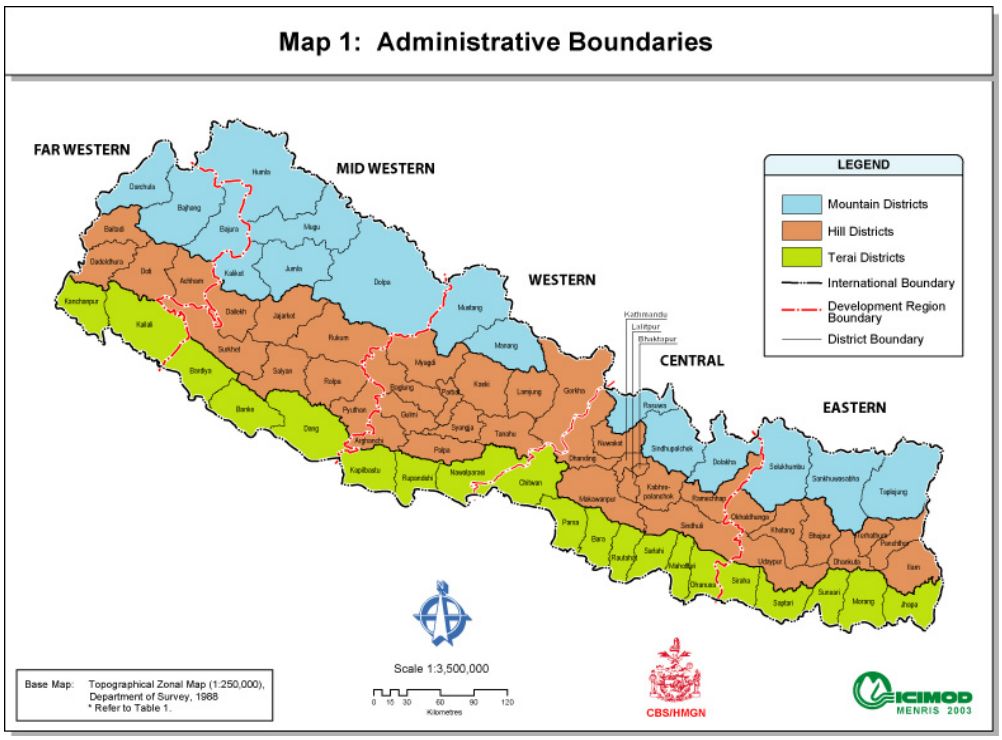
to temperate flora and fauna in this zone (NYB, 2006). Nearly 32% of the forests in Nepal occur in the Mid-hills, and the zone includes 52 types of ecosystems. Dobremez (1996) listed the highest number of angiosperms in the Mid-hills, particularly between 2,000-2,500m in altitude.

Highlands (above 3,000m)

The Nepal highlands are the meeting place of two major geographical regions of the world - the Palaearctic region to the north and the Palaeotropical or Indo-Malayan region to the south (NBY, 2006). High-hills cover the elevations from 2500–5000m. The Himalayas proper are located to the north of these High-hills and are again aligned east/west, which include the highest mountains in the world and range from 5000–8848m. These last two zones are either only sparsely inhabited, or are totally uninhabited, with most land above 5500m being permanently snowbound (Abbington, 1992). Ten of the world's 14 peaks over 8,000m are found in the Himalayas. 127 peaks over 7,000m and 1,311 others above 6,000m are also found in the Himalayas (Pandey 1995).

Snowline in the east starts at 5,000m and in the west at 4,000m. The high Himalaya is a cold desert where coarse debris, rocks and snow dominate. The high hills comprise an alpine zone, while above 5500m, the temperature is almost always below freezing point. Rainfall varies from as little as 500mm per annum in the rain shadow areas to the north of the high Himalayas to over 5000mm in areas to the south of some of the major Himalayan massifs. For most of the country average rainfall lies between 900mm and 1900mm per annum, becoming progressively drier from the east to the west. The greater part of this rain falls during the monsoon between the middle of June and the end of September.

There are 38 major ecosystems found in the highlands. The highlands are relatively less diverse in flora or fauna than the Mid-hills and lowlands because of the adverse environmental conditions. However, they are characterized by a large number of endemic species. They comprise around one third of the total forest cover of Nepal, representing birch, oak, rhododendron, juniper, fir, cedar, larch, and spruce forests (NBY, 2006). The mountain region covers about 34% of the total land areas (WWF Nepal, 2001).



Source: CBS/ICIMOD, 2003

2. Description of the key ecosystems in Nepal

Nepal comprises only 0.09% of land area on a global scale, but it possesses a disproportionately rich diversity of flora and fauna at genetic, species and ecosystem levels (Nepal Biodiversity Yearbook, 2006). Biodiversity in Nepal varies with physiographic zone, with the Mid-hills, characterised by a subtropical to temperate climate, representing the highest number of species of many floral and faunal groups. Biodiversity in the country varies with physiographic zone, with the Mid-hills, characterised by a subtropical to temperate climate, representing the highest number of species of many floral and faunal groups. Numbers of species decreases with altitude, but it is important to note that large numbers of endemic species occur in the high mountain zone, where the topography and cold climate have facilitated floral and faunal endemism.

Altogether 118 ecosystem types are found in these three landscapes (23 in Terai and Siwaliks, 52 in Mid-hills, and 38 in highlands) and 5 others (NBAP, 2000), however its number is still contested. Broadly, ecosystems in these landscapes have been divided into: forest ecosystems, rangeland ecosystems, wetland ecosystems, mountain ecosystems and agro-ecosystems. The biological resources of the Terai and Siwalik hills forest ecosystems are mostly dominated by Sal trees (*Shorea robusta*), tropical deciduous reverine forests and tropical evergreen forests. These ecosystems are of international importance both in terms of number of globally threatened wildlife and floral species as well as their diversity. The Mid-hills have the greatest diversity of ecosystems (52) and species in Nepal. Nearly 32% of Nepal's forests occur in the Mid-hills. Likewise, there are 38 major ecosystems in the mountains and lowlands because of harsh environmental conditions, they nevertheless characterized by a large number of endemic species (NBS, 2002).

Table 1.1 Ecosystems identified by Dobremez (1970)

Physiographic zone	Total number of ecosystems
Terai	10
Siwalik hills	13
Mid-hills	52
Highlands	38
Other	5
Total	118

Source: Modified from BPP (1995) by Maskey (1996)

Major ecosystems found in these three different landscapes can be classified as follows.

2.1 Forest ecosystem

FRSD (1996) estimated about 39 % of land in Nepal is covered by forest and shrub land although this figure is still contentious. However many authors reported that forest areas in Nepal have been increased after the introduction of community forests (Jackson et al., 1998; Brown 1997; Oli 2002; Branny and Yadav, 1998).
Forest ecosystem of Nepal can be classified on the basis of altitude and geographic regions. There are 10 kinds of forest types in Nepal based on the altitude and ecological zones (NBS, 2002) along with a plantation forests in Terai and the Mid-hills. Characteristics of these forest types also vary from east to west according to local climatic conditions. One of the most outstanding features of the landscape in Nepal is the altitudinal gradient, from the tropical broadleaf forests of Jhapa district to the eastern subtropical and lower temperate forests of Illam and Panchthar districts and the diverse forest types. Major forest types in Nepal are presented in table 2.1.

Table 2. 1 Major forest types of Nepal

SN	Forest types	Altitude ranges	Species	Geographic zones	Poverty Linkage
1	Tropical forest	below 1,000m	*Shorea robusta, Acacia catechu/Dalbergia sissoo, Bombax ceiba, Terminalia/Anogeissus*	southern parts of Nepal riverine forests foothills of western Nepal	Forest based industries, fuelwood enterprise, timber, fuelwood, and fodder
2	Subtropical broad-leaved forest	1,000-2,000m	*Schima wallichii/Castanopsis indica, Cedrela/Albizia, Alnus nepalensis*	central and eastern Nepal Arun on subtropical foothills	Timber, fuelwood, small woods and fodder
3	Subtropical pine forest	1,000-2,200m	*Pinus roxburghii*	south-facing slopes of the Mid-hills and Siwalik Hills in western and central Nepal	Day to day basic needs, furniture, timber, litter
4	Lower temperate broad-leaved forest	2,000-2,700m 1,700-2,400m	*Quercus leucotrichophora/Q. lanuginosa Q. lamellosa , Alnus nitida, Q. floribunda Alnus nitida,*	West: Mugu valley, Mid-hills East Mid-hills	Fodder, small woods, litter

SN	Forest types	Altitude ranges	Species	Geographic zones	Poverty Linkage
			Castanopsis tribuloides/C. hystrix, Lithocarpus pachyphylla		
5	Lower temperate mixed broad-leaved forest	1,700-2,200m	*Lauraceae* family	north and west-facing slopes	Fuelwood, smallwood, litter
6	Upper temperate broad-leaved forest	2,200-3,000m	*Quercus semecarpifolia*	central and eastern Nepal on south-facing slopes	Fodder, NTFPs
7	Upper temperate mixed broad-leaved forest	2,500-3,500m	*Acer and Rhododendron species* *Aesculus/Juglans/Acer forests*	central and eastern Nepal mainly on north and west-facing slopes confined to western Nepal	NTFPs, small woods Edible plants and fruits
8	Temperate coniferous forest	2,000-3,000m	*Cedrus deodara, Cupressus torulosa, Tsuga dumosa and Abies pindrow* *Pinus wallichiana* *Cedrus deodara, Picea smithiana, Juniperus indica and Abies pindrow* *Cedrus deodara* *Larix himalaica, Larix griffithiana*	3,000m Upto 3,700m western Himalayas Bheri River valley Langtang and Buri Gandaki valleys of Nepal	NTFPs, Medicinal plants, timber
9	Sub-alpine forest	3,000-4,100m	*Abies spectabilis, Betula utilis, and Rhododendron forests*	subalpine zones, the latter in very wet sites	NTFPs, Small woods, timber
10	Alpine scrub	above 4, 100m 6,100m	*Juniper-Rhododendron associations include Juniperus recurva, J. indica, J. communis, Rhododendron anthopogon, and R. lepidotum with Ephedra gerardiana, and Hippophae tibetana Caragana versicolor, Lonicera spinosa, Rosa sericea and Sophora moocroftiana*	Dhaulagiri-Annapurna massif	NTFPs, Edible plants and fruits i.e. Mushroom

SN	Forest types	Altitude ranges	Species	Geographic zones	Poverty Linkage
			Stellaria decumbens and Parrya lanuginose		
11	Plantation Forests		*Dalbergia sissoo, Eucalyptus species, and Tectona grandis Pinus roxburghii, P. wallichiana, P. patula, and Alnus nepalensis*	Terai, Sagarnath and Nepalgunj forestry development projects Mid-hills	Timber, Fuelwood, poles, raw material for forest-based industries

Source: NBS, 2002

Forest ecosystems provide a variety of services to local inhabitants such as food, fiber, nuts, wildlife, timber and non-timber forest products (NTFPs). A diversity of NTFPs including aromatic, medicinal, food, and fiber plants is found in Nepal. Many of these species grow in the hills and mountains, providing an important supplemental livelihood resource for families who can grow only enough crops to feed themselves for a few months of the year and that wild plants are the only source of medicine for many rural families (Schweithelm et al., 2006). The rural communities of Nepal are dependent on forests as their source of energy, animal fodder, leaves, and herbs for medicine, charcoal, farm implements and wood products. Leaf litters are used for mixing with dung to enrich farm soils. Further, use of the forest is closely interrelated with subsistence agricultural activities in the country. Forests provide 75 percent of total energy consumed in the country and more than 40 percent of livestock nutrition from fodder (MPFS 1988). Hydrological services associated with the forest ecosystem are maintenance of water quality, increased dry season water flow, reduced salinization, flood control, soil erosion control, reduced sedimentation and maintenance of aquatic habitats (MPFS, 1988). The role of forests in reducing run-off rain water and flooding in downstream areas is well recognized. Forests play a dynamic role in the protection of fragile mountains and maintain complex and diverse ecosystems (Thomson 1995). For instance, improvement of the levels of underground water aquifer has been reported as a contribution of community forestry intervention in a recent study (Roy, 2002). Forest products also have an important commercial value covering everything from high value timber exploited on an industrial scale to collection and sale of firewood, grasses and herbs by the poorest of the poor for day to day survival.

Forest catchments are the main sources of water used for hydroelectric power, irrigation and drinking water for domestic consumption in Nepal. Nepal has a large supply of water in proportion to its size and has the potential to produce large quantities of hydropower because of the steep gradient of the rivers flowing out of the Himalayas (Schweithelm et al., 2006). A large number of micro- and small- to medium-scale hydropower systems have been developed to serve remote communities and urban areas which have direct contribution in reducing poverty. Farmer-managed irrigation has a very long history in Nepal. There are well-established traditional institutions and procedures for the management of irrigation water in the country. While most of the farmer-managed irrigation systems (FMIS) are in the hills, Government Managed Irrigation Systems (GMIS) are in the Terai commonly cover tens of thousands of hectares, with thousands of users (Schweithelm et al., 2006)

Tourism is one of the major sources of earning for the country and that tourism industry is widely supported by forest ecosystems. Nature-based eco-tourism promotes local cottage industries, communication services and many other aspects of local development. Forests enhance aesthetic beauty of the surrounding landscape which attracts both local and international visitors. NPC (1988) shows that about 23 percent of tourists visiting Nepal in 1996 cited Nepal's green forests as the important reason for their visits. Tourists visit in the protected areas area create huge amount of employment opportunities to the local people in terms of tourist guide, hotel, shops travel agencies, and entry fee to the government.

In terms of forest resources, Bhutan has the highest percentage of forest area (68%) compared to that of (29.9%) for Sri Lanka and 25.4% for Nepal. Annual average decline of forest in Nepal is estimated to be 1.6 % and which is highest decline among the SAARC nations (Appendix A). Carbon dioxide emissions in Nepal are only 3 mt., which is negligible in light of world's emission. Forest areas have helped to reduce global CO2 emission by 26.9 mt., which is a major contribution of forest conservation in Nepal.

However, forest ecosystems are under increasing pressure from development intervention and population growth. Deforestation and habitat degradation with unsustainable harvesting are considered to be important factors in the declining trend in the availability of forest ecosystem services in Nepal. Out of the total landmass of Nepal, the percentage of forest has dropped from 37.82 percent in 1986 to 29 percent in 2000 (CBS, 2006) Most of these forests have been cleared for agricultural purposes (Dhakal, 2007). As shown in Table 2.2 and 2.3 the estimated changes in area of natural forests during the period 1979-86 was relatively higher for Terai. The area of natural forests in the High Himalaya and high mountains has changed slightly due to the rehabilitation of some of the degraded areas. The rate of deforestation in the Mid-hills and Siwaliks area is insignificant compared to that of Terai, where the annual rate is 3.9 %. Nepal's forest area declined at the annual rate of 0.4 % during this period. It has been estimated that about 22,700 ha were cleared from 1978-79 to 1984-85 and are assumed to be lost due to illegal settlements during this period (HMGN/MPFS, 1988).

Table 2.2 Change in Forest Area in Nepal 1964-1979

Region	1964-65 (000 Ha.)	1978-79 (000 Ha.)	Difference (000 Ha.)	Area Change	Annual Change
Hills	5683.1	5492	-191.1	-3.4	-0.2
Tarai	783.8	592.9	-190.9	-24.4	-2.0
Nepal	6466.9	6084.9	-382.0	-5.9	-0.4

Source: HMGN, 1986

Table 2.3 Changes in Area of Natural Forests, 1978/79 to 1985/86 ('000 ha)

Region	1978-79	1985-86	Difference	% Change 78-85	Annual
High Himal	154	155	+ 1	0.6	0.0
High Mountain	1628	1634	+ 6	0.4	0.0
Mid-Mountain	1791	1781	- 10	-0.6	0.0
Siwaliks	1445	1434	- 11	-0.8	-0.1
Terai	587	445	-142	-24.1	-0.4
Total	5605	5449	-156	-2.8	-0.4

Source: HMGN, 1986

Not all of the deforested lands were converted to agriculture. Some remained as degraded forests and grasslands. The forest area, including natural forests, degraded forests, shrublands, and new plantations, declined by only 84,900 ha or 1.3 % in 1979-86. As an annual rate, this is only 0.2 % or half that of the 1964-79 period (HMGN/MPFS, 1988). The scale and impact of deforestation varies greatly within Nepal. Table 2.2 and 2.3 present the projected decline in Nepal's forest area over time.

Conversion of forests and grasslands to agriculture and settlements is most intense in the country. Deforestation causes erosion and complicated cultivation, affecting the future productivity. Deforestation has disturbed the natural water sources, forcing people to spend more time collecting water from rivers and other contaminated sources. This situation has

adverse effects on people's health, making them sick. As there is complex and symbiotic relationships between farms and forests in Nepal, deforestation mean loss of productivity of agricultural lands which depend heavily on sustainability of forest ecosystems.

Table: Annual deforestation by ecological zone

Physiographic zone	Annual rate of forest area decreased
Mountain and hills	2.30
Terai	1.30
Nepal	1.70

Source: Adopted from Dhakal (2007), CBS (2006)

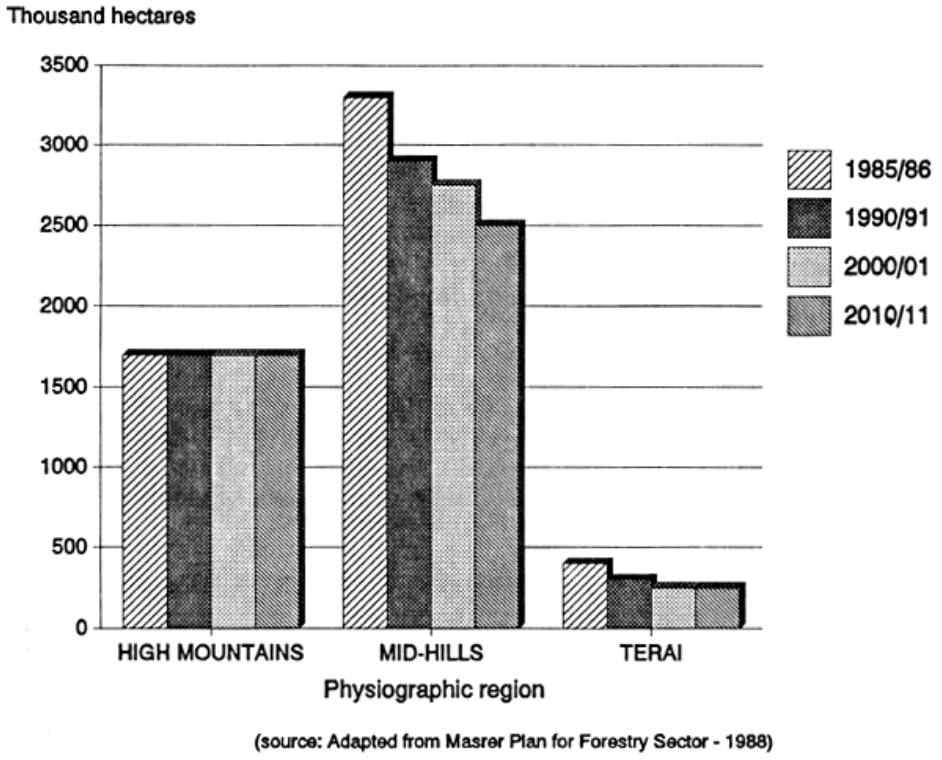


Figure 3.1 Projected declines in forest areas in Nepal

Although the systematic documentation of the flora of Nepal is a continuous process, invasive species is another threat to forest ecosystem. Perhaps, the most widely distributed invasive species found in Nepal are *Eupatorium adenophorum, E. odoratu, Lantana camara, Ageratum houstoniamum, Mikania micrantha* and some water plants such as *Eichornia* and *Nelumbius* (Bista and Chaudhary, 2003). As these invasive species compete with native species for resources such as nutrients, soil moisture, sunlight and space, loss of naturally occurring species is a threat to the forest ecosystem.

The major environmental problems in Nepal are caused by land degradation, deforestation, and pollution. Both the Siwalik and Mid-hills are geologically unstable and prone to natural disasters, set off by heavy rain, drought, steep slopes, and loose soil structures. In recent years, deforestation has accelerated the degradation of natural resources (Churia/WMP, 2001).

Nelson wt al. (1980) conducted a reconnaissance survey using imagery has assessed the watershed condition of the major ecological land units. It was found that watersheds of Nepal are in a state of physical and biological degradation due to the over-exploitation of watershed resources. The productivity of the land has been significantly reduced in 35 per cent in Siwalik and 21 per cent in the middle-hills. Shrestha et al. (1983) pursued the study further by ranking the districts with respect to watershed condition. It is estimated that the 7th, 5th and 13th districts in Nepal are under very poor, poor and marginal conditions, respectively.

Table 4.1 Area of the ecological zones falling into watershed condition classes

Physiography		**Watershed Condition**[10]					
		Total	1	2	3	4	5
High Himal	Area in sq.km.	35103	23870	4212	4212	2808	0
	Percent	24	68	12	12	8	0
Transition *	Area in sq.km.	26288	13670	11041	1577	0	0
	Percent	18	52	42	6	0	0
Middle Mountain	Area in sq.km.	43930	7029	27676	7907	1318	0
	Percent	30	16	63	18	3	0
Siwaliks	Area in sq.km.	19096	7066	5347	6302	0	382
	Percent	13	37	28	33	0	2
Terai	Area in sq.km.	22764	22764	0	0	0	0
	Percent	15	100	0	0	0	0
Total	Area in sq.km.	147181	74571	48421	20068	4137	384
	Percent	100	51	33	14	3	0

Source: DSCWM/Modified after Nelson et. al. (1980)

It was found that about 25 districts are in fairly good and good condition. However, the districts with good or fairly good average watershed conditions may have land units which are poor, or very poor, watershed conditions.

As around 77% of the total land area is occupied by mountains and high Himalayas in Nepal, the vegetation cover plays a crucial role in watershed management and the supply of water source within the country (Karki, 2004). However, the rate of deforestation in Nepal is quite severe, i.e. around 1.6% per annum (Joshi et al. 2003) as well as loss of top soil. Over 200

[10] **Excellent (1).** In or near undisturbed condition but natural erosion processes including landslides may be present; **Good (2).** Minor amounts of disturbance may be present. Correction can come about through normal management practices. Productivity of land is not significantly impaired; **Fair (3).** Significant disturbance in the soil mantle and / or stream channel exist. Productivity of land is diminished; **Poor (4).** Disturbance by accelerated erosion is serious and results in considerable stream sedimentation and reduced land productivity. Extension, structural and land use changes are required to upgrade the land to a productive condition; and **Very Poor (5).** Accelerated erosion is advanced. Agricultural and forest productivity is absent or greatly reduced. Sediment production and extreme runoff conditions have effectively destroyed the natural character of the streams. Rehabilitation requires structural protection and high investment cultural practices.

tones/ha/yr of soil loss in overgrazed lands lying below 1000m has been reported in some studies (Carson, 1992). Chhetri and Bhattarai (2001) claimed that landslides and floods damaged about 1,140 ha, 41,800 ha and 182 ha of land in 1994, 1995, and 1999 respectively indicating erratic and unpredictable rainfall. Poor people living in both the mountains and the plain areas will suffer from watershed degradation caused by soil erosion, landslides and flooding (Karki, 2004).

Table 4.2 Distribution of Districts According to Average Watershed Condition

Average watershed condition	Numerical value of ranking points	Number of districts
Good	<500	25
Fairly good	500-1500	25
Marginal	1500-3000	13
Poor	3000-4500	5
Very poor	>4500	7

Source: Shrestha et.al. (1983)

The following figure captures watershed conditions in different districts of Nepal

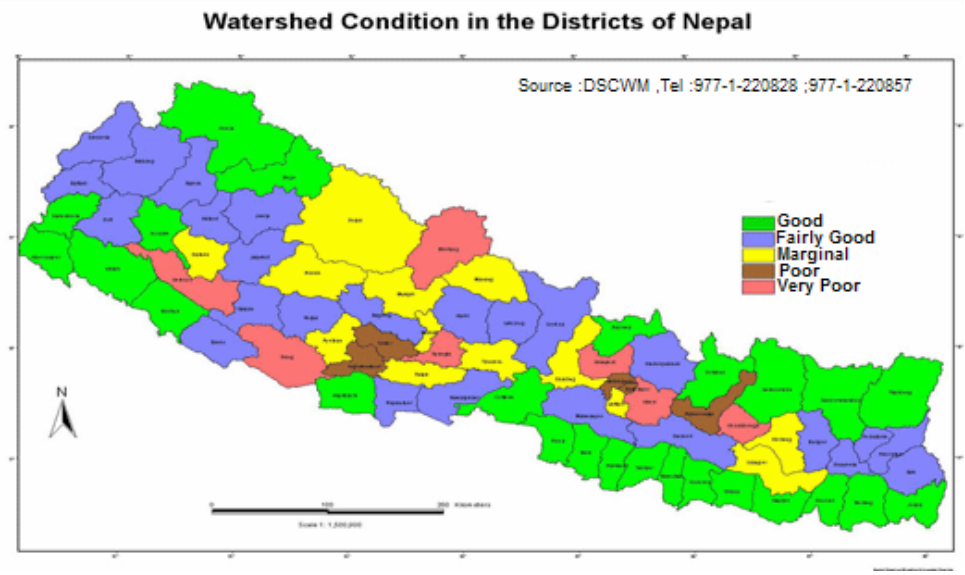


Figure 4.1 Watershed condition in the districts of Nepal

2.2 Rangeland ecosystem

Rangeland ecosystems comprise grasslands, pastures, and scrubland (NBS, 2002). Nepal's total grassland areas are estimated to cover about 1.75 million hectares, or nearly 12% of Nepal's total land area. About 70% of the rangelands are situated in the western and mid-western regions, and it is estimated that only 37% of rangeland forage is actually available or accessible for livestock (LRMP 1993; Pariyar 1998). Nepal's rangelands have high biodiversity as they range from subtropical to temperate grasslands, alpine meadows, and include the cold, arid steppes north of the Himalayas. The grasslands of Nepal are divided into five climatic zones (Table 2.2), but a high proportion is located in the Mid-hills and Mountain regions.

Table 2.2 Grassland categories according to climatic zones

ZONE	REMARKS
Tropical	Grasslands grazed almost all the year round.
Subtropical	Non-palatable species such as ferns, stinging nettle, and Eupatorium species are becoming dominant because of heavy grazing.
Temperate	Winter grazing for cattle, sheep and goats. Burning to improve grasslands is a common practice, causing increased soil erosion.
Sub-alpine	Seasonal grazing only because of heavy snow cover in winter. Burning of grasslands at the end of the grazing season and in early spring is common.
Alpine	Grasslands are grazed only during the summer (June - September).

Source: NBS, 2002

Rangeland in the protected areas makes up 4,773km^2 in Nepal, which is about 27% of the total rangeland and about 18% of Nepal's protected areas. Such rangeland coverage, however, should not lead to complacency because there have not been any programmes in the protected areas system to specifically address rangeland biodiversity. Nepal's high altitude rangelands are home to a unique assemblage of flora and fauna which comprises about 131 endemic plant species (53% of the total number of endemic plants in Nepal), 41 key non-timber forest products including primarily medicinal herbs.

Endangered wildlife species such as snow leopard, Tibetan wolf, Tibetan argali, lynx, brown bear, Tibetan wild ass, and wild yak predominantly occur in this region (NBAP, 2000). Although bird species diversity is low, 9 species are restricted to alpine rangeland and 5 species have international significance in rangeland. Of over 20 indigenous breeds of livestock species that are found in Nepal, 8 endemic breeds are from the alpine region (NBAP, 2000).

As rangeland ecosystems include both sub-tropical and temperate regions, they provide grazing and pasture services for domestic and wild animals and habitats for them. Rangeland provides forage or vegetation for grazing or browsing livestock. Tropical and sub-tropical grasslands have tall grasses which become good habitat for birds, deer and large animals and high altitude rangelands have short grasses which are place for grazing and browsing.

Range lands are under increasing grazing pressure and there are several times more grazing animals than the land can viably support (NBAP, 2000). Although human activities have degraded wildlife habitat and contributed to the loss of biodiversity, primarily through poaching and trapping of wildlife and the over-harvesting of herbs and medicinal plants throughout Nepal, several mountain protected areas do safeguard rangeland biodiversity within their borders.

2.3 Wetland ecosystems

Wetlands are those sites distinguished by the presence of water, which often have unique soils that differ from adjacent uplands and support vegetation adapted to wet conditions. They comprise a wide range of inland, coastal and marine habitats characterized by the presence of flood-tolerant vegetation. The Ramsar Convention defines wetlands as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salty, including areas of marine waters, the depth of which at low tide does not exceed 6 meters”, and which may include “riparian and coastal zones adjacent to the wetlands, or islands or bodies of marine water deeper than six meters at low tide lying within” (Ramsar, 1971).

Nepal has many different types of wetlands that range from areas of permanently flowing rivers to areas of seasonal streams, lowland oxbow lakes, high altitude glacial lakes, swamps and marshes, paddy fields, reservoirs and ponds. They are broadly classified into two categories: natural and man-made. Nepal has 2323 high mountain glacial lakes (ICIMOD, 2002), 6000 rivers and rivulets (WECS, 2002), over 80 freshwater lakes/ponds in mid hills, 163 Terai wetlands which includes floods plains, lakes and ponds, marshes, reservoir etc (IUCN 1998).The natural wetlands comprise lakes and ponds, riverine floodplains, swamps, and marshes, while man-made wetlands include water storage areas and deep-water agricultural lands (IUCN-Nepal 1996). Nepal's wetlands can be divided into five categories (Karki and Chhetri, 2007).

- The trans-Himalayan wetlands comprising lakes such as Rara, Tilicho and Phoksundo
- The relatively shallow midland-mountain wetlands lakes such as Phewa, Begnas and Mai Pokhari
- The lowland-tropical wetlands which are seasonally flooded riverine flood plains, including Koshi Tappu
- The human managed wetlands such as ponds, rice fields, ghols, etc.
- Artificial wetlands such as reservoirs, irrigation canals and sewage ponds

Table 2.3 Wetland areas in Nepal

Wetland type	Estimated area (ha)	Percent
Rivers	395,000	53.0
Lakes	5,000	0.7
Reservoirs	1,380	0.2
Village ponds	5,183	0.7
Paddy fields	325,000	43.6
Marshland	12,000	1.6
Total	743,563	100.0

Source: DOAD, 1992, Fisheries Development Division

The systematic study of wetlands in Nepal is very recent. Surveys conducted over the last 15 years on the distribution of wetlands in three ecological zones (high mountains, Mid-hills and Terai) have contributed much to the knowledge of services associated with this ecosystem. In 1996, IUCN-Nepal prepared a detailed wetland inventory of 163 sites from the Terai and 79 sites from the hills and mountains (Table 2.4). Nepal's government has undertaken rapid assessments of the status of wetlands in the Terai (lowlands). In total, 51 sites were explored and 36 deemed of significant biodiversity importance. Additionally, Sah (1997) conducted a detailed study of the ecological and social features of wetlands in the Koshi Tappu Wildlife Reserve. Recently, four high altitude wetlands were declared as RAMSAR sites in September 2007 in Nepal (Karki, 2007).

Table 2.4 Number of Wetland Sites in Nepal

Development Region	Number of sites (%)		Total (%)
	Terai	Hills and Mountains	
Eastern	18 (7.4)	24 (9.9)	42 (17.4)
Central	37 (15.3)	15 (6.2)	52 (21.5)
Western	34 (14.4)	16 (6.6)	50 (20.7)
Mid-western	12 (5.0)	22 (9.1)	34 (14.0)
Far-western	62 (25.6)	2 (0.8)	64 (26.4)
Total	163 (67.4)	79 (32.6)	242 (100.0)

Source: IUCN-Nepal (1996)

These wetlands are rich in biological diversity and are known to regularly support more than 20,000 waterfowl during the peak period between December-February. About 172 species of the major wetland plants are listed by IUCN (IUCN-Nepal 1996). Four endangered macrophyte species are often found in wetlands: *Spiranthes sinensis* (orchid), *Cyathea spinulosa* (tree fern), *Sphagnum nepalensis* (sphagnum moss), and *Pandanus nepalensis* ((Joshi & Joshi 1991).

Out of 833 bird species found in Nepal, 193 are known to be dependent on wetlands. Of these wetland-dependent species, about 187 are known to be dependent on the wetlands of the Terai. 180 species of water birds are reported from Koshi Tappu and the Koshi barrage (IUCN-Nepal 1996). Of the wetland birds in the Terai, 39 species are threatened at a national level. About 11 species occurring in the Terai wetlands are described as globally threatened while another 11 species are identified as near-threatened (Collar et al. 1994). The diverse wetland flora of the different ecological zones are significant producers in ecosystems that support indigenous populations of amphibians and fishes, and also attract many birds.

The gharial and marsh mugger, two species of crocodile, are the largest reptiles found in the Kali Gandaki River and the major tributaries of the Narayani River. The Gangetic dolphin is also reported in the Narayani River. A total of 185 species of fish are found in the wetlands of Nepal, out of which 8 are endemic. Three species of Schizothorax have been recorded in Rara Lake and as many as 43 species are found in hill streams. About 5,000 species of insects may be found in Nepal; however, wetland insect assemblages are not fully understood.

Wetland ecosystems provide a variety of services such as fishing; habitat for migratory birds, reptiles and amphibians; drinking water, and water for irrigation. The cooling and heating phenomenon of landscape and hydro-electricity potential (Micro-hydro to high dam) and their recreational values are other important benefits. Wetland plants provide food, forage and cover for both domestic and wild animals.

Despite their importance, wetland biodiversity is under threat from encroachment, unsustainable harvesting of wetland resources, industrial pollution, agricultural runoff, the introduction of exotic and invasive species into wetland ecosystems, and siltation (NBAP, 2000). Many wetlands are drying out, converted into agricultural lands, or otherwise subjected to unsustainable use. Hunting, unplanned growth of human settlements, illegal occupation, disturbance from recreation and reclamation for other uses are some major problems being faced by wetlands. Other threats to Nepalese wetlands are dam construction, siltation, ground water extraction and lack of awareness among people, planners and policy makers, lack of an effective wetland policy, lack of responsible institutions and multiple ownership of wetlands (Karki and Chhetri, 2007).

2.4 Agro-ecosystems

Nepal has a high degree of agro-ecological diversity that is largely associated with the hills and mountains, where variations in factors such as topography, slope, aspect and altitude allow for an enormous range of biological environments, climatic regimes and varied ecosystems. Broadly speaking, farming systems in Nepal vary according to the three major physiographic regions of the country, namely the Terai, the Mid-hills, and the mountains as discussed earlier. Each physiographic region has its own cropping patterns demonstrated by a variety of food crops. The crop diversity present in each ecological zone reveals that primitive cultivars of specialty cultigens and crop landraces are the major building blocks of traditional farming systems in Nepal.

About 21% (3.2 million hectares) of the total land area of Nepal is used for cultivation, and the principal crops are rice (45%), maize (20%), wheat (18%), millet (5%) and potatoes (3%), followed by sugarcane, jute, cotton, tea, barley, legumes, vegetables and fruit. Crops such as rice, rice bean, eggplant, buckwheat, soybean, foxtail millet, citrus and mango have high genetic diversity relative to other food crops. Crop species in Nepal owe their variability due to the presence of about 120 wild relatives of the commonly cultivated food plants and their proximity to cultivated areas (Regmi 1995). Jha et al. (1996) have listed 60 food species (fruits, vegetables, cereals, legumes) and 54 wild relatives of food plants. Livestock is an important part of the farming system, particularly in the Mid-hills where crop production, livestock and forestry all form part of the farming system).

There is a great diversity in indigenous livestock breeds in Nepal because of climatic and physiographic differences and prevalent traditional animal husbandry systems. Twenty-four breeds of cattle, buffalo, sheep, goat, pig and poultry are recognised in Nepal, but the strains within each breed have not been adequately identified. Among known breeds, pure Siri cattle have become extinct in Nepal and crossbreeds of Siri cattle are only seen in small numbers. Lulu and Achhame cattle are on the verge of extinction. The Yak population is also decreasing at the rate of 1.41% a year. Lime buffalo is endangered and likely to disappear soon. Lampuchhre and Kage sheep are at risk. The Bampudke pig is on the verge of extinction while Chwanche and Hurrah pigs are only seen in small numbers. Breeds and strains of domestic animals, including poultry, in different ecological belts are yet to be identified and characterised. Livestock is a source of security, as animals can be sold to cope with emergencies. Households whose land holdings are too small to maintain livestock use enormous amounts of time and energy in collection of fodder and water, which has serious implications on the health of women and children and their participation in education.

The services from agro-ecosystem are food, vegetables and grains, fodder and grasses, land improvement, employment, income generation, raw materials among others. Agro-ecosystem services and products are very closely linked with peoples' livelihood. People can uplift their livelihood by applying advanced technologies in agriculture which could enhance the level of employment and incomes. The Government of Nepal had implemented several programmes related to the agro-based development initiatives like establishment of horticulture centers, and establishment of agricultural research centers by representing different agro-climatic conditions and implementing twenty years Agriculture Perspective Plan (APP, 1995).

However, agro-biodiversity is threatened primarily due to use of high yielding varieties, destruction of natural habitat, overgrazing, land fragmentation, commercialization of agriculture and the extension of modern high-yielding varieties, indiscriminate use of pesticides, population growth and urbanization, and changes in farmer's priorities (NBAP, 2000). Fragmentation of holding is really an important area of concern in agro-ecosystem management. The already small holdings are further fragmented into several parcels. In 1961 the average number of parcels per holding was 6.8 with an average parcel size of only 0.16 hectares, an indicator of the subsistence nature of farming. Over the past four decades however the trend has reversed. The average parcel size has increased by 50% to 0.24 hectares.

The majority of people are dependent on agriculture and related sectors and are adversely affected by the loss of the top fertile soil due to soil erosion, landslides and floods. Soil loss is one of the major causes of decline in agricultural production in Nepal. Miller (2004) reported two major harmful effects of soil erosion: loss of soil fertility and its ability to hold water and; runoff of sediment that pollutes water, kills fish and shellfish, and clogs irrigation ditches, boat channels, reservoirs, and lakes. Lowered agricultural productivity resulting from loss of soil nutrients and severe erosion as a consequence of hill forest degradation and

fragmentation, has lowered rural communities' income and livelihood support (Gautam, Roberts and Singh, 2003). This has adversely affected poverty levels, resulting in 45% of hill population having to survive below the poverty line in Nepal (Gautam 2000).

Table: Estimated soil erosion rate at different sites

Area	Location and characteristics	Land use	Erosion rate (t/km2.yr)
Siwalik range	Eastern Nepal, south aspect, sand stone foot hills	Forest to grazing	480-3680
Middle hills	Far western Nepal, South Aspect of Surkhet	a. Degraded land b. Gully c. Degraded, heavily grazed gully land	2000 4000 20000
	Central Nepal, Mahabharata Lake, Steep Slope, Metamorphic and Sedimentary rocks	a. Degraded, forest and agriculture land b. Gully Land	3150-14000 6300-42000
	Northern Foothills of Kathmandu Valley	a. Degraded, forest and shrub Land b. Over grazed shrub land c. Severe gully dense forest	2700-4500 4300 12500-5700
	South of Kathmndu Valley Phewa Watershed	a. Protected pasture b. Overgrazed grass land c. Gully oergrazed grass land	800-920 2200-34700 2900

Source: Adopted from CBS (2006); Dhakal (2007)

Climate change may also be affecting agro-ecosystem in Nepal as evidenced by extreme climatic events such as flood, draughts, heat wave, cold stream, and melting of Himalayan glaciers. Melting of the Himalayan snowline would disrupt the ecology of mountainous and hilly regions and agriculture productivity would suffer, with food security under tremendous threat (Lohani, 2007).

2.5 Mountain ecosystem

Though the mountain may not be treated as a separate ecosystem, certain special characteristics associated with mountainous regions deserve attention for their socio-economic development and conservation benefits. Jodha (2001) described , 'the characteristic features of mountains such as high degree of fragility, marginality, and inaccessibility' and argued that these characteristics 'not only cause environmental vulnerability (inability to withstand the negative consequences of change) but also socioeconomic vulnerability - by limiting the range and dependability of livelihood options for people to withstand the stress caused by change'.

The Mountain Agenda ratified during the 1992 UN Conference on Environment and Development (UNCED) is the most recent manifestation of international interest in conserving the islands of high biodiversity often found in mountain ecosystems. At the Fourth Meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity held in Bratislava in 1998, mountain ecosystems were listed as an item for "in-depth consideration" in the Programme for Work for the Seventh COP to be held in 2004. In light of this renewed interest and the fact that more than half of Nepal is above 3,000m, the national biodiversity strategy proposes initial policy and programmatic steps to specifically address the conservation and sustainable use of mountain biodiversity.

As discussed earlier, Nepal's landscape is predominantly composed of hills and mountains, covering about 83% of the total land area. Nepal has the highest mountain in the world, Sagarmatha (Mount Everest). Another important feature of mountain ecosystem is high levels of biological diversity. For instance, there are more lichens, bryophytes, and ferns in the mountain zone than in the lowlands.

But, mountain biodiversity is exposed to threat due to ecological fragility and instability of high mountain environments, deforestation, poor management of natural resources, and inappropriate farming practices (NBAP, 2000). The other factors for loss of biodiversity include landslide and soil erosion, pollution, fire, overgrazing, introduction of alien species, illegal trade, hunting and poaching (NBAP, 2000). Mountain ecosystems considered to be important in terms of research in light of the interrelationships between ecosystem services and poverty alleviation.

3. Experience of Ecosystem Governance and Management and in Nepal

3.1 Institutional aspects of forest resource management

During the last fifty years, institutional arrangements for forest resource governance and management have gone through different levels of change in Nepal. There was a long tradition of local-level forest management in many parts of the country under informal institutional arrangements or indigenous management. But in 1957, the government of Nepal nationalized the forests by enacting the Forest Nationalization Act 1957. It was instituted with the assertion that bringing the private and communally managed forests under state ownership would prevent the ongoing trend of deforestation. However, after nationalization local communities throughout the country reacted negatively believing that their traditional right of access and use had been curtailed. While the stated objectives of nationalization were noble, and were designed to protect, manage and conserve the forest for the benefit of entire country, it became in fact a highly disruptive factor in the overall well-being of the hill forests and related resources (Bajracharya, 1983).

Most of the studies conducted during the late eighties in Nepal have reported massive destruction of forest resources and their cyclical impact on increased soil erosion, fertility loss, decline agricultural productivity, and increased poverty which later formalized as a Himalayan crisis theory[11] (Eckholm, 1975, 1976; World Bank, 1978). Browning (1974) estimates the area of commercial forest in the Terai was reduced by more than 20 per cent from 1,344,000 hectares in 1964 to 1,067,000 in 1973. Though the nationalization of forest is largely blamed for the destruction of forests due to the lack of clearly defined state ownership over forests, some scholars later counter argued that the extension of agricultural

[11] In 1975, Eric Eckholm published an article on the issue of ecosystem degradation in the Nepalese Himalayas. After this influential article, substantial amount of attention were drawn regarding the problem of deforestation, soil erosion and mountain ecosystem degradation. The article was about the alarming rate of deforestation in Himalayan Mountains of Nepal, which later formalized as "Himalayan Degradation" or "Himalayan Crisis" theory. This was set within a broader debate about the extent of a deep environmental "crisis" affecting the whole of the Himalayan region, resulting from heavy deforestation in the upper watershed region of Himalayan Mountains (Gilmour and Fisher , 1991).

areas during this period was one of the principal causes of deforestation (Pant and Jain, 1972; Shrestha and Jain, 1978). Ives and Messerli (1989) argue that human intervention has the potential for significant landscape changes at the scale of the micro-watershed or individual mountain slope. The decline is believed to be due to centralized management policy, insecure land tenure policy and confusion between open access and common property system of resource management.

After experiencing failure following forest nationalization, the government introduced another act, the Forest Act 1961, which was more focused on forest administration. It was an attempt by the government to solidify its claim to ownership that had been formally established when the forests were nationalized (Wallace, 1981). Under this act, the definition of forestland was extended to all land that adjoined forest areas that were left fallow for two years (Manandhar, 1982). This act also defines forest categories, covering description, registration, and demarcation of forest (Mahat *et al*., 986). In 1967, the Forest Preservation (*Special Arrangements*) Act was introduced to define forest offences and prescribe penalties, thus strengthening the role of the Forest Department as a policy and law enforcement agency. The Forest Preservation Special Courts were established under provision of this act. However, because of inadequate forestry administration and lack of appropriate forest policy, this act was again not enforced, and was also largely ignored by villagers.

A series of legal measures were undertaken after enactment of Forest Act, 1961 to consolidate the power of government over forests and other forms of public lands as well as regulating the use of forest products to ensure better management of forests by the state's forest administration (Chapagain *et al*. (1999). The Forest Act 1961 was first amended in 1978 with provision of devolution to the local level political unit in managing the mountain forests.

A more people-oriented policy was advanced through the formulation of a Master Plan for the Forestry Sector (MPFS) in 1988 with assistance from bilateral and multilateral donor agencies, which provided a comprehensive policy statement for community-based forest management in Nepal. MPFS emphasized that all accessible hill forests were to be handed over to local users by 2010 (HMG/MPFS, 1988). MPFS identified six primary development programs, including a) community and private forest; b) national and leasehold forest; c) medicinal and aromatic plants and development of minor forest product-base industries; d) development of wood based industries; e) soil conservation and watershed management; and f) conservation of ecosystems and genetic resources. Furthermore this policy explicitly considered six supportive development programs; a) policy and legal reform; b) institutional reform; c) human resource development; d) forestry research and development; e) resource information and planning, and f) monitoring and evaluation.

Actual community-based forest management materialized only after the endorsement of the Master Plan by HMG/N (then His Majesty's Government of Nepal). The recognition of community-based resource management has led to the devolution of natural resource management from centralized government control to local user groups. After the restoration of democracy in 1990, the government has further framed the Forest Act (1993) for the sustainable management of forest resources under community-based property rights regimes. This new forestry legislation replaced the Forest Act (1961) in line with the Master Plan for the Forestry Sector in Nepal. The Forest Act vests more legal authority in the Forest User Groups (FUGs) so that they may manage the community forests on a sustainable basis. This legislation was given greater coherence by the Forest Rules 1995, which further clarified the powers and duties of FUGs. The most distinct feature of this new legislation is that it explicitly mentions the FUGs as the formal organization to hand over the forests and its focus on user groups as primary beneficiaries.

According to a recent National Database record, there are already about 14500 FUGs managing about 124, 000 ha of forests, with more than 35 % of the population of the country (NPC, 2007). The new policy emphasized handover of all accessible hill forests to local communities so that all government forests in the hills are managed as community forests and all of the benefits from such forests go to the community. This became an integral component of the poverty reduction strategy in rural Nepal. The future challenge lies in increasing the productivity of these forests and streamlining the benefits from forests towards livelihood promotion (particularly poverty alleviation), and strengthening good governance for equitable performance (Kanel, 2004). Based on a study of 1,788 forest user groups from Terai, Mid-hills and mountain, Kanel and Niroula (2004) estimated that these forests contribute significant to household income in terms of timber (69 %), fuel wood (19 %) and fodder and leaf litter (10 %) besides a supply of a large amount of NTFPs. They further estimated that the annual income from Nepal's community forestry would be a total of Nrs 913.8 million which could be even higher if properly valued. The study claimed that total annual income from Nepal's community will be NRs. 1.9 billion if the market price applied to the various products harvested from community forests.

Community forest (CF) policy was given higher priority compared to other forest management strategies to develop and manage forest resources through the real participation of individuals and communities to meet basic needs (HMGN, 1989). The other successful programme for forest ecosystems in the country is a leasehold forestry programme. It was initiated in some hilly areas of the central and western part of the country. Basically, this programme offers 40-year leases of small plots of degraded, public forest land exclusively to pre-identified groups, mostly to the poorest of the poor. Leasehold forestry user groups usually consist of 10 or fewer household who lease these forests to restore them and to conduct potential income generating activities. There are about 2,213 leasehold forestry user groups managing 10,000 hectares of forests, which is about 0.2 % of the total forest area (Oli and Kanel, 2006). About 7 million people or about 1.5 million households benefiting from community and leasehold forestry in Nepal (Oli and Kanel, 2006).

In another study, Poudyal et al (2007) show that the leasehold forests provides less than half of the total fodder requirements of the households and that the livestock income was found to be positively correlated to the amount of fodder appropriated from leasehold forests. The results also show a significant participation of women in the management and decision-making with regards to leasehold forests. Some studies also establish a proved linkage between leasehold forestry and food security. For example, Tamrakar and Kafley (2004) reported that food security of participating household in leasehold forestry increases by 16 per cent.

Table 3.3 An overview of property rights structures and legal provisions over forest resources management and governance in Nepal

Year	Main Policy Features
1925	Ban Jach Adda (Forest Inspection Office)
1942	Establishment of the Department of Forests
1957	Private Forest Nationalization Act
1959	Birta Abolition Act
1961	Forest Act
1964	Land Reform Act
1967	Forest Protection (Special Arrangement) Act
1976	National Forestry Plan
1978	Panchayat and Panchayat Protected Forest Rules
1982	Decentralization Act
1988	Master Plan for the Forestry Sector
1993	Forest Act
1995	Forest Rules
1998	Forest Act (First Amendment)

Source: Adapted from Pokhrel (1998)

It can be concluded that the last decade in Nepal has seen a fundamental restructuring of forest policies towards participatory resource management with a focus on poverty alleviation and environmental conservation. Table 3.3 shows that forest policy has progressed through a series of different institutional arrangements over time.

3.2 Conservation and protected area systems of Nepal

The National Parks and Wildlife Conservation (NPWC) Act (amended 1974) establishes regulations for protected areas, and recognizes species for protection in Nepal. Protected areas (PAs) were initially established in Nepal for the protection of wildlife, especially endangered wildlife. However, the objectives have since been broadened to include the preservation of natural, historic, scenic, and cultural values. According to the latest estimates, declared protected areas cover 26,695 km^2 (18.32%) of the total area of Nepal. The Department of National Parks and Wildlife Conservation (DNPWC) is mandated with conserving the country's major representative ecosystems, unique natural and cultural heritage, wildlife protection, and research. The National Parks and Wildlife Conservation Act of 1973, and its four amendments, recognises six categories of protected areas in Nepal namely: national parks, strict nature reserves, wildlife reserves, hunting reserves, conservation areas and buffer zones (BZ).

These protected areas are distributed in sub-tropical areas (ranging 150 to 1000 meter altitude) to Mid-hills (1000-300 meters altitude) and extend up to the highest peak of the world including temperate to alpine zones (more than 3000 to 8500 meter altitude). For instance, recognising the great significance of the biodiversity of the lowlands, Government of Nepal (GoN) established five protected areas in the Terai and Siwalik Hills. These are: Koshi Tappu Wildlife Reserve, Parsa Wildlife Reserve, Chitwan National Park, Bardia National Park and Shuklaphanta Wildlife Reserve (BYN, 2006). The park, located in the highly productive Terai, supports an important tiger population and the second largest greater one-horned rhinoceros population. The rhinoceros population in Chitwan National Park is the second largest in the world. The two populations in Bardia National Park and Sukla Phanta Wildlife Reserve are being augmented through successful translocations of rhinoceros from Chitwan. Similarly, to protect the highland ecosystems, seven protected areas in the highland mountains (and three protected areas spanning the Mid-hills and highlands), covering 78.52% (20,939km2) of total protected areas was established. Two of these are large conservation areas—Annapurna and Makalu Barun—which have become models for community-based biodiversity management. These protected areas represent 30 of the 38 ecosystems of the highlands (MoFSC. 2002). These protected areas have diverse forest ecosystems, grassland ecosystems and wetland ecosystems and have both the national and international significance with enlisted world heritage (Sagarmatha NP), Ramsar sites (Koshi Tappu) etc. Sagarmatha base camp is considered the 10th tourists' favorite sites in the world (WWF-US, 2005). Protected areas of Nepal could be linked across international boundaries by creating corridors and habitat linkages to maximize ecosystem conservation and associated services in the region. For instance, Bardia National Park of western Nepal could be linked with Katerniaghat in India. Similarly, Sukla Phanta in Nepal, could be linked with Dudwa National park in India.

Table 3.4 Protected Areas of Nepal and major ecosystems

SN	Category (Year of Establishment)	Area (km^2)	Altitude (m)	Major Ecosystems
	National Park (NP)			
1	Chitwan NP (1973)	932	150-815	Sal forest (sub-tropical)
2	Bardia NP (1976/1988)	968	152-494	Sal forest (sub-tropical)
3	Shivpuri NP (2002)	144	1366-2732	Midhills forest
4	Khaptad NP (1984)	225	1000-3276	Grassland, temperate, subtropical forest
5	Makalu Barun NP (1991)	1500	435-8463	Sub-tropical to alpine forest
6	Sagarmatha NP (1976)	1148	2800-8850	Temperate & alpine forest
7	Langtang NP (1976)	1710	792-7245	Temperate & alpine forest
8	Shey phoksundo NP (1984)	3555	2000-6885	Wetland, alpine forest, grazing
9	Rara NP (1976)	106	1800-4048	Wetland, temperate-alpine forest
	Total	**10288**		
	Wildlife Reserve (WR)			
10	Koshi Tappu WR (1976)	175	150-815	Wetlands, Terai forest
11	Parsa WR (1984)	499	150-815	Terai Sal forest
12	Suklaphanta (1976)	305	90-270	Terai Sal forest
	Total	**979**		
13	Hunting Reserve (1987)	1325	2850-7000	Temperate-alpine forest, grassland
	Conservation area (CA)			
14	Kanchanjunga CA (1997)	2035	1200-8598	Temperate-alpine forest, grassland
15	Manaslu CA (1988)	1663	1360-8163	Temperate-alpine forest, grassland
16	Annapurna CA (1986, 1992)	7629	1000-8092	Temperate-alpine forest, grassland
	Total	**11,327**		
	Buffer Zone (BZ)			
	Chitwan NP	750		
	Bardia NP	328		
	Shivpuri NP			
	Khaptad NP			
	Makalu Barun NP	830		
	Sagarmatha NP	275		
	Langtang NP	420		
	Shey phoksundo NP	449		
	Rara NP			
	Total	**3051**		
	Total protected areas	**26,970**		
	% of Nepal Territory	**18.32**		

Source: Nepal Biodiversity Strategy, 2002

The National Parks and Wildlife Conservation Act (1973) with its amendment in 1993, has made legal provision to share 30-50% of the revenue generated from the protected area for

local community development, which is administered through the buffer zone group and BZ committee at local level. The Himalayas National Park Regulations (1979) provide for people living in national parks to collect natural resources for subsistence. The Buffer Zone Management Regulations (1996) and Buffer Zone Management Guidelines (1999) are meant to design programs compatible with National Park management and facilitate public participation in conservation, design and management of buffer zones.

However, protected areas of Nepal are still under severe pressure. Major threats to protected areas include grazing all year the round, poaching for high value products, illegal timber harvesting and unsustainable tourism in a few protected areas. For instance, the high demand for tiger and rhinoceros parts places tiger and rhinoceros population under extreme threat. Poaching is high even in well protected areas such as Chitwan and Bardia National Park. For instance, reduced security inside protected areas due to the prolonged conflicts in Nepal has provided opportunities for wildlife poachers and illegal loggers as the result of the Nepal Army's reduced ability to patrol protected areas. As a consequence, the number of rhinos in and around Royal Chitwan National Park has declined by 32% over five years (2000-2005) after decades of successful conservation (Schweithelm et al., 2006). Wildlife killing also takes place as a result of conflict with the human population living in the vicinity of the parks. Retaliation against rhinoceros for crop damage is prevalent and continues to intensify as humans and wildlife compete for land and other resources in these areas.

4. Poverty Context and Trends in Nepal

Land is a principal source of income and employment for the majority of households in Nepal especially in rural areas which host90 percent of population. The size and quality of farm land are determinants of poverty (Sharma, 1999). Agriculture is a main activity of the economy. Arable land resources are scarce, and both in the Terai and in the Hills there is a tremendous pressure to expand the cultivated area, in most cases at the cost of a sustainable management of the natural resources. In the Terai, a large proportion of the households are either landless (about 10%) or tenants (40-50%). IFAD (2002) identified population pressure, poor natural resource base and the degradation of the environment as a few dominant poverty processes in Nepal.

4.1. Definition of poverty

Poverty is a widespread social phenomenon in Nepal, and its magnitude remains large. It is difficult to provide accurate data on the incidence of poverty in Nepal as there are methodological differences between the various surveys undertaken in different periods. Poverty in Nepal is basically defined in terms of minimum consumption basket using the cost-of-basic-needs (CBN) approach. The poverty macro-indicators are based on income, and poverty is defined as low income, basically so low that it does not allow for attaining basic needs, including sufficient food. The micro- studies also emphasize availability of food as the key indicator and access to productive assets or to employment as the important means for overcoming poverty. The Central Bureau of Statistics (CBS) methodology takes into account differences in cost of living in different areas of the country by dividing the nation into six regions and deriving price indices for each region.

The first large-scale household-level survey on Employment, Income Distribution and Consumption Patterns was conducted in fiscal year 1976/77.The data from the Nepal Living Standard Survey (NLSS) of 1995/96 and 2003/04 (NLSS I & II) undertaken by the Central Bureau of Statics (CBS) are used to estimate trends in poverty incidence in the country during 8 years between these two surveys. It shows that the minimum calorie intake was slightly higher in 2003/04 then, due to changes in family composition. Head count rates suggest that poverty has declined from 42% in 1995/96 to 31% in 2003/4.

Among the south Asian countries, Nepal is ranked lowest in Human Development Index (HDI); the HDI for Nepal is 0.514 (UNDP, 2007). Similarly the per capita GDP of US$ 1550 is also the lowest in the South Asian region. However, HDI in Nepal has improved over time (in 1975 the HDI was estimated to be 0.301 in 1975. The population below the poverty line is estimated to be 30.9 % at the end of tenth plan (i.e. 2007). Nepal's Gender Empowerment Measurement (GEM) rank is 86, which is the lowest among the South Asian Association for Regional Cooperation (SAARC) countries. However, the ratio of female income is 0.5. (For detail see tables in Appendix A)

Nepal's public expenditure on health is moderate among SAARC nations. It is about 1.5 % of GDP which is slightly lower than that of Bhutan, Sri Lanka and Maldives and higher than that of India, Pakistan and Bangladesh (Tables in Appendix A). Among the SAARC countries, the inequality of income is highest in Nepal. The poorest 10 % have 2.6 % share of national income, whereas the richest 10 percent have 40.6 % share of it (see tables in Appendix I). Per capita consumption of energy is lowest in Nepal in comparison to other SAARC countries. It is about 86 kilowatts, whereas it is 229 for Bhutan and 618 for India.

4.2 Employment situation

A majority of Nepal's population and the labour-force is engaged in agriculture sector and that a large segment of the population lives below the absolute poverty line. Even the employed labour-force suffers from underemployment and from low wage/salary leading to very low levels of productivity. Most of the females are involved in unproductive sectors (domestic chores), while, due to pervasive poverty in rural areas, children below 15 years of age are also forced to work as child labour.

Unemployment and underemployment are considered as major problems inhibiting the process of development in Nepal. On one hand, there is lack of reliable information and data in regard to employment trends and on the other hand, there is variation in the definition and concepts of employment trends used in different censuses, surveys, and research projects. These have become major constraints in making a meaningful comparative as well as situation analyses and time series study of the trends in employment, unemployment and under-employment. Table 4.1 shows employment related data from various surveys and studies.

The NLSS 2003/04 highlights that the great majority of the underemployed labour force live in the rural areas. Out of the total underemployed labour force, 86 % are self- employed (unpaid family workers 38% and other self employed 48%). On the basis of the industrial classification, three quarters of the underemployed work in the agriculture sector.

The available information indicates that there is a high degree of urban unemployment (Table 4.1). Urban unemployment mostly represents the educated people. It indicates under utilisation of available human resources and also highlights the need for change in the education system to generate skilled labour force. Growing underemployment (which is defined in the most liberal way) is another major issue as it is found to be increasing both in rural areas and urban areas. Rural underemployment arises because most of the rural people are involved in agriculture with very low levels of economic return.

4.3 Sources of Household Income

The analysis of sources of household income is significant when studying the income distribution of a country. Evidence suggests that farm income has been the major source of household income in Nepal. It accounted for almost 64.4% of total household income during 1984 and declined to 34.8% of the total household income in 2003-04. On the other hand,

income from non-farm enterprises accounted for 24.1% and 33% respectively over the same period. There are some indications that the share of other income has increased significantly after the economic reform of 1995-96, whereas slight changes have taken place in non-farm income. The share of farm income also has decreased during the same period. There is 157% positive change in the remittance income from 1995-96 to 2003-04 and its share to total income increased by 77% during the same period (Table 4.3).

The share of income from self employment income declined from 71.2% in 1984 to 44.2 % in 2003-04 (Table 5.2).This may be due to the increase in employment opportunities in the service sector and the non-formal sector as well. It also indicates the gradual shift of agriculture labor into non-agriculture sectors. Though there is a rise in household income, there is rising inequality as well. The Gini coefficient increased from 34.2% to 41.4% from 1995/96 to 2003/04, indicating a rising disparity in income (Table 4.4). This indicates that the reform process has resulted in an increase in the income disparities in both rural and urban areas of the country.

The trends observed from this information are found to be fluctuating but it indicates two facts clearly: (i) there was growing disparity of income in 2003/04 compared to 1995/96; (ii) it is more pronounced in urban centers than in the rural areas. This fact is also indicated by the figures of the household and per capita income in urban and rural areas. The average household income of the urban area was less than double that of rural household in 1984, whereas it was more than double in 1996 and it is treble in 2004. The average household income of Kathmandu was found nearly 4 times greater than the income of the rural areas in the year 2003/04 (Table 4.5).

Table 5.6 provides a clear picture of concentration of the income distribution in Nepal. In 1984, the bottom 40% of the population and top 10% population share the same percent of total income (23%). The share of the top 10% of the population in rural area ranged from 13% in the Mountains to 23% in Tarai, and the share of the bottom 40% ranged from 23% in the Mid-hills to 33% in the mountains. The income share in the urban areas ranged from 24 to 27% for the bottom 40% of the population and 20 to 21% for the top 10% of population. Income distribution is more uneven in 1996 as the share of the bottom 40% people in total income was just 11% and that of the top 10% was as high as 52%. There were some improvements in the trends in 2003/04 with the share of top 10% population declining to 37.7% from 52%, whereas the share of bottom 40% increased from 11% to 14.2% during the period (Table 4.6).

There is a strong relationship between size of landholding and household income. In 1985, the household income of large farm households was nearly 3 times higher than that of the marginal farmers (NRB 1988). Similarly, the household income of the large farm households was 50% higher than that of the medium size households, and nearly doubles the income of small size households. The average income of the landless households in the rural areas was just one-third of the large size households (Table 4.7). This indicates the positive association between household income distribution and size of landholding.

The overall analysis presents some important information. Rural income disparity is associated with land distribution. As most of the population lives in the rural areas, the land distribution appears to be major feature of income distribution for the average people. The urban income distribution is also not even, and the income distribution is getting worse during the post liberalization period. In urban areas, land may not be the significant factor. The taxation policies could be the reason of such disparity. Such changes in disparity may also be due to slack in production activities in rural areas due to prolonged conflict and low production in agriculture coupled with the concentration of economic activities in urban areas (e.g. housing construction, land plotting etc). Such economic activities may have contributed to an increase in the income of the rich people leading to an increase in inequality of income.

4.4 Poverty: Distribution and Regional Trends

Almost one third of the population of Nepal is below the poverty line (NLSS, 2003/04). It has been found that the incidence of poverty has increased in the last two decades and it has increased more in the rural areas than in the urban ones, though there are some signs of improvement in the last five years. This survey clearly indicated disparities between the rural and urban sectors in term of poverty incidence. It showed that the poverty incidence in the rural area was 37.23% and only 16.97% in urban area as measured by subsistence income criterion for population level. It was 32.14% in rural and 20.01% in urban areas as measured by subsistence consumption for population (Table 4.8).

The first estimate of income poverty (1976/77) revealed that 33 percent of the total population lives below the poverty line. The second survey carried out in 1984/85 estimated the percentage of people living below poverty line to be 41.2 percent, a significant increase to that of 1976/77. Again the survey done in rural areas in 1990/91 has estimated that high incidence of poverty falls hard on landless and small farmers. There is also a clear pattern of poverty incidence by development regions such as incidence of poverty in mid western and far western development regions are the highest (Tenth Plan, 2002). According to the living standard Survey, 1995/96 and poverty rate in 1995/96 was estimated at 38.8 percent. Similarly for 2003/04 it was estimated at 32.0 percent. In urban areas poverty rate in 1995/96 was 32.2 percent which dropped to 19.9 percent in 2003/04. Similarly for the rural areas it was 39.1 percent in 1995/96. It dropped to 32.5 percent in 2003/04. Based on the data NLSS, 1995/96, 95 percent of the poor people of Nepal live in the rural areas. These surveys indicated a substantial disparity in the poverty incidence across the three major physiographic zones highlands being the zone of highest poverty incidence followed by Mountains and the Terai (Dhakal, 2007).

Table: Trend of poverty situation in Nepal

Fiscal year	Percentage of population below poverty line		
	Rural	Urban	Nepal
Poverty incidence in 1976	33.0	22.2	33.0
Poverty incidence in 1995-96	39.1	32.2	38.8
Poverty incidence in 2003-04	32.5	19.9	32.0

Source: Adopted from CBS (2006), Dhakal (2007)

The NLSS (1996) conducted by the CBS has introduced a new category to reveal the incidence of poverty. As in the findings of the previous studies, the proportion of the poor in the rural area is almost two times higher than in the urban areas. Looking at the regional incidence of poverty, the mountain region has the highest concentration of the poor followed by the Terai and the hills (Table 4.9)

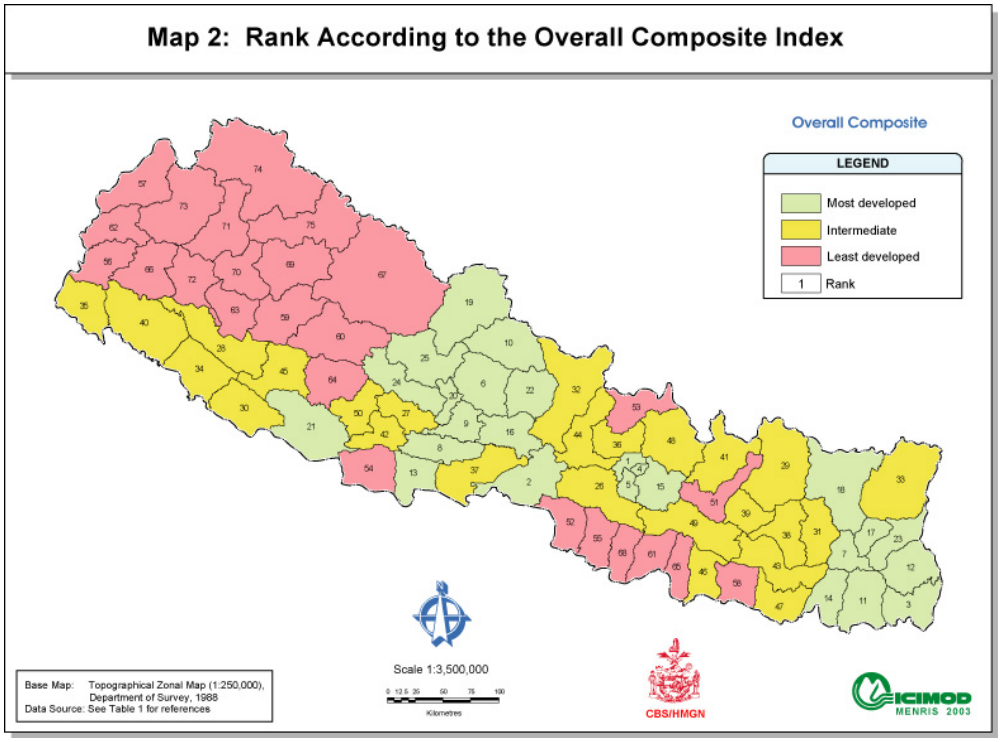
Regarding the concentration of the 'ultra poor', the mountain region has the highest concentration. Indeed, the proportion of the 'ultra poor' in the mountain region is two times higher than that of the Terai. Overall, the data indicates that significant segments of the poor are hardcore poor, barely making a subsistence living in the fragile ecosystems, which lack basic infrastructures.

The poverty level is found increased in 1995-96 when it is measured on consumption basis (Table 4.10). All the indicators, namely head count rate, poverty gap and squared poverty gap show the rising poverty in the survey of 1995-96. 43.3% of the population in rural areas is reported below poverty level whereas only 21.55 of the urban population is recorded below poverty line. The trend is found slightly changed in the year 2003/04, with the fall in

poverty level in Nepal. The total poverty level declined from 41.6 in 1995/96 to 30.8% in 2003/04. The trend is observed both in rural as well as urban areas.

Improvement is seen in almost every part of the country except in rural eastern hills where poverty has increased from 36.1% to 42.9% from 1995/96 to 2003/04 (Table 4.11). The poverty level is reduced in all five development regions, although the mid-western region remains the worst in both time periods. In terms of ecological regions, mountain regions show a 43% decline in poverty level in 2003/04 compared to that of 1995/96. Hill and Terai poverty levels reduced by 15% and 32% respectively. Thus, in 2003/04, it is the hill region that has the highest degree of poverty among three ecological belts (Table 4.11).

The absolute poverty incidence is thus higher in the rural areas, where people are mostly involved in agricultural activities. This fact also indicates that skewed land distribution could be one of the major factors for high level of absolute poverty. A higher rate of poverty is noted when it is measured on the basis of income. It shows about 47.2 of the population below the poverty level in 1995/96, which declined to 34.9% in the year 2003/04 (Table 4.12).



Source: CBS/ICIMOD, 2003

4.5 Relative Poverty: Evidences

Relative poverty refers to the people falling behind the rest of their community. There is no reliable systematic statistical source in Nepal, which provides detailed information on poverty. However, there are some survey data with different methodology and sampling. Based on these data on income distribution, it can be stated that there is a high-income gap among the people. The data on the income distribution show that the lowest 20% of the people have only 7.6% share of the national income/consumption, whereas the highest 20% of the people have about 45% share of the national income or consumption (WDR, 2000/01).

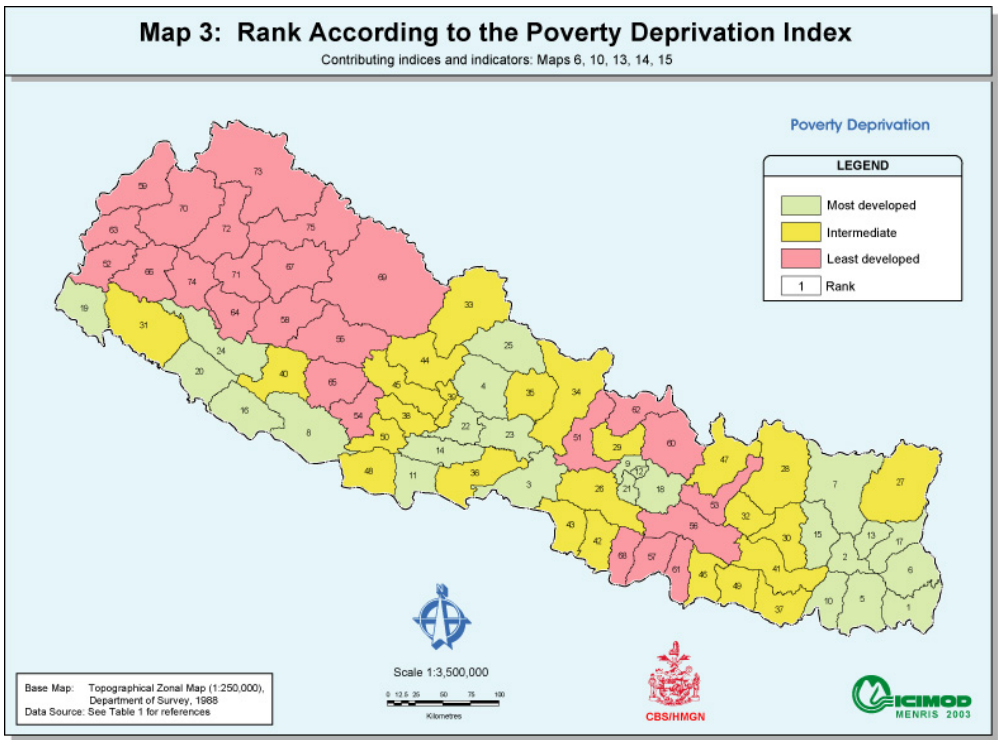
Land distribution in Nepal is also highly skewed in favor of big landowners. Table 4.13 shows the land distribution in different Census periods. In 1981, 50% of the households, each operating less than 0.5 ha., owned only about 7% of the total cultivated land, whereas the top 10% households, operating 3 hectares and above owned nearly 47% of the total cultivated land. Although land distribution in the 90s was found to have improved slightly in favor of small holders, the distribution remained highly skewed. According to the Census of Agriculture (1991), around 43% of holders own less than 0.5 hectare land but it represents only 11% of cultivated land. The top 10% of households owning 2 ha and above constituted around 42% of the total cultivated land. There is rise in the share of households holding less than 0.5 hectare land in 2001/02 with 46.9% of the households with less than 0.5 hectares of land, representing 14.7% of the total cultivated land.

The most recent available information about land holdings manifests that nearly half of the holdings are less than 0.5 hectare, with the average holding being 0.24 hectare (Table 4.14). Land holdings with more than 2 hectare have better facilities, with nearly two thirds of the land being irrigated, 56.9 percent of land in this category uses iron plough, 23.0% of the land in this group has access to pump sets and 19.6% of the group runs tractors in their field.

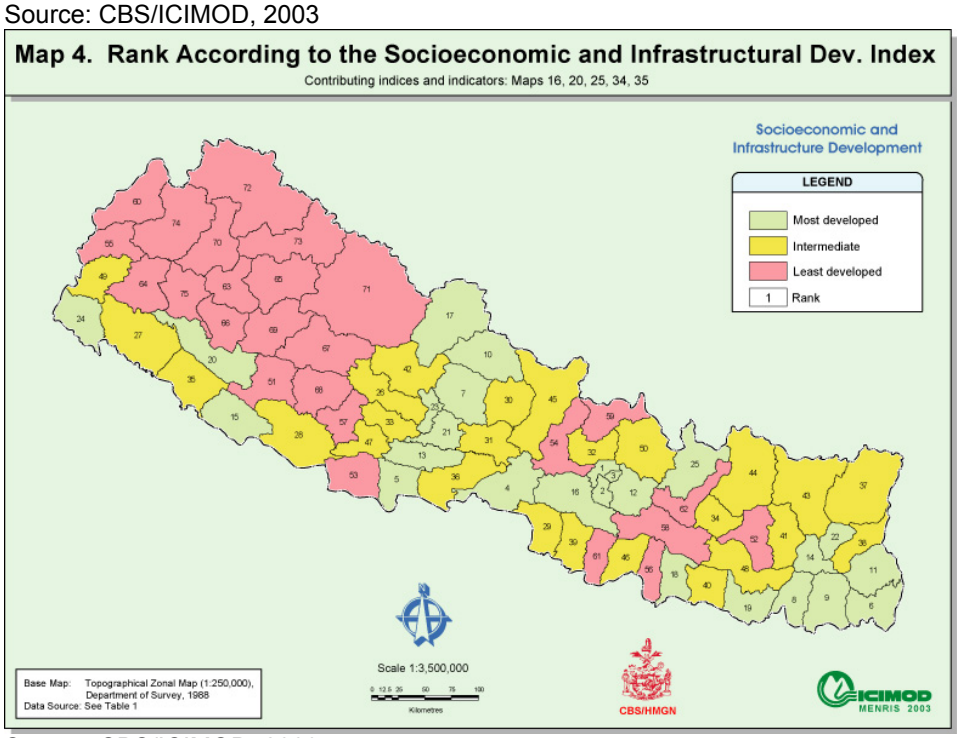
The data on income distribution and land distribution shows that there is a strong positive relationship between income consumption and land ownership. These surveys also indicate a gender dimension of land holding distribution. It reveals that about 94 % of holdings both in 1981 and 1991 were held by males. The average size of land holdings of males was 0.98 hectares as against 0.66 hectares held by females (Sharma, 2003).

Income distribution is highly skewed between the rural and urban areas. As a result, stark differences exist in the poverty incidence by place of residence and sources of income. The available information shows that poverty is concentrated in the rural areas but the figure or information varies greatly in one study to another depending on the methodology, coverage, and definitions. However, it seems that there are some improvements in the status of poor people. The level of poverty has shrunk to the lowest level of 34.6% in 2003/04 since 1977 (Table 4.15). Such improvement is closely related with the level of remittances from abroad.

The incidence of poverty using the income criterion is significantly higher among landless/marginal landowner and small farmers. Thus, among the landless people in the Hills, 70% are poor and only 30% are somewhat resourceful. The situation in the mountains is more or less the same with the corresponding figures being 77% and 23%. In contrast, only 24% of the medium/large landowners in the mountains are poor (Table 4.16). However, poverty is not limited to the landless/marginal and small landholders. About 43% of the medium and large holders of the Hills, 24% in the Mountains and 18% in the Terai are below the poverty line. In addition, 60% of the small holders of the Hills, 58% of the Mountain and 30% of the Terai are below the poverty line.



Source: CBS/ICIMOD, 2003



Source: CBS/ICIMOD, 2003

5. Ecosystem-Poverty Nexus in Nepal

5.1 Natural Resources and rural livelihoods

Natural resources are an integral part of livelihoods of the poor people of Nepal. About 80 % of the population lives in rural areas and is heavily dependent on common pooled resources such as forests, pastures and community woodlands. About 80% of the country's household energy is dependent on fuel wood (Clean Energy Nepal, 2008). Further, for subsistence livelihoods in the Mid-hills, non-timber forest products (NTFPs) play important roles in health care (FAO, 1982; HMG/Nepal, 1988) and in the maintenance of nutritional standards between agricultural harvests (Daniggelis, 1992). NTFPs include medicinal and aromatic herbal plants, a variety of fruits, nuts, seeds, oils, spices, resins, gums, wild mushrooms, craft products and many more products specific to the particular areas from which they originate.

Joshi (1994) reported that in Nepal more than 3,000 medicinal plants are used to alleviate disease or suffering. According to another study, poorer households in the mid hills of Nepal are so dependent on forest resources that 14-20 per cent of their income comes directly from community forests (Adhikari, 2005). Poor people are thus affected more by degradation of natural resources because of their limited assets and their greater dependence on common property resources (DFID/EC/UNDP/World Bank, 2002).

The economy of Nepal is also closely bound to its natural resources—arable land, water, forested areas, and protected areas. The community forestry initiative in Nepal has high potential to make a significant contribution to rural income and employment through NTFP enterprises, particularly to the poor. A study undertaken by the World Bank (1994) estimated that under an intensive forest management regime, community managed forests that could reach a total of about 1.8 million ha after 70 years, could be yielding products valued at Nepalese Rupees (NRs) 12.5 billion per year (US$ 18,000,000), taking into account only woody forest products. The World Bank study further concluded that there were real financial benefits for households, resulting from a shift to a national strategy for productive, sustainable forest management, as compared with the current less intensive management, if this approach could be combined with attention to other critical external constraints (e.g. marketing and transportation of products). The incremental benefits of making this shift were estimated at NRs 2,390/ha/yr (US$ 34) for timber; NRs 9,500/ha/yr (US$ 135) for bamboo and rattan production; NRs 30,700/ha/yr (US$ 438) for medicinal plants; and NRs 660/ha/yr (US$ 9) for fuel wood and fodder.

From the macroeconomic perspectives, the contribution of the forest sector is shown in Table 5.1 and 5.2. Pudasaini (1993) claimed that forestry contributes a significant amount to the GDP—up to 15 percent. However, the official estimate of contribution of forestry sector to the national economy seems very low as it considers only the actual recorded sales and earnings. If we consider all the potential benefits from forests the contribution of forest in the Nepalese economy would be much higher than the official estimates. However, there is no accounting system developed and approved by the government agencies in deriving contribution of forest ecosystem to the overall economy of the country.

Tourism is the second most important source of foreign exchange for Nepal, after agriculture. About 45 percent of tourists coming to Nepal visit protected areas, generating substantial revenue. Tourism revenues from Chitwan and Annapurna contribute substantially to the national and local economies. About NRs 66 million is collected from the protected areas annually out of which 30-50% is shared with buffer zone groups/committee for local community development, but there is more scope for increasing tourism revenue further, and nature-based tourism will be a significant component. Protected areas support ecotourism and vice-versa., thus, providing a leading source of foreign income for Nepal.

Approximately, 45.50% of tourists (191,617) out of a total 421,188) visited protected areas in fiscal year 1998/99 (NBS, 2002).

Agriculture is the mainstay of the economy, providing a livelihood for over 80 percent of the population and accounting for 41 percent of Gross Domestic Product (GDP). As discussed earlier, forest and agriculture are integral part of mountain farming systems of Nepal. Agriculture contributes more than 50 percent of household income (HMGN/MFSC 2002) but this sector is heavily dependent on services provided by forest ecosystems and any deterioration of these services will jeopardize the growth of the agricultural sector in the country.

5.2 Vulnerability to natural disasters

Increased vulnerability to environmental disasters leads to increased poverty by imposing human and economic costs, including loss of life, injuries, disabilities and displacement, as well as damage to agriculture, livestock, and infrastructure. The majority of the rural poor in Nepal live in marginal, ecologically fragile areas, and urban poor live and work in those areas with high exposure to environmental hazards. The poor are forced to live with very poor housing, built on fragile lands. They build their shacks on steep hillsides, on floodplains, in fragile ecosystems and watersheds (SIDA. 2004). As such, the poor are most vulnerable to natural disasters and suffer the greatest exposure to health risks resulting from environmental degradation.

The unique geo-climatic conditions have made Nepal most vulnerable to a variety of natural and manmade disaster. Aryal ( ) pointed out that, 'of the 75 districts in the country, 49 are prone to floods/landslides, 23 are prone to fire (forest/bush) and one is prone to windstorm disasters. A total of 64 out of 75 districts in the country are prone to disaster'. Water-induced disasters such as torrential rains and flooding, landslide and flash floods are serious problem in Nepal which has direct bearing on poverty. For instance, rural poor living in the Middle Hills are highly reliant on subsistence agriculture and this one reliable livelihood option is directly affected by extreme climate conditions leading to food insecurity.

The frequency and severity of natural disasters have increased in recent years, and those trends are expected to continue in future in a country like Nepal (Aryal). Incidents such as earthquake are a major factor affecting the poor. The 1988 earthquake killed 721 people, destroyed 65,000 houses, 15,000 classrooms and many water supply and irrigation networks. Obviously it was the poor people who were hit hardest by the earthquake. The country is experiencing severe impacts from draughts and other adverse weather conditions. Lohani (2007) reported that in 2005-06 farmers from mid and far-western hills and mountains experienced dry winter, which affected their subsistence winter crops. Overall, rainfall during the summer monsoon of 2006/07 was about 16 percent below normal, which reduced cultivation area of paddies in the country. In addition to draughts, mid and far-western regions experienced flood, hailstones and crop diseases which caused serious production losses (ABPSD/MOAC, 2006). Every year, the number of people dying in floods and landslides is trend upwards. In the years 2000 to 2005 more than 1314 people died of floods and landslides across the country (CBS 2006). In such circumstances, it is widely accepted that the poor are the most vulnerable; they suffer the highest number of casualties and have the least capacity to recover. Natural disasters decrease the livelihood opportunities available to the poor, resulting in a decline in well-being.

5.3 Health and the environment

Poor people are most affected by environmental health problems, including a lack of safe drinking water, sanitation, and traditional environmental hazards such as indoor air pollution and exposure to disease vectors (WHO, 1997; Lvovsky, 2001). Infectious diseases

represent 43% of mortality in developing countries versus 2% for developed countries. The most striking health disparities involve shorter life expectancy among the poor, as well as higher rates of cancer, birth defects, infant mortality, asthma, diabetes, and cardiovascular disease. Premature death and illness attributable to environmental factors are now estimated to make up one fifth of the total burden of disease in developing countries. This is comparable to the proportion caused by malnutrition and other preventable risk factors and groups of disease. Minority and poorer communities are more likely to live in polluted environments and to work long hours and in hazardous occupations. There may also be a disproportionate placement of pollution-intensive industries and hazardous waste sites in low-income and minority communities.

The World Bank has calculated that improvements in local environmental conditions facing the poor could lower the incidence of major killer diseases by up to 40%. This realization yields a new dimension to our understanding of the complex links between poverty, environment and health outcome. Around the world about one billion people are exposed to indoor air pollution. An estimated 2.1 million people, of whom 1.8 million live in rural areas in developing countries, die annually from respiratory diseases related to indoor air pollution generated by traditional biomass fuels (firewood, dung). Women and girls account for 80 per cent of these deaths (draft report of the UN Secretary General 2002).

Exposure to water borne disease, indoor air pollution and toxic agro-chemicals, account for a large percentage? of Nepal's disease burden. Diarrheal disease is one of the serious environment-related problems resulting in ill health. Hygienic disposal of excreta and access to sufficient quantities of safe drinking water play a decisive role in reducing diarrheal disease transmission. Lack of safe drinking water is becoming one of the major components of the poverty-environment nexus in Nepal not only in urban areas but also in rural settlements. Due to lack of drinking water in their vicinity, women have to spend a substantial amount of time collecting water. The problem is more pronounced in winter, October/November to April/May, when the natural spring water sources dry up. Due to an increase in population, the existing water sources are not adequate to meet the needs of the people. The effect of reduced access to safe water results in women and girls spending more time fetching water over ever increasing distances. The high cost of treating water borne illnesses adds to the miseries of income lost due to the reduced number of working days for the poor. In urban areas, the poorer sections of the society suffer most, with a disproportionately large number of them also having to pay exorbitant rates to commercial water vendors.

5.4 Poverty reduction Strategy paper (PRSP) and Ecosystem Services in Nepal

Nepal's ongoing tenth national plan accentuates the eradication of poverty through sustainable management of natural resources. The poverty reduction strategy paper (PRSP and The Tenth Plan) highlights the medium-term strategic direction for Nepal, which is sharply focused on poverty alleviation comprising four pillars – sustainable growth, social sector development with emphasis on human development, targeted programs with emphasis on social inclusion and improved governance (NPC/HMG, The Tenth Plan, 2003). However, the environmental determinants of poverty are not adequately referred in the PRSP such as the role forests, pastures, and wetlands. Although the PRSP emphasized the role of agricultural sectors in poverty alleviation, how the sustainable management of natural capitals helps increase the productivity of agriculture is not getting enough attention.

The PRSP is also not able to integrate some very important poverty-environment indicators, such as agricultural land affected by desertification/soil erosion, village lands in commons accessible to poor people, percent of population using traditional fuels, rates of forest land conversion, share of households using clean fuels, and time taken/distance involved in

collecting water and fuel wood, to name a few. The existing PRSP is not able to capture very crucial indicators that matter for poverty alleviation and environmental management.

6. Identified information and knowledge gaps

6.1 Research gaps

Review of literature reveals that the links between ecosystem services and poverty in Nepal is not explicitly explored. Where there are some studies, these studies mainly address sectoral issues and that understanding towards contributions of ecosystem services to poverty alleviation is rather weak. Further, research study that demonstrates the direct and indirect drivers of ecosystem change is scanty. The review suggests that there is no reliable data on the current status of different ecosystems. For instance, even official estimates of forest areas in the country are unreliable and these figures are highly contentious. These estimates were undertaken in late eighty's while preparing the Master Plan for the Forestry in Nepal. However, the situation has been changed tremendously then after.

It is, nonetheless, interesting to note that research that deals with different aspects of community forestry in Nepal is abundant. A strand of existing literature on community forestry suggests that the condition of forests in the Mid-hills has drastically improved after the decentralized effort of forest management with the introduction of community forestry program. As of 2007, about 14300 community forests have been handed over to local communities as the community forests. Along with the condition of forests, access to forest products such as fodder, forage, fuel wood, timber and NTFPs has also increased. However, equity and distributive aspects of resource management, particularly access of the poorest of the poor still an important issue. Attempts should be made to further understanding the relationship between actors and the politics of power between different stakeholders. Who controls and manages forest ecosystems and their services? Who makes decisions? How will women and the disadvantaged sections of society be empowered to address their social and political constraints? These are very interesting and policy relevant questions that need to be addressed through empirical research. Future research needs to be located within a wider analysis of political economy and other issues such as property rights and access to ecosystem services including customary rights of local communities.

The conventional notion of forest management such as timber production is still prevailing as a dominant form of forest management strategy. For example, management focus of community forestry so has been concentrated more on timber and less on non-timber products. The mean annual increment of timber, which is a standard measure of productivity of forest ecosystem described in the classical forest economics literature, is of little value in communities where forest-based livelihoods are pervasive feature of rural economy. It is in this respect that it is very important to conduct studies not only on provisioning services but also supporting, cultural and regulating aspects of forest ecosystems in Nepal.

Quite a few literature claims that the use of alternative forest products mainly NTFPs play a significant role in rural livelihoods, especially the economics of poorer households. Despite this claim, review of literature suggests a mix results with regard to prospects of NTFP management in poverty alleviation. Further, impact of existing forest policy for the management of NTFPs has been little studied. There is a need to improve local capacity in NTFP management by enhancing knowledge, skills and information related to resource management, marketing and institutional arrangements for the promotion of NTFPs and value addition at the local level. More research is needed to document the future of NTFPs management and income generating possibility in community forests.

Community managed forests in the Himalayan region are becoming an important carbon poor, as previous deforested areas in these forests are showing signs of regeneration. The mean carbon sequestration rate of community forests in India and Nepal is close to 2.79 ton

carbon per hectare per year or 10.23 ton carbon dioxide per hectare per year (Singh & Banskota, 2007). However, research on the potential of community forestry in Nepal for carbon sequestration is still under researched. Who should own the benefits of the carbon sequestration of community forests in Nepal? This is an issue that needs to be further explored. This is of particular importance in light of recent climate change agreement about Reducing Emissions from Deforestation in Developing Countries (REDD) , which aims to include the reduction of tropical deforestation as part of the solution to climate change.

A critical dimension of research gap seems to be the analysis of impacts of government environmental policy on ecosystems of the country. Although outcomes of forest policy especially community forestry initiative is much explored but impact of different policies related to the management of ecosystems in Nepal is under researched. Another emerging policy with regard to community forestry in Nepal is the nature and form of external support in ecosystem conservation and environmental management. For instance, assistance from donor- have played crucial role in the community forestry initiative in the country for more than two decades. In this context, as the CF process develops and matures, there is a concern of what form of external support should continue to reach the stage of self-governance of these community-based organizations. More importantly, whether the external agencies should still nurture the local forest institutions (e.g. community forest user groups) already developed as a self-governing entity is far from clear. This will be a genuine topic for further research.

6.3 Enhancing research capacity for poverty alleviation

The country is remained at preliminary stage of recognizing ecosystem services as a way out of getting poor people from the trap of poverty. It is obvious that criteria and indicators to evaluate poverty-ecosystem nexus are not in place. Ecosystem/ environment dimensions of poverty are not adequately recognized in the national policy documents such as Poverty Reduction Strategy Paper (PRSP), Tenth Plan (2002-2007), Interim Plan (2007-2010), Sustainable Development Agenda for Nepal (SDAN) or by sectoral policies of Ministry of Forest and Soil Conservation (MOFSC) and Ministry of Agriculture and Cooperatives (MOAC) and Local Governance. There is a narrow focus of existing institutions in terms of their mandates. For instance, there are ministries and departments to deal with visible goods such as forests, water and lands but there is no ministry for non-visible goods such as ecosystem services. That is why contributions of ecosystem services remain uncoordinated and often ignored and that mainstreaming ecosystem services into national development policy strategies remain a major constraint. At least four barriers to mainstreaming ecosystem services approach into national development strategy have been identified: (i) inadequate understanding of the contribution of ecosystems services to both macro and micro economy of the country (ii) lack of understanding towards linkages between poverty and ecosystem services (iii) little or no data on types of ecosystem services and (iv) limited understanding and documentation of services provided different ecosystems and how degradation of ecosystem will affect the provisioning of these services.

Few important capacity building measures include: (i) training to relevant government and non-governmental organizations on valuation of ecosystem services and analyzing poverty-ecosystem causal links (ii) development and establishment of national green accounting systems to appreciate contributions of ecosystem services to both local livelihood and national economy and explore ways and means of integrating environmental factors into macro-economic decisions (iii) support greening the poverty reduction strategy paper as well as environmental management responses and indicators for the poverty reduction efforts (iv)

support in establishing spatial analysis facility to map the relationship between poverty and selected ecosystem services that help to devise a more comprehensive poverty reduction strategy for the country and (v) enhancing research capacity for poverty alleviation and ecosystem management. There is a dire need of bringing together different stakeholders together who working on poverty, agriculture, biodiversity, water, and other ecosystem services by establishing a national umbrella organization to deal with ecosystem services and poverty reduction strategies in the country.

7. **Trend in ecosystems and its implication on poverty: Insights from stakeholder workshop**

Stakeholder consultation undertaken for this situation analysis has identified a variety of socio-economic and political factors that led to degradation of different ecosystems in Nepal. For instance, when there were political upheavals in the country, politicians have made it a political agenda to give people assurance of the distribution of forest lands for settlements. During the period of these instabilities, thousands of hectares of forests were destroyed and government could not take any action, instead the illegal encroachments were given to the encroachers.

In the name of commercial exploitation of forest for different uses, the natural forests of Terai have been heavily exploited without measures being introduced to replace these forests. There are many cases of irregularities in the community forests of Terai and inner Terai. Reports of huge timber and forest product harvest for quick money for the individual benefit of authorities of forest user groups has had negative impacts on forests. Grazing is open throughout the year in many forests leading to their degradation. The local people also keep animal sheds for grazing inside forests for 4-8 month periods, which has a negative impact on the health of the forests.

Infrastructure development, including roads, electricity extension, wire installation, irrigation canals, dams and establishment of market centers are just a few examples by which thousands of hectares of forests have been deforested and converted to other uses without replacing forests. Similarly, due to the government's resettlement programmes, numerous government commissions recommended and approved the distribution of forest lands for new settlements. Chitwan valley, Jhapa Jhora settlement, and Sarlahi resettlement are just some of the examples resettlements.

Ecosystem degradation is not only driven by human activities but also by natural disasters such as landslides and floods, which have deforested thousands of hectares of forests. Forest fire is very common, both intentional and unintentional.

The ecosystems within the country are also subjected to the changing climatic regime. The changes in ecosystem and ecosystem services are already noticed in the rangeland, mountain and agro-ecosystems. With rising temperatures, areas covered by permafrost and glaciers are decreasing in extent in the high Himalayas. Further, snowmelt begins earlier and winter is shorter: this affects river regimes, natural hazards, water supplies and people's livelihood and infrastructure.

Agriculture and range ecosystem are considered to be more prone to climatic change. This kind of changed phenomenon ultimately causes a shift in crop rotation and changes in crop patterns in agriculture. Climate change will affect the distribution of vegetation types, such as shifts towards high altitude and the depletion of marginal species.

Deforestation has caused many unprecedented events, such as flooding, landslides, long drought period, drying spring water, increased invasive species in the productive lands and reduced production of forest products. Thus, poor and local community people have to spend more time to collect the same amount of forest product. In Bhabar and Terai, thousands of hectares of productive lands have been destroyed by river-cutting and deposition of silts on productive agricultural lands due to the massive destruction of forests in Churia hills. This can be observed in Dhanusha, Siraha and Sapatari districts where Churia hills are denuded and downstream populations are getting poorer then before due to destruction of their agricultural lands. Many of them have become homeless; some have changed their occupation to labourer or rickshaw puller due to loss of their agricultural lands.

Due to deforestation, the incidents of landslides have increased; top soil has been washed away by rainwater in the absence of vegetation cover which has a direct negative impact on the production of agricultural crops and the livelihoods of farmers. In hills, many natural water springs have dried or the quantity of water as well as periodicity of water from natural springs has declined due to deforestation in watershed areas. This has a direct bearing on women who are primarily responsible for fetching water. It has also negative impacts on irrigation for cultivation of crops. Due to deforestation, invasive species such as *Eupatorium* are reducing the production of forest products.

The stakeholder consultation has identified the following observable trends in ecosystems of Nepal:

Positive Changes

- NTFPs/production/collection increased in community forests
- Increased production of timber from community forests
- Increased greenery in community forests
- Soil conservation in managed watersheds
- Increased wildlife in community forests
- Increased biodiversity in community forests and protected areas
- Ecotourism increased

Negative Changes

- Deforestation in Terai region
- Forest degradation in government-managed forests
- Encroachment in government-managed forests
- NTFPs/production/collection decreased in government-managed forests
- Decreased biodiversity in government-managed forests
- Disappearance of water bodies (wetlands)
- Deforestation for infrastructure increased (road, canal, high extension line, industries)
- Increased flooding
- Increased landslides
- Reduction in agriculture production
- Reduction in wildlife population (extinction of few)
- Reduction in livestock population due to lack of grazing lands
- Climate change/global warming
- Reduction in fish production

Table 7.1 Reduction in NTFPs/Medicinal and Aromatic Plants

Drivers/factors	Observed trend	Poverty Outcome
Poverty Unclear state policies Bureaucracy Lack of skill /knowledge/ technology / market	Reduction in NTFP	- Less herbal medicine - Less tourism - Reduction in cash earning - Destruction in system - Negative impact on livelihoods

Table 7.2 Increased flood trend

Drivers/factors	Observed trend	Poverty Outcome
Climate change Forest area decline	Flood increasing	- Soil erosion and loss of fertility - Reduction in agricultural land - Reduction in productivity - Wash out infrastructures - Effect in health - Waterborne disease - Sanitation problem

Table 7.3 Loss of Biodiversity

Drivers/factors	Observed trend	Poverty Outcome
Bio-piracy Monoculture plantation Loss of indigenous knowledge Frequent forest fire Over-grazing Deforestation Forest encroachment	Loss of Biodiversity	- Reduced productivity - Reduced availability of fodder/forage - Increased coverage of invasive weed species - Reduced availability of desired species to fulfill basic needs - Reduced availability of food species

8. CASE STUDIES

8.1 Study in Shivapuri National Park

Investigating the Delivery of Ecosystem Economic Benefits for Upland Livelihoods and Downstream Water Users in Nepal. IUCN/ Institute of Economic Growth, Delhi/ ICIMOD

Shivapuri National Park (ShNP) is the nearest national park to Nepal's capital, Kathmandu. It is located about 12 km north of Kathmandu and covers an area of 14,400 ha. This park is important for biodiversity conservation (contains more than 2,000 plant species, 21 mammals and 180 birds); cultural and religious values (contains Shipocho peak which has religious importance, and provides water to three holy rivers); supports the livelihoods of people living in and around the park in many ways, and most importantly it provides a vital watershed that contributes about one-fifth of total piped water supply in Kathmandu valley. Lying in the middle mountain physiographic zone with elevation range from 1,320 to 2,732 m, this park attracts about 25,000 tourists and pilgrims annually in recent years. This study centred on the 67 sq. km Bagmati Watershed, with a special focus on the 15.76 sq. km Sundarijal sub-catchment.

The current status of this National Park has evolved through a series of conservation efforts that were initiated following heavy deforestation and land conversion to agriculture during early 1970s. It was declared as a protected area in 1973, and as Watershed Reserve in 1976, further upgraded as Wildlife Reserve in 1983, and finally declared as Shivapuri National Park in 2002 imposing strict rules for land and resources use. However, these conservation efforts have imposed costs to about 100, 000 people in and around the park who depend on its resources in some way, while at the same time it provides benefits to downstream in terms of water for drinking water supply, electricity generation and irrigated agriculture.

A key management issue currently facing ShNP is the ongoing effort to conserve the forested catchment that is contained within the park boundaries, in the face of intense and growing threats, and at the same time recognizing the need to ensure sustainable and secure livelihoods for park-dwelling population. One of the binding constraints in effectively managing park the ecosystem is the lack of financial resources available to park authorities, and weak economic incentives to motivate and enable local households to limit their land and resource uses to sustainable levels. While park authorities bear the operational costs of managing ShNP, local communities in and around the park incur the bulk of the opportunity costs of ecosystem conservation. On the other hand, downstream water users in Kathmandu valley enjoy high economic benefits.

Costs and cost bearers:

The opportunity costs of the local communities of managing catchment ecosystems are often ignored in decision making and they remain uncompensated. This situation makes poor upland communities economically unwilling or unable to support conservation, and the protected area management authority finds it increasingly difficult to achieve the management goal. Thus, the direct (park budgets) and indirect costs (crop damages by wildlife, restricted land use options, etc.) and cost bearers of upper catchment management are assessed through basic financial and economic analysis of the management and opportunity costs of different upland ecosystem management options.

There are two major costs associated with this park management. Direct operational expenditures on conservation activities within and around the park by Department of National Parks and Watershed Conservation (DNPWC) which is about NPRs. 6.6 million (or US$ 165,000) annually in recent years. On average, crop damage costs are worth some NPRs 2,873 a year for each park-dwelling household. Loss of use of park resources due to restrictions on harvesting amounts to some NPRs 16,000 a year (comprising timber and NTFP use), and loss of access to agricultural markets incurs average opportunity costs of NPRs 8,000 per household per year.

About 600 households have been living within the park in two villages (Mulkharka and Okhareni) and depend heavily on park resources to fulfill their basic needs such as fuelwood, timber, fodder, herbs etc. About 100,000 people around the park have also been dependent on the park resources - in some way. The incidence of poverty is high among park residents and adjacent communities. About 10% of households are landless, a similar proportion of households female-headed, and more than a quarter suffer recurrent food shortages for 4-10 months of the year (HMG 1996). With restricted legal access to agricultural land and forest resources, limited other income-earning and employment opportunities, frequent crop damages by wildlife, limited infrastructure, little access to markets or basic services, and located in relatively remote enclaves within the national park, the livelihood base of these communities remains extremely weak and insecure. The most affected are those who reside inside the park.

Traditionally the majority of people depended on subsistence farming and livestock raising, however, over time the restriction over grazing and fodder collection has shifted their livelihood option towards alcohol making which is currently an important source of earnings. In addition, crop damage by wildlife has forced farmers to abandon about 431 ha. of cultivable land along the bordering areas of ShNP. However, there is no recognition of the services they are providing and no compensations are given for the rights they have foregone or damages they face. In the absence of any incentive or motivation to conserve, people in and around still use park resources though with restrictions and fears of being caught. Their current alcohol making enterprise also depends heavily on fuelwoods that are being collected from the nearby forest. This can also be seen in satellite images which indicate increasing forest cover in the deep forests while deteriorating conditions around the boundaries and in the fringes of settlements.

Benefits and beneficiaries:

Remote sensing images indicate improvement in forest cover over time. It has led to a more steady flow of water downstream, as evidenced by stream discharge records showing a decreasing trend in potentially damaging peak flows and increasing base flows. Currently, the available water from ShNP is being used for a variety of purposes - mainly irrigation to agriculture, hydropower generation and domestic consumption. It contributes water to over 4,000 ha of agricultural farms to irrigate for the production of rice, wheat, millet, maize, potatoes, other fruits and vegetables. Water from the Sundarijal sub-catchment is collected into a reservoir and channeled to a hydropower plant located in Sundarijal that generates about 4,231,000 KWh of electricity a year. This water from the hydropower plant is finally diverted to Sundarijal Water Purification Plant wherein it is processed and transferred to the city for the distribution to domestic consumers who uses about 33.3 million cubic metres of water a year from this source. Each of these water uses generates huge financial revenues and economic benefits. Currently, the net financial value-added across different water uses totals NPRs 306 million, or some US$ 7.65 million, a year. Besides the water values, the park authority obtains a considerable income from park entry fees.

Park dependence:

In the context of restricted land and resource use, the primary livelihood activity is off-farm, which accounts for an average of 41% of total household income. Although largely exploited without license, non-timber forest products (NTFPs) mainly fuelwood, fodder and timber make a substantial contribution of an average of 23% of livelihoods. A third significant source to earn livelihood is alcohol production that earns cash income contributing about 19% of the household income. Agriculture contributes some 15% of household income, with the remainder composed mainly of livestock sales and products.

There is a marked differentiation in both the level and the composition of household income between different socio-economic groups. Most significant is the varying role that agriculture and the collection of non-timber forest products — the two livelihood components that depend on park resources — play in household livelihoods. There is a direct correlation between household poverty and dependence on the land and natural resources of the park. For the poorest members of the community, park-dependent livelihood components (NTFPs and agriculture) contribute about 47% of total household income, which falls to 39% for poor households and to just 31% among the least poor households (Figure 1). The numbers in this figure indicates the contribution in absolute term. Although the absolute value of these livelihood activities is about one and a half times greater for less poor households than for the poorest, their relative contribution to household livelihoods is much less.

Management:

Based on available information on annual rainfall inflow and outflow from the Sundarijal sub-catchment, three management scenarios as below were developed and modeled to see the impact of different land use cover patterns on the amount of effective rainfall retained in the watershed.
Baseline: Continuation of the status quo: 80% mixed forest, 20% agricultural area.
Scenario 1: Co-management: 80% forest with good cover, 20% agriculture with conservation treatment;
Scenario 2: Resettlement: 100% forest with moderate cover;
Scenario 3: Conversion: 100% agricultural area.

Different scenarios maximize different types of benefits. Overall, the Co-management scenario that benefits local communities and allows some level of sustainable resource uses yields the best mix of hydrological, livelihood and economic benefits. It incurs a low total cost and is second only to scenario three, the 'no management' costs option. Whereas the 'Resettlement' option where no human residence or use of the park is continued, generates the highest difference between upstream and downstream in net present value, it imposes a high cost on the current residents of ShNP. Continuation of the status quo maintains water benefits, but at lower levels than the other two conservation options. Choosing to allow the forest to degrade over time yields high local benefits (from the increased farming activities that could take place in the catchment), but would be insufficient to sustain current high levels of downstream water benefits.

Given the huge benefits downstream at the cost of upstream dwellers, there seems good potential for establishing a reward mechanism like Payment for Environmental Services (PES) which could capture a part of downstream benefits to provide incentives/rewards to upstream catchment managers.

8.2 Kulekhani Watershed, Makwanpur district: RUPES project/Winrock Nepal

The catchments area of Kulekhani reservoir, Kulekhani watershed, is located in Makwanpur district of Nepal encompassing portions of 8 village development committees (VDCs) and distributed over 12492 hectares. The upper catchment area is inhabited by about 45,000 people. The watershed provides valuable environmental services that affect the functioning of hydropower plants. Kulekhani watershed (about 125 sq.km) supplies water to two hydroelectric plants that generate a total of 92MW of electricity, which constitute about 17% of Nepal's currently installed total hydropower capacity. Upland areas of Kulekhani watershed are not only the sources of water, but also a source of sediment influx in the Kulekhani reservoir. About 6730 hectare of forest area has been maintained in the upstream of the Kulekhani watershed. Amatya (2004) evaluated soil erosion rates for different land-use types in the Kulekhani watershed between 1997 and 2002. The study found that soil erosion rate for agricultural land in the Kulekhani watershed is substantially higher (73 metric ton/ hectare/ year) than that of forest land (1 metric ton /hectare/year).

The deposition of sediments in the reservoir affects the life and capacity of the hydropower plant adversely. At the time of design, a sedimentation rate of $700m^3$ per km^2 per year was projected based on previous data. Thus, the project life was estimated to be 50 years from the date of construction, although the project was expected to function for 100 years. The actual sedimentation rate turned out to be much higher, reducing the reservoir capacity much faster than expected. The original bed level of Kulekhani reservoir was 1427 meters and the full supply level was 1530.2 meters. The height of the intake was 1471 meters. There total storage capacity of Kulekhani reservoir was 85.3 million m^3 out of which 73.3 million m^3 was live storage and 11.2 million m^3 was dead storage. By November 2002, the

total storage capacity of the reservoir had reduced to 62.3 million m3, (live 55.56 million m^3 and dead 6.74 million m^3), a reduction of 23 million m^3. The greatest rate of sedimentation occurred in 1993, 1994, and 1995 following the disastrous flood of July 19, 1993.

Following massive deforestation in Kulekhani watershed area between the late 1970's and early 1980s, conservation efforts started in 1978 by USAID leading to FAO-UNDP assisted watershed management and conservation education project in 1982. The main objective of the project was to reduce the rate of sedimentation to increase the life of Kulekhani hydropower projects and improve land use management for the rural population. The project helped in forming community forestry groups, supported conservation education programs, terracing and fruit plantation in marginal lands. These conservation efforts have resulted in two valuable services: reduced siltation and increased dry season water flow. The study was able to establish the linkage between the land use and sedimentation rate. It was calculated that Agricultural land produces an excess 72 Metric Ton of sediments compared to forest land. Maintenance of 6730 hectare of forest land reduces soil erosion by 484,560 metric ton per year. Thus, it is estimated that 243,311 m^3 of additional water is available for power generation because of forest conservation in the upstream watershed of Kulekhani.

The suppliers of these services are the upstream inhabitants, 43% of which are living below the poverty line (CBS, 2005). The major beneficiary of water services is Nepal Electricity Authority (NEA) which generates revenue from selling the electricity generated. NEA pays approximately NRs 250 millions per year revenue to the Nepal Government. As per revised Local Self-Governance Act (1999), the central government allocates 12% of royalty (about NRs 12.0 million per year to the Makwanpur District Development Committee (DDC). Makwanpur DDC has approved guidelines (2006) to spend 50% of its revenue in the upstream-downstream of the Kulekhani watershed i.e. 20% in upstream, 15% in downstream and 15% in the VDC where electricity is generated. The remainder of the 50% revenue is spent in other VDCs, which do not fall in the upstream or downstream watershed of Kulekhani river.

The conservation efforts made by upstream communities have added to that revenue by lowering sedimentation and making more water available for the generation of electricity, especially during the dry season. Economic valuation showed that the forest conservation resulted in additional revenue of NRs. 3, 12 millions a year. Winrock Nepal, under the RUPES action research program, facilitated the set up and operation of a reward mechanism to upland communities sharing benefits from the hydropower revenues, to motivate them to change their land use patterns. A certain percentage of hydropower royalty is allocated for the development activities for the upland communities in this watershed.

8.3 Economic Valuation of Churia Region: IUCN/WWF Nepal/CARE Nepal

The Churia hills region protects watersheds that provide vital ecosystem goods and services supporting upland livelihoods and downstream populations in the Terai plains. Churia hills accounts for 13 per cent of the total land area and forms the southern-most range of hills in Nepal lying between the plains of the Terai and the mountain ranges of the Himalayas with an elevation ranging from 120m to 2,000m. Most of the Churia Hills region is forested but is also inhabited in many places.

Churia is considered to be playing a vital function as a watershed for the downstream Terai plain - where the bulk of the Nepalese population resides and relies on delivered water resources for domestic and agricultural purposes. Terai agriculture produces about half of the country's foods requirement. Churia hills are also important for safeguarding the lives, livelihoods and properties in the Terai plains by regulating the water flow (reducing the flow in monsoon and ensuring the flow in dry season). Likewise, upstream people heavily depend

on Churia resources, e.g. fuel wood for energy, fodder, herbs, raw materials for many handicrafts, bamboo and timbers for construction etc.

Despite its tremendous importance, Churia's conservation and management is receiving little attention in official circles partly due to low awareness of its importance, and partly the pressing needs for socio-economic development investments. Churia faces severe problems of degradation and over exploitation. Churia's natural habitats and ecological processes remain under heavy pressure from human activities compounded by natural factors such as its fragility and high intensity rainfall during monsoon. Common problems that Churia faces are soil erosion and landslides which are caused by heavy monsoon rains, frequent forest fire, intensive agricultural activities, encroachments and uncontrolled grazing. The Churia hills are geologically new, fragile and hence naturally prone to disasters such as floods, landslides and erosion. Upland residents suffer from land loss caused by erosion, mass movement and river bank erosion whereas downstream people suffer from flooding, sedimentation and inundation. Changing climate might impose further threats to Churia and the downstream population through climate vagaries, flood damages and impacts to agriculture.

The scale of damages is often higher in the downstream Terai and would require huge investment in man-made infrastructure to mitigate or avert them. A more cost effective alternative could be to invest in watershed conservation and management in a way that could sustain and improve downstream water services (both quantity and quality) and sustain and enhance upland livelihoods. The loss of downstream water services can have immense social and economic ramifications for the overall socio-economic development of the Terai and thus the entire country. An underlying cause of these threats is the low appreciation and understanding of the economic value of ecosystem goods and services among economic decision-makers. To address this gap, this study was conducted with the objective of assessing the economic value of select goods and services provided by the Churia watershed, and valuating the possibility of piloting innovative financial measures such as Payment of Environment Services (PES) that can act as incentives to support conservation and management efforts.

Table 8.1 Economic value of water per kattha in irrigated agriculture & beneficiaries

Physio-zone	***Foot hills***	***Bhabar***	***Terai***	***Total***
Econ. value of water from paddy (Rs./kattha)	397.3	315.5	541.2	499.8
Econ. value of water from wheat (Rs./kattha)	44.3	251.3	277.3	258.2
Total value of water (Rs./kattha)	441.6	566.8	818.5	757.9
Study sites	***Chanju/Bagd***	***Jaladh***	***Banaganga***	***Kandra***

The study covered four watersheds across the length of Churia hills from east to west. These sites were – Chanju/Bagdwar watershed in Ilam district, Jaladh watershed in Dhanusha district, Banaganga watershed in Arghakhanchi/Kapilvastu district, and Kandra watershed in Kailali district. The goods and services selected for the study were NTFPs, sand/boulders, and water uses. NTFPs and sand/boulders were valued using opportunity costs as well as market values wherever available, while the water use in agriculture was valued using residual imputation method. Information was collected primarily from the households upstream and downstream at all four sites through household surveys, group discussions, and community workshops, and also from secondary sources.

a) Economic value of Irrigation water:

Agriculture is the major livelihood option for the majority of the rural population in Nepal. In the study sites, it accounts for about 31% of the household income. Major crops grown in the downstream area are paddy and wheat followed by maize. On average, the value of water per kattha as an input to paddy production is calculated about NRs. 500 (≈US$231/ha), and about NRs. 258 (≈US$119/ha from wheat. Returns to water in these crops varies greatly across the study sites. For example, in the case of paddy, it varies from a lowest of about Rs. 350 in Kandra area to even slightly more than double (NRs. 763) in Banaganga area. In terms of beneficiaries of water, a clear pattern is observed from north to south, i.e. from the foot hills south towards the in Terai plains. Terai farmers seem to have benefitted almost twice (NRs.819/kattha) compared to foot hills farmers (NRs.442/kattha).

b) Economic value of Churia forest resources utilized:

The commonly collected forest resources at all the study sites are fuel wood, fodder, timber and herbs. Fodder and some herbs were found to have collected for personal use while fuel wood and timber are collected for both household use and for trading. There are a range of medicinal herbs available in the Churia forests but due to a lack of knowledge, only a few common herbs are commonly extracted for home remedy purposes.

On average, 2.02 MT of fodder, 1.62 MT of firewood and 23.7 ft3 of timber are being extracted by a household annually. The value of all these resources together approximately 100700 Nepalese rupees on average per household per year. Use level of those goods varies greatly across the four study sites, ranging from a minimum in Banaganga and maximum in Kandra. The total benefit from these major Churia forest resources account to NRs. 3800 in Banaganga to a maximum of NRs. 22500 in Kandra per household per annum compared to an average of NRs. 10700. Jaladh and Chanju/Bagdwar have these figures NRs. 5800 and NRs 9600 respectively. The values presented here for traded goods such as fire wood, timber and herbs are gross at the market prices and doesn't account for the labor costs involved in their collection and transportation.

An interesting trend can be seen in the resource use pattern along the north south trajectory of the study sites. The number of cattle and especially goat raised in and around Churia hills is higher, an increasing amount of fodder is being collected towards these areas.

Table 8.2 Average quantity and value of Churia resources collected per HH per annum

Average quantity and value of Churia resources collected per HH per annum

	Quantity of goods			Estimated value of collected goods ('000 NRs.)				
	Fodder (MT)	Firewood (MT)	Timber (ft3)	Fodder	Firewood	Timber	Herbs & others	Total
Chanju Bagdwar	2.52	1.42	18.47	2.59	3.73	3.10	0.16	9.6
Jaladh	0.62	0.69	14.59	1.25	1.89	2.41	0.24	5.8
Banaganga	1.52	0.80	0.96	1.86	1.71	0.16	0.12	3.8
Kandra	3.23	3.34	58.31	7.56	4.97	9.86	0.15	22.5
Up hills	6.68	1.55	2.07	5.87	3.51	0.35	0.27	10.0
Foot hills	2.76	1.35	22.82	3.89	3.22	3.84	0.22	11.2
Bhabar	2.08	2.22	15.83	5.41	4.20	2.72	0.08	12.4
Terai	1.20	1.56	28.47	2.63	2.76	4.79	0.15	10.3
EC1	1.30	1.20	6.04	1.43	2.62	1.01	0.17	5.2
EC2	2.35	1.77	21.55	4.60	3.24	3.64	0.18	11.7
EC3	2.71	2.07	54.89	5.20	3.65	9.24	0.12	18.2

Examining benefits across the economic classes indicates that all of these resources are being intensively collected more towards higher economic classes [total value NRs. 5200 in EC1 (poorer group) to NRs. 11700 in EC2 and 1NRs. 8200 in EC3 (less poorer group)] against the general conception that the poor collect more resources. Contribution of Churia resources to a household economy is about 13% in average, which varies across sites (upto 23.6% in Kandra). As can be generally expected, this contribution is higher towards nearby communities, i.e., foothills and Bhabar and also towards lower economic classes. Though the percentage contribution of Churia goods to total livelihoods is higher towards lower economic class people, it is much less in terms of absolute value.

Collection of sand/boulders/pebbles was done from almost all but Chanju/Bagdwar streams where people use the neighboring 'Ratuwa' river for quality reasons. Usually DDCs contract out the collection of such materials from rivers/streams in the respective district, and no studies have been undertaken to assess whether these collection activities have any adverse impact on local environment or watersheds. Based on data from the other three study sites (Jaladh, Banaganga, and Kandra), DDCs receive about 0.42 million NRs from sand/boulders.

Possibility implementing payment for environmental services (PES) in Churia region

Potential beneficiaries in the downstream could be asked to invest only if some assurance could be provided that proposed management actions will result in the delivery of expected hydrological services. Although there is a lack of such established linkages and other scientific uncertainties, a positive aspect is that most of the potential beneficiaries have experienced and observed a level of relationship between upstream watershed conservation and dry season water flow downstream. About 85% of respondents believe that such relationship (good & strong) exists, while some 14% respondents were skeptical about it.

One of the major problems related to hydrology downstream is increasing flood damages, and for mitigating this problem local communities are willing to pay some premium. About 55% of respondents have closely observed or been faced with landslides and flood damages, and believe that such damages are increasing, varying from only 25% at Kandra site to a maximum of 79% at Banaganga site. They believe that on average, 60% of such damages could be attributed to deteriorating watershed condition.

From the above responses, it seems local people believe that there exists some level of linkage in Churia hills conservation, and downstream water benefits- and flood damages. At the same time they have been facing increasing water shortage for irrigation, and more often in recent few years due to climatic variability. About 70% of respondents felt that they usually have to forego some crops in a year or cause damage to the crops due to water shortage, while 30% of them felt this problem only now and then. With respect to groundwater, about 41% respondents believed the declining water table makes it more costly and economically infeasible to extract for agriculture. Declining groundwater availability is noticed more at Chanju/Bagdwar and Jaladh sites than at the Banaganga and Kandra sites.

Having been faced with different level of water shortage especially for agriculture, about 97% of respondents expressed their willingness to contribute financially or in kind for the Churia conservation. However, would like to be assured of the desired outcome. No effort was made to elicit the level of contribution. People in the up hills area also indicated an intention to invest if they could get a guaranteed supply of water for their agricultural farms from any source. These responses all indicate the potential for PES in this region.

However, this study also indicates that though upstream settlements in the Churia hills

depend relatively more on Churia resources (which is natural due to their limited livelihood options), the higher scale of damage seems to have been caused by outsiders' invading the area, mainly downstream people from the foothills and Bhabar (resource collection table). In this case the feasibility for piloting PES and its implementation effectiveness becomes dubious. Additionally, most of the people who expressed their willingness to contribute for Churia conservation indicated their kind support and not cash, and also they were a bit skeptical on if this can really be solved through Churia conservation.

Further, some respondents also raised issues against PES which might need careful examination. Some of the downstream people raised concern over their natural right to use water resources flowing down the river, and on the groundwater extracted over their land. Though they understand that water availability is being threatened, they would be reluctant to pay and there is a possibility of free rider problems. Some people commented that the upper catchment is managed or will be managed well because these are mostly under community forest and they have incentive to do so. They manage community forest for their own sake and not for the downstream benefit, and thus, people living in downstream areas would be willing to contribute only if additional hydrological benefit could be assured/ demonstrated through additional management approaches upstream. However, it makes the piloting of PES difficult. It is often easier if water users could be convinced to pay for existing services by demonstrating the existence of a threat than to pay for restoration to increase the level of services, and that is how many PES schemes around the world have worked out.

8.5 Property rights and natural resources: Socio-economic heterogeneity and distributional implications of common property resource management

Working Paper 01-03 South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu. Nepal

This study provides a comprehensive analysis of the contribution of community forestry to household level income with particular emphasis on group heterogeneity and equity in benefit distribution in the Mid-hills of Nepal. The main objective of this paper was to examine whether recent policy shifts from government management to community-based forest resource management have increased access of poorer households to community forest (CF).

The paper analysed both gross and net income incurred to households and found that poorer households are getting lower gross value from CF (Table 1). Income from CF increases gradually as one moves from lowest to the highest income group. This may be due to the fact that poorer households have less land and livestock ownership and so could not use intermediate forest products like fodder, leaf litter and grasses, which constitute a major portion of household income from CF. It appears that less poor households are still better off than poorer households from CF in term of net income from community forests. However, evidence suggests that net income from common property resource (CPR) is an increasing function of wealth only up to a certain level, and then it declines. Though gross income is significantly different between income groups, comparison of net income suggests that the three income groups are not statistically different.

Table 8.3 Annual average gross and net incomes per household from CF (Nepalese Rupees)

Income Group	*N*	*Gross Income*	*Net Income*
Poor	81	7,756	2,701
Middle	136	14,815	5,731

Rich	92	24,466	4,335

Comparison of the percentage of total household income from CF to total household income for three different income groups shows that the percentage of total household income from CF is lower for poorer households compared to middle wealth and richer or less poor households (Table 2). Gross income from CF as a percentage of total income is lower for poorer households (14%) than those for middle-wealth (20%) or richer households (22%). But comparing net income, it appears that the percentage of net CF income relative to total household income of poorer households is slightly higher (5%) than that of richer households (4%). The results also suggest a possible inverted U shaped relationship between net CPR income and wealth.

Table 8.4 Percentage of gross and net income from CPR to total household income

Income group	*% Gross CPR Income*	*% Net CPR Income*
Poor	14	5
Middle	20	8
Rich	22	4

A higher proportion of household level income from CF comes from either fuel wood or livestock related products such as tree fodder, cut grass and leaf litter. The percentage of CF gross income from livestock related products for each stakeholder group shows that in most cases livestock-related products represented more than 60 percent of the gross value of production (Table 3). The proportion of gross value from livestock related products increases with wealth, as richer households derive higher income from tree fodder, grass fodder, and leaf litter.

Table 8.5 Percentage of CF gross income from livestock related products

Income Group	*N*	*% CF Income*
Poor	80	63
Middle	134	78
Rich	92	85

The results clearly show differences in both gross and net income derived by households in different income classes. Poorer households in forest-dependent communities obtain much less value from community forests than middle income and rich households. The average 'poor' household obtains NRS 7756 from CF annually, while the more 'rich' households obtain in average NRS 24,466 per year from the community forests. Thus, in terms of absolute contribution to the total household income, community forests contribute more to less poor households compared to the poor.

It was found that on average 85% of forest income accruing to rich households is from collecting of livestock related forest products. In contrast, approximately 63% of CPR income accruing to poor households is related to livestock. This relationship between forest income and household income is likely to be because of easier access to intermediate forest products, which benefits wealthier households. A straightforward comparison of gross income shows that the richest class of households gains the most from CF, the middle-income classes gain less than the rich and the poorest households gain the least. However, when net income from CF across these income categories is compared, then an interesting inverted U shaped relationship emerges. In terms of net income (taking all costs into consideration), the poor, on average, obtain 5% of total household income from community

forests, middle-income households obtain 8% of total income from forests, and, the most well off households obtain 4% of their total income from forests. Overall, the study findings seem to suggest that because of the dependence on intermediate products, households with assets gain more from CF than the poorest households in villages.

The study also found a strong relationship between private endowments of households and dependency on CFs. The paper recommended private property rights provisions within CF management regimes. The existing system of CF management does not allow a user group member to sell her/his use rights or rights to a particular forest product to outsiders or other members within the same community. If property rights cannot be transferred, there is no way of allowing households poorly endowed with lands and livestock benefiting from commons. Thus private property options within common property arrangements may be one way to move forward for equitable distribution of benefits among heterogeneous social groups.

This study suggests that since poor people do not get substantial benefits from agricultural related forest products, forest management policy needs to be directed at increasing alternative forest products, mainly NTFPs that played a significant role in supplying livelihood needs in the past. In order to ensure that the interests of poorer households are fairly represented in an operational regime, it may be necessary to require that the number of poorer and occupational households as well as women on the decision-making authority of forest user groups (FUGs) should at least be proportional to their numbers in the community. Equally important is supporting and empowering FUGs in various aspects of CF management that especially focus on poorer forest-dependent households so that their interests are adequately represented in forest planning and management decisions.

8.6 Ecosystem Services of Himalaya Mountains Forests: Survey, Payments Options and Assessment of Carbon and Recreational Value

International Development Research Centre (IDRC), South Asia regional office/ ANSAB (Asia Network for Sustainable Agriculture and Bioresources), Kathmandu/Nepal

This study assessed forest carbon and quantified contribution of forests to carbon-sequestration in Nepal and Uttaranchal based on the existing data and growing stock estimation.

The formation of community forest user groups (CFUGs) in Nepal has played a significant role in restoring degraded forests. In Uttaranchal the government has taken an initiative to put community forest in place. In terms of carbon sequestration of community forests, Tewari and Phartiyal (2006) taking two cases in Nepal and three cases in Uttaranchal recorded that an average of 2.1 t C/ha/yr (Nepal) and 3.7 t C/ha/yr (Uttaranchal) is sequestered. At this rate, a community forest area of 100 ha can yield about US $3,953 (IRs 166,000) in Uttaranchal, and US $2,730 (NRs 196,560) in Nepal (estimated at the rate of US $13 per t carbon). Though not a huge amount, this is can be a substantial cash income for poor local people.

Table 8.6 Carbon stock (t ha -1) and sequestration rate (t ha -1 yr -1) in community managed forests of Uttaranchal and Nepal

Uttaranchal, India	Carbon mass (t ha $^{-1}$)			Mean C sequestration rate (t C ha $^{-1}$ 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 forests				**3.7**
Nepal	**Year 1**	**Year 2**	**Year 3**	**Mean C sequestration rate (t C ha $^{-1}$ yr $^{-1}$)**
Ilam	57.94	60.75	64.13	3.1
Lamatar	51.19	52.31	NA	1.13
Manang	30.94	NA	NA	-
Mean C- sequestration rate across the forests.				**2.12**

Note: N/A refers to data unavailable

In whole of Uttaranchal, in relatively undisturbed forests carbon sequestration rates in total biomass (above ground plus below ground) generally range between 4 and 5.6 t C /ha/yr, which are similar to those reported for tropical forests. However, the average value of sequestration for the region is about half as much as above. This gives a total amount of sequestration in entire forest area of Uttaranchal, about 6.6 million t C per year. Its value at the rate of US $13 per ton carbon comes to US $85.5 million or about 3.1 billion Indian rupees or NRs 5 billion (1 US $= IRs. 46; 1 US $ = NRs. 72). In Kumaun region of Uttaranchal, Chirpine (*Pinus roxburghil*) forest is the largest contributor to carbon sequester, but at the state level temperate broad leaved forests, in which various Oaks dominate, account for the largest fraction of carbon accumulation.

Table 8.7 Carbon in different forest ecosystem types of Uttaranchal

Forest Type	Area (km2)	Carbon Pool				
		Biomass (M t C)	Forest floor Mass (M t C)	Soil (150 cm depth) (M t C)	NPP (M t C yr1)	Net Accumulation in biomass (M t C yr1)
Temperate Conifer Forest	6017.06	37.15	1.93	68.54	3.49	1.59
Temperate Broad Leaved Forest	7808.81	119.30	2.39	111.95	4.72	2.29
Tropical Coniferous (Pine) Forest	5418.03	33.45	1.74	61.71	3.14	1.43
Moist Deciduous Forest	3027.25	54.45	0.30	15.10	1.85	0.92
Dry Deciduous Forest	695.31	12.51	0.07	3.47	0.42	0.21
Sub Tropical (Sal) Forest	561.59	10.10	0.05	2.80	0.34	0.17
Total	**23528.05**	**266.96**	**6.48**	**263.57**	**13.96**	**6.61**

Similarly, in Nepal, as for estimation of productivity we used appropriate quotients derived from studies in Uttaranchal and in certain sites of Nepal. Our estimation shows approximately 126 million t C is stored in the tree stems of Nepal forests. Since the forest soil pool is likely to be of a similar size, the total forest C pool can be assumed to be about 250 million t in Nepal. The yearly C sequestration from all forest comes to about 10 million t, contributions being large from sal forests, oak forests, pine forests and fir forests. Since our estimates do not include branches, which may account for 20-40% of biomass in forest types like oak and other broadleaved species, we suggest that actual yearly carbon sequestration could easily be about 15 million t. Furthermore, this estimate does not include the additional revival of community forests, which have clearly shown signs of recovery during the last decade or so. National parks, sanctuaries and other protected areas have some of the least disturbed forests of Nepal. We estimate that at present forests in Nepal sequester about 20-25 million t C each year, which gives a value US $260-325 million.

Table 8.8 Estimation of forest carbon in Nepal

Species	Total stem volume ('000 m3)	Density (kg/m3)	Total biomass ('000 t)	Total Carbon ('000 t)	Quotient (NPP/Biomass)	C-sequestration ('000 t yr^{-1})
Acacia catechu	1335	993.1	1325.8	662.9	0.15	99.44
Acer spp.	2778	646.6	1796.4	898.2	0.05	44.91
Abies spp.	10499	448.5	4709.0	2354.5	0.05	117.73
Abies pindrow	1777	469.9	835.0	417.5	0.05	20.88
Abies spectabilis	6733	448.5	3019.9	1509.9	0.05	75.50
Adina cordifolia	6893	731.5	5042.3	2521.1	0.07	176.48
Alnus nepalensis	11049	440.5	4867.2	2433.6	0.07	170.35
Anogeissus latifolius	6338	982.1	6224.8	3112.4	0.15	466.86
Buchanania latifolia	534	525.9	280.9	140.4	0.1	14.04
Bombaox ceiba	794	376.4	298.9	149.4	0.15	22.41
Coriaia nepalensis	966	758.2	732.4	366.2	0.05	18.31
Castanopsis spp.	3631	668.8	2428.3	1214.2	0.07	84.99
Garuga pinnata	2537	624.7	1584.9	792.5	0.07	55.48
Ilex doniana	257	881.0	226.4	113.2	0.04	4.53
Lagerstroemia parviflora	4872	842.6	4105.0	2052.5	0.08	164.20
Mallotus philippensis	451	756.1	341.0	170.5	0.04	6.82
Michelia spp.	1710	590.9	1010.4	505.2	0.04	20.21
Myrica esculenta	351	763.5	268.0	134.0	0.03	4.02
Persea spp	1367	1121.3	1532.8	766.4	0.03	22.99
Pinus wallichiana	3825	512.6	1960.7	980.3	0.1	98.03
Pinus roxburghii	24414	666.4	16268.7	8134.4	0.1	813.44
Quercus species	35187	1041.2	36636.7	18318.4	0.05	915.92
Rhododendron species	16394	643.9	10556.8	5278.4	0.02	105.57
Shorea robusta	109397	914.7	100060.4	50030.2	0.1	5003.02
Symplocos spp	1747	674.8	1178.8	589.4	0.1	58.94
Symplocos paniculata	1635	592.7	969.0	484.5	0.1	48.45
Terminalia spp	32577	764.1	24891.5	12445.7	0.05	622.29
Tsuga dumosa	7175	448.5	3218.1	1609.1	0.04	64.36
Other spp.	27429.9	573.3	15726.4	7863.2	0.07	550.42
Total	**324652.9**			**126048.2**		**9870.57**

This study shows that forests managed by communities both in Uttaranchal and Nepal can sequester carbon in addition to meeting their needs of subsistence living, provided the area of forests under their control is sizeable. Payment for carbon sequestration may be used as an economic incentive for further improvement of the forest management.

3. Assessment of recreational service value of Nepal and Uttaranchal Mountain forests

An important aspect of Himalayas and Himalayan forests is the recreational services provided by them. The Himalayan forests attract a number of local, regional and international tourists. In order to estimate the value of recreational services, an extensive study was carried out in Nepal and Uttaranchal. The sites selected for the primary data collection were: Chitwan National Park, Nagarkot, Pokhara and Langtang National Park in Nepal and Nainital, Bhimtal, Sattal, Naukuchiatal, Mussoorie and Jim Corbett Park in Uttaranchal. A total of 369 tourists – 242 domestic and 127 were selected at random from the sites in Nepal in the month of February and March 2006. In Uttaranchal, 279 local and 156 foreign tourists were selected at random in the months of April to June, 2006.

Table 8.9 Reason for Visiting Himalayas

Reason to Visit Himalayas	**No of Tourists Responded**	
	Domestic	**Foreign**
Presence of Mountains	113 (46.69)	115 (90.55)
Combination of Hills and Lake	42 (17.36)	
Opportunity for exercise/hiking/boating etc.	79 (32.64)	3 (2.36)
Presence of number of nearby tourist places	4 (1.65)	
Presence of Wild Life	4 (1.65)	2 (1.57)
Presence of Temples, History etc.		4 (3.15)
Any Other		3 (2.36)
Total	**242 (100.00)**	**127 (100.00)**

Note: Figure in parentheses gives the percentage of the total tourists surveyed.

Table 8.12 gives the per hectare recreation for these four sites in Nepalese rupees and US $. From the table, it can be inferred that tourism value from Himalayan forests are falling between US $ 272 – 526 or NR 18490 to 35797 respectively depending upon the functional form assumed. However, the values as obtained for foreign tourists to different sites in Uttaranchal are lying between US $ 44.12 to 95.34 depending upon the functional form.

Table 8.10 Total Consumer Surplus (In NR and US $) for the four sites – Domestic and Foreign Tourists

	Consumer Surplus (NR / hectare)@		**Consumer Surplus (US $)**	
Sites	Linear Form (1)	Semi-log Form (2)	Linear Form (3)	Semi-log Form (4)
Chitwan National Park	223.07	169.45	3.28	2.49
Nagarkot	32134.36	16323.01	472.56	240.04
Pokhara	3424.08	1979.95	50.35	29.12
Langtang National Park	15.83	17.87	0.23	0.26
Total Consumer Surplus	35797.32	18490.28	526.43	271.92

Note: @ - 1 US $ ≈ NR 68.

The analysis and results based on f the 4 sites in Nepal show that the value derived from domestic tourists in the Himalayan forests is to the tune of US $3.8 to 4.5 (NRs 273 to 323) per hectare. Accordingly, the total value of Himalayan forests for domestic tourists comes out to be US $60,000 to US $70,000 (NRs 4.06 million to 5.06 million). Similarly, the value of Himalayan forests for foreign tourists comes out to be US $1.04 to 1.85 million. The total

tourism value from Himalayan forests falls between US $272 – 526 (NRs. 18,490 to 35,797) per hectare.

Similarly, the value of Himalayan forests for foreign tourists to six sites in Uttaranchal comes out to US $3.7 to 7.6 million. The total tourism value from foreign tourists comes out to US $48 to 102 (IRs 1,985 to 4,290) per hectare.

The findings are expected to be useful to the governments and other stakeholders of both the countries in terms of designing and planning participatory conservation initiatives; strategizing buffer zone management approaches; determining conservation or entrance fee for tourists; and identifying roles and developing revenue sharing mechanisms among local communities, governments, and other stakeholders.

8.6 Development and Climate Change in Nepal

Organization for Economic Co-operation and Development
COM/ENV/EPOC/DCD/DAC (2003)
Author: Shardul Agrawala

A study carried out under an OECD project on Development and Climate Change in Nepal investigated the impacts of climate change on water resources and hydropower sectors. It analyzed recent climate trends and climate change scenarios, key sectoral impacts and multiple indicators to establish priorities for adaptation. Nepal's water resources sector was identified as being highly vulnerable to climate change.

Table 8.11 General Circulation Model of temperature and precipitation changes for Nepal

Year	Temperature change (0C) mean (standard deviation)			Precipitation change (%) mean (standard deviation)		
	Annual	DJF4	JJA5	Annual	DJF	JJA
Baseline average				1433 mm	73mm	894 mm
2030	1.2 (0.27)	1.3 (0.40)	1.1 (0.20)	5.0 (3.85)	0.8 (9.95)	9.1 (7.11)
2050	1.7 (0.39)	1.8 (0.58)	1.6 (0.29)	7.3 (5.56)	1.2 (14.37)	13.1 (10.28)
2100	3.0 (0.67)	3.2 (1.00)	2.9 (9.67)	12.6 (9.67)	2.1 (25.02)	22.9 (17.89)

Source: COM/ENV/EPOC/DCD/DAC (2003)

4: December, January, February; 5: June, July, August

Analysis of climatic trends reveals a significant warming trend in recent decades which has been even more pronounced at higher altitudes. Climate change scenarios for Nepal across multiple general circulation models show considerable convergence on continued warming, with country averaged mean temperature increases of 1.2°C and 3°C projected by 2050 and 2100. Warming trends have already had significant impacts in the Nepal Himalayas – most significantly in terms of glacier retreat and increases in the size and volume of glacial lakes, making them more prone to Glacial Lake Outburst Flooding (GLOF). Although there is a moderate confidence across climate models that the monsoon might intensify under climate change, continued glacier retreat may reduce dry season flows fed by glacier melt. The likely result is enhanced variability of river flows. A subjective ranking of key impacts and vulnerabilities in Nepal identifies water resources and hydropower as being of the highest priority in terms of certainty, urgency, and severity of impact, as well as the importance of the resource being affected.

Human health is ranked below water resources and agriculture mainly because of the significant uncertainty about many impacts, although it is likely that climate change will present health risks to Nepal from increased exposure to floods and vector-borne illnesses. We do not know how significant the health effects could be. The health related effects of flooding could be apparent in the near future, but other health effects may not become apparent for many decades. Ecosystems/biodiversity are ranked last because little historical research has been conducted on the effects of species diversity. Nepal is not a center of endemism, yet its vegetation diversity makes biodiversity an important issue. We are uncertain how sensitive biodiversity will be to climate change or when impacts may be realized.

Table 8.12 Priority Ranking of climate change impacts for Nepal

Resource/Ranking	Certainty of impact	Timing of impact (urgency)	Severity of impact	Importance of resource
Water resources and hydropower	High	High	High	High
Agriculture	Medium-low	Medium-low	Medium	High
Human health	Low	medium	Uncertain	High
Ecosystems/biodiversity	Low	Uncertain	Uncertain	Medium-high

Source: COM/ENV/EPOC/DCD/DAC (2003)

The in-depth analysis of water resources in Nepal identifies two critical impacts of climate change – GLOFs and variability of river runoff – both of which pose significant threats not only to hydropower, but also to rural livelihoods and agriculture. A preliminary discussion on prioritization of adaptation responses highlights potential for both synergies and conflict with development priorities. Micro-hydro, for example, serves multiple rural development objectives, and could also help diversify GLOF hazards.

On the other hand, storage hydro might conflict with development and environmental objectives, but might be a potential adaptation response to increased variability in stream-flow and reduced dry season flows which are anticipated under climate change. Further, while addressing one impact of climate change (low flow); dams could potentially exacerbate vulnerability to another potential impact (GLOFs), as the breach of a dam following a GLOF might result in a second flooding event. Finally, the in-depth analysis also highlights a trans-boundary or regional dimension to certain impacts, highlighting the need for regional coordinated strategies to cope with such impacts of climate change.

Many catastrophic GLOF events in Nepal, in fact originated in Tibet. Nepal has a potential of generating hydro-electricity with total capacity of 83,000 MW but only 1.5 of this generating potential has been harnessed and even this may be at risk due to climate change. In addition to national discourses on linkages between climate change and development, such discussions might also be needed at a regional level to formulate coordinated strategies.

References

Abbington, J. B., 1992. Introduction: The Country of Nepal. In J.B. Abbington (ed.) Sustainable livestock Production in the Mountain Agro-ecosystem of Nepal, FAO Animal Production and Health Paper 105, Rome, Italy.

Adhikari, B., 2005. Poverty, Property Rights and Collective Action: Understanding the Distributive Aspects of Common Property Resource Management. Environment and Development Economics 10: 1-25.

Achet, S. H., 2000. An Ecosystem Approach in a Watershed Continuum: Some Perspective from Nepal's Experience in Participatory Watershed Management. Proceedings of Danida's Third International Workshop on Watershed Development, Danida.

APP (1995) Agriculture Perspective Plan of Nepal. Ministry of Agriculture, Kathmandu, Nepal.

Aryal, K.R., Ibid. Vulnerability, Disasters and Nepal. Environment Nepal, Available at http://www.environmentnepal.com.np/disaster_m.asp.

Bajracharya D, 1983. Deforestation in the Food/Fuel Context: Historical and Political Perspective from Nepal. Mountain Research and Development, 3 (3) 227-240.

Banskota, K. and B. Sharma, Rural Livelihoods in Nepal: A Case of Mustang District. Sustainable Rural Development in Mountainous Regions of TAR (Chapter 6).

Bhandari, B. (Ed.) 1998. An Inventory of Nepal's Terai Wetlands. IUCN- The World Conservation Union, Nepal. Kathmandu.

Bhatta, S. and S. K Sharma, 2006. The Determinants and Consequences of Chronic and Transient Poverty in Nepal. CPRC Working Paper 66, University of Illinois at Chicago.

Bhattarai, R., 1997. Water Rights in Nepal. in Water Rights Conflict and Policy, International Irrigation Management Institute, Colombo.

Biodiversity and MDGs in Nepalese Perspective, A Bi-annual newsletter of IUCN Nepal, Vol 7 (1), 2006.

Bista, M. and M.P. Chaudhary, 2003. Forest invasive Species Country Paper: Nepal. Proceedings of the Asia-Pacific Forest Invasive Species Conference, Kunming, Yunnan Province, China, 17 - 23 August 2003.

BPP (1995) Biodiversity Profiles Project 3 volumes for Terai and Siwaliks, Mid-hills and High mountains/High Himal Physiographic zones. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Branney, P. and Dev, O. P. 1993. Development of Participatory Forest Management for Community Forests in the Koshi Hills. Banko Janakari: Vol 4, No.1, 47-52 pp. Kathmandu, Nepal.

Branney, P; Malla, Y. B. and Neupane, H. R. 2000. Learning by doing: Participatory Research with Forest user Groups in Nepal. In: edited by Lawrence, A. Forestry, Forest Users and Research: New Ways of Learning. ETFRN, Wageningen, The Netherlands. 97-108 pp.

Branny, P., and K.P. Yadav, 1998. Changes in Community Forest Condition and Management 1994-1998: Analysis of Information from the Forest Assessment Study and Socio-economic Study in the Koshil Hills. Nepal-UK Community Forestry Project Report # G/NUKCEF/32, Kathmandu.

Brown, S.J., 1997. Soil Fertility, Nutrient Dynamics and Socio-economic Interaction in the Middle Mountains of Nepal. Unpublished PhD Thesis, University of British Columbia, Canada.

Browning A J, 1974. Forest Development, Nepal: Marketing. Prepared for the Government of Nepal, (FAO: DP/NEP/69/513 Technical Report No. 1, FAO, Rome).

Carson, B., 1992. The Land, the Farmer and the Future: A Soil Fertility Management Strategy for Nepal. ICIMOD Occasional Paper # 21, Kathmandu, Nepal.

CBS,1984. National Sample Census of Agriculture 1981, Nepal Government, National Planning Commission Secretariat, Central Bureau of Statistics.

CBS, 1993. National Sample Census of Agriculture 1991, Nepal Government, National Planning Commission Secretariat, Central Bureau of Statistics.

CBS, 2003. National Sample Census of Agriculture 2001, Nepal Government, National Planning Commission Secretariat, Central Bureau of Statistics.

CBS, 2004. Nepal Living Standard Survey 2003-2004, Nepal Government, National Planning Commission Secretariat, Central Bureau of Statistics.

CBS, 2005. Poverty Trends in Nepal (1995-96 and 2003-04), Nepal Government, National Planning Commission Secretariat, Central Bureau of Statistics.

CBS, 2006. Nepal Living Standard Survey 1995-1996, Nepal Government, National Planning Commission Secretariat, Central Bureau of Statistics.

Chapagain, D. P., K. Kanel and R. Regmi, 1999. Current Policy and Legal Context of the Forestry Sector with Reference to the Community Forestry Programme in Nepal, A Working Review, Nepal-UK Community Forestry Project, Kathmandu, Nepal.

Chhetri, M.B. and D. Bhattarai, 2001. Mitigation and Management of Floods in Nepal. Ministry of Home Affairs, Kathmandu, Nepal.

Churia WMP, 2001. Reducing Deforestation and Soil Erosion to Improve the Livelihoods of Poor and Vulnerable People in the Churia Hills: Churia Watershed Management Project Brief. Government of Nepal/CARE Nepal.

Collar, N.J., Crosby, M.J. and Stattersfield, A.J. 1994. Birds to Watch: the World List of Threatened Birds. BirdLife International, Cambridge.

Clean Energy Nepal, 2008. Energy Consumption in Rural Nepal. Clean Energy Nepal Newsletter, January 2008.

Daniggelis, E., 1992. Forest Resources as an Adaptive Strategy in Sankhuwasabha, Eastern Nepal. Paper Presented at the International Conference on The Anthropology of Nepal: People, Problems and Processes, Kathmandu, 7-14 September 1992.

DFID/EC/UNDP/The World Bank. 2002. Linking Poverty Reduction and Environmental Management: Policy Challenges and Opportunities. IBRD/The World Bank, Washington DC, USA.

Dhakal,N., 2007. Agriculture and Environment: Interlink with Poverty Dimension. Journal of Agriculture and Environment, Vol. 8, pp:74-82.

Dhakal, B., H. Bigsby and R. Cullen. 2005. Impacts of Community Forestry Development on Livestock-Based Livelihood in Nepal, Journal of Forest and livelihood 4(2).

DNPWC, 2004 (Annual Report 2003/04). Department of National Parks and Wildlife

DNPWC, 2005 (Annual Report 2004/05). Department of National Parks and Wildlife

DOAD. 1992. National Fisheries Development Plan, 1992/93. Fisheries Development Division, Department of Agriculture Development, HMGN, Kathmandu, Nepal.

Dobremez, J. F., 1970. Biogeographic due Centre Nepal. Bull. Ass. Geographes, France 379-380: 79-90.

DoF, 2002. Hamro Ban. Department of Forests, Kathmandu, Nepal.

DoF, 2003. Hamro Ban. Department of Forests, Kathmandu, Nepal.

DoF, 2004. Hamro Ban. Department of Forests, Kathmandu, Nepal.

DoF, 2005. Hamro Ban. Department of Forests, Kathmandu, Nepal.

DoF, 2006. Hamro Ban. Department of Forests, Kathmandu, Nepal.

Durr, C., 2002. The contribution of Forests and Trees to Poverty Alleviation, inter cooperation, Natural Resource Management, Rural Economy, Local Governance and Civil Society.

Dobremez, J.F. 1970. Biogeographie du Centre Nepal. Bull. Ass. Geographes France 379-380:79-90

FAO, 1982. Medicinal Plants of Nepal. Report No. RAPA 64, FAO Regional Office for Asia and the Pacific, Bangkok, 26 p.

(FRSD) Government of Nepal, Forestry Research and Survey Department. 1996. Forest and Shrub Cover of Nepal. Kathmandu: Babar Mahal.

Eckholm E P, 1975. The Deterioration of Mountain Environments. Science, 189, 764-770.

Eckholm E P, 1976. Losing Ground: Environmental Stress and World Food Prospects (Norton: New York).

Gautam M. K., 2000. Social Impact Assessment of South Asia Poverty Alleviation Programme: Nepal Syanja Pilot study. Impact Assessment Technical Report, SAPAP/UNDP/ UNOPS, Malaysia.

Gautam, M.K., E. H. Roberts and B K Singh, 2003. Community Based Leasehold Approach and Agro-forestry Technology for Restoring Degraded Hill Forests and Improving Rural Livelihoods in Nepal. Paper presented at Rural Livelihoods, Forest and Biodiversity Conference, 19-23 May 2003 Bonn, Germany.

GoN, 2006. Strategic Plan 2006-2016: Broad Strategy Document of Sacred Himalayan Landscape – Nepal

Gilmour D A, and R. J. Fisher, 1991. Villagers, Forests and Foresters: The Philosophy, Process and Practice of Community Forestry in Nepal (Sahayogi Press: Kathmandu).

HMGN, 1986. Land Use in Nepal: A Summary of the Land Resources Mapping Project Results, HMG/Nepal, Ministry of Water Resource and Energy Commission Report No. 4/1/310386/1/1 Seq. No 225.

HMGN/MPFS, 1988. Master Plan for Forestry Sector in Nepal: Main Document, Ministry of Forest and Soil Conservation, Baber Mahal, Kathmandu, Nepal.

IUCN-Nepal. 1996. An Inventory of Nepal's Wetlands. IUCN-Nepal, Kathmandu.

ICIMOD (2002) Inventory of Glaciers, Glacial Lakes and Glacial Lakes Outbrust Flood Monitoring & Early Warning System in the Hindu Kush- Himalayan Region. ICIMOD/UNEP, Kathmandu and Bangkok.

Ives J D, Messerli B, 1989. The Himalayan Dilemma-Reconciling Development and Conservation, The United Nations University and Routledge: London and New York.

Jackson, W. J. and Ingels, A. W. 1994. Developing Rural Communities and Conserving the Biodiversity of Nepal's Forests through Community Forestry. In proceedings of community development and conservation of biodiversity through community forestry. RECOFTC, Bangkok.

Jackson, W.J., R.M. Tamrakar, S. Hunt, and K.R. Shephred, 1998. Land Use Changes in Two Middle Hills Districts of Nepal. Mountain research and Development, Vol 8 (3):193-212.

Jha, P.K., Shrestha, K.K., Upadhyay, M.P., Stimart, D.P. and Spooner, D.M. 1996. Plant Genetic Resources of Nepal: a Guide for Plant Breeders of Agricultural, Horticultural and Forestry Crops. Euphytica 87:189-210

Jianchu, X., A. Shrestha, R. Vaidya, M. Eriksson, and K. Hewitt, 2007. The Melting Himalayas: Regional Challenges and Local Impacts of Climate Change on Mountain Ecosystems and Livelihoods, Technical Paper, ICIMOD

Jodha, N.S., 2001: Sustainable agriculture in fragile resource zones: technological imperatives. In: Life on the Edge: Sustaining Agriculture and Community Resources in Fragile Environments, N.S. Jodha (ed.), Oxford University Press, New Delhi

Joshi, V.K., 1994. Conservation and Cultivation of Medicinal Plants of Global Need. Journal of Non-Timber Forest Products, Vol. 1 (314) pp. 158-160.

Joshi, A.R. and Joshi, D.P. 1991. Endemic Plants of Nepal Himalaya: Conservation, Status, and Future Direction. Mountain Environment and Development 1(2):1-35

Kanel, K. R. 2004. Twenty five years' of community forestry: Contribution to Millennium Development Goals, Proceedings of the Fourth National Workshop of Community Forestry, 4-6 August, 2004 Kathmandu, Community Forestry Division Department of Forest December 2004.

Kanel, K.R. and D. R. Niraula, 2004. Can Rural Livelihoods be Improved in Nepal through Community Forestry? Banko Jankari, Vol 14 (1).

Karki, K (2004) Land Degradation in Nepal: A Menace to Economy and Ecosystems. International Master's Programme in Environmental Science (LUMES), Lund University,Sweden.

Karki, J. B., 2007. Review of High Altitude Wetlands Initiatives in Nepal, The Initiation: Annual Publication of SUFFREC, p 104-110 SUFFREC-KAFCOL, Nepal.

Karki, S., and P. Chhetri, 2007. Nepal's Wetlands: A Conservation Plan for Action. Report of National Workshop on Conserving Nepalese Wetlands: Sharing Experiences and Building Partnership, Kathmandu, Nepal.

Lohani, S.N., 2007. Climate Change in Nepal – Shall We Wait Until Bitter

Consequences? Journal of Agriculture and Environment, Vol. 8, pp: 38-45.

Luintel, H., and B., Bhattarai. 2006. Exploring Priority Problems of the Forest Dependent Poor in Nepal, Journal of Forest and Livelihood 5 (1)2006

Luvovsky, K. 2001. Health and Environment. Environment Strategy Papers, No. 1. Environment Department, World Bank, Washington DC, USA.

Maharjan, M. R. 1998. The Flow and Distribution of costs and Benefits in the Chuliban Community Forest, Dhankuta district, Nepal. Rural Development Forestry Network Paper 23e, 1-11 pp. ODI, UK.

Mahat T B S, Griffin D M, Shepherd K R, 1986. Human Impact on Some Forests of the Middle Hills of Nepal (1): Forestry in the Context of the Traditional Resources of the State," Mountain Research and Development, 6 (3), 223-232.

Malabed, R. N., 2001. Ecosystem Approach and Inter-Linkages: A Socio-Ecological Approach to Natural and Human Ecosystems

Malla, Y. B. 1992. The Changing Role of Forest in the Hills of Nepal. Australian National University, Canberra (Unpublished PhD thesis).

Malla, Y. B. 1997. Sustainable Use of Communal Forests in Nepal. Journal of World Forest Resource Management: Vol 8, 51-74 pp. AB Academic Publishers, Great Britain.

Malla, Y. B. 2000. Impact of Community Forestry Policy on Rural Livelihoods and Food Security in Nepal. Forests, Food Security and Sustainable Livelihoods. Unasylva: Vol 51, No. 202, 37-45 pp. FAO, Rome.

Manandhar P K, 1982. Introduction to Policy, legislation and Program of Community Forestry Development in Nepal, HMG/UNDP/FAO, Community Forestry Development Project, Kathmandu, mimeo.

Maskey, T. M., 1996. Study of Biodiversity in Nepal. A Review paper. In Shengji, P. (ed.) Banking on Biodiversity: Report of the Regional Consultation on Biodiversity Assessment in the Hindu Kush Himalaya 19-20 December 1995, Kathmandu Nepal, ICIMOD

Mayers, J., and S. Vermeulen, 2002. Power from the trees: How good forest governance can help reduce poverty, IIED, London.

MOFSC, GoN, 2002. Nepal Biodiversity Strategy.

MOFSC, GoN, Nepal Biodiversity Strategy Implementation Plan: 2006-2010.

NBS, 2002. Nepal Biodiversity Strategy, Ministry of Forest and Soil Conservation, Kathmandu, Nepal.

NBAP, 2000. Nepal Biodiversity Action Plan, Ministry of Forest and Soil Conservation, Kathmandu.

NPC, Interim Plan, 2007. National Planning Commission, Kathmandu

Nelson et.al., 1980. A Reconnaissance Inventory of The Major Ecological Land Units and Their Watershed Condition. IWMP/WP/17, Integrated Watershed Management, Torrent Control and Land Use Development Project, Department of Soil Conservation (DSC), Kathmandu, Nepal.

NRB. 1988. Multipurpose Household Budget Survey Report, 1985-86, Kathmandu, Nepal.

NBYB (2006) Nepal Biodiversity Year Book. HMG/Nepal

NESAC,1998. Nepal Human Development Report, 1998, Nepal South Asia Centre.

Neupane, H., 2003. Contested Impact of Community Forestry on Equity: Some Evidences from Nepal, ForestAction, Journal of Forest and Livelihood 2 (2),

Neupane, H. R. 2000. Factors that Influence the Poorer Households' Benefit from Community Forests: An Analysis of Forest Management and Benefit Sharing Processes (Unpublished MPhil thesis). The University of Reading, UK.

NPC/HMG, 2003. The Tenth Plan: Poverty Reduction Strategy Paper 2002-2007. IMF, Washington D.C., USA.

Oli, K.P., 2002. Land Use Change Dynamics, A Case of Rupa and Begnash Watershed Area of Kaski District, Nepal. Unpublished PhD Dissertation, Tribhuvan University, Kathmandu.

Oli, K.P., and K.R. Kanel,2006. Community-based Forest Management in Nepal: Reversing Environmental Degradation and Improving Livelihoods. In Poverty, Health, and Ecosystems: Experience from Asia, Paul Steele, Gonzalo Oviedo, and David McCauley (eds.), IUCN, Gland, Switzerland and Cambridge, UK and Asian Development Bank, Manila, Philippines

Pariyar, D. 1998. Rangeland Resource Biodiversity and Some Options for their Improvements. National Biodiversity Action Plan, Kathmandu, Nepal.

Pant Y P, Jain S C, 1972. Long Term Planning for Agriculture in Nepal (Vikas Publications: New Delhi).

Paudel, D. 1999. Distributed Impacts of Community Forestry Programme on Different Social Groups of people in the Mid-hills of Nepal (Unpublished MPhil thesis). Downing College, University of Cambridge, UK.

Paudyal, B., P. Neil and G. Allison, 2006. Experiences and Challenges of Promoting Pro-Poor and Social Inclusion Initiatives in User Group Forestry, Journal of Forest and livelihood 5(1)

Poudyal, M., B. Adhikari, J. Lovett and KP Acharya (2007) Impacts of Leasehold Forestry on Benefit Sharing and Gender Issues in Nepal. Paper Presented at the National Workshop on Leasehold Forestry, Kathmandu, Nepal.

Pokharel, B., D., Paudel, P., Branney, D., Khatri and M. Nurse. 2006. Reconstruction the Concept of Forest-based Enterprise Development in Nepal: Towards a Pro-poor Approach, Journal of Forest and livelihood 5(1).

Pokharel B K, 1998. Foresters and Villagers in Contention and Compact: The Case of Community Forestry in Nepal, Unpublished PhD Thesis, University of East Anglia, Norwich, UK.

Pokhrel, Bharat and Jane Carter. 2007. An unpublished article on Addressing chronic poverty traps in Nepal's middle hills: The Nepal Swiss Community Forest Project, 2007

Poudyal, M., B. Adhikari, J. Lovett and K.P. Acharya, 2007. Impacts of Leasehold Forestry on Benefit Sharing and Gender Issues in Nepal. Paper Presented at the National Conference on Leasehold Forestry, Kathmandu, Nepal.

Pudasaini, S. 1993. Population, Environment and Sustainable Development in Nepal in Population Dynamics in Nepal and Related Issues of Sustainable Development, Vol 2, Nov.

Roy, R., 2002. Rural Livelihoods, Time Saving and Community Forestry. Community Forestry Bulletin Vol. 9,29-35.

Ramsar Convention on Wetlands (1971) Ramsar Convention Bureau, Rue Mauverney, Gland, Switzerland.

Regmi, P.P. 1995. Wild and Under-utilised Food Plants in Nepal. In Plant Genetic Resources - Nepalese Perspective, NARC/IPGRI, Kathmandu.

Sah, J.P. 1997. Koshi Tappu Wetlands: Nepal's Ramsar Site. IUCN, Bangkok.

Sainju, M. M., 2006. Securing Livelihood for mountain People, Securing Sustainable Livelihoods in the HKH, ICIMOD's 21st Anniversary Symposium, ICIMOD.

Schweithelm, J., R. Kanaan, and P. Yonzon, 2006. Conflict Over Natural Resources at the Community Level in Nepal Including Its Relationship to Armed Conflict. USAID/ARD, INC. 159 Bank Street, Suite 300 Burlington, Vermont.

Sharma, U.R. 1999. Country Paper - Nepal. In Oli, K.P. (ed) Collaborative Management of Protected Areas in the Asian Region, pp 49-59. IUCN-Nepal, Kathmandu.

Sharma, K., 2003. The Macro Economics of Poverty Reduction: The Case Study of Nepal, HKKH Partnership for Ecosystem Management, IUCN Nepal, Available at www.hkkhpartnership.org.

Sharma, S.2007. Scientific Land Reform in Nepal, Working Paper presented in the Workshop on Land Reform in Nepal, Organized by NPC, July 2007.

Shrestha, B. D., P. van Ginnekan and K. M. Sthapit, 1983. Watershed Condition of the Districts of Nepal. FO: DP/NEP/80/029. Field Document No. 9. Watershed Management and Conservation Education Project, Department of Soil Conservation and Watershed Management, Kathmandu, Nepal.

Shrestha B P, S C., Jain, 1978. Regional Development in Nepal: An Exercise in Reality, Development Publishers: New Delhi.

SIDA/ Embassy of Sweden, 2004. Environmental Degradation and Disaster Risk. Issue Paper Prepared by Asian Disaster Preparedness Center/ Embassy of Sweden/Sida Bangkok.

Singh B. & K. Banskota (2007) The Kyoto Protocol and Community-Managed Forests. Published in Reducing Carbon Emissions through Community-managed Forests in Himalayas, ICIMOD, Kathmandu.

Tamrakar, J.K., and G.P. Kafley, 2004. Leasehold Forestry –An Endeavor for Reducing Poverty, Department of Forest, Kathmandu, Nepal.

Thomson W., 1995. Using and Protecting Nepal's Forest Genetic Resources. In: Tree Breeding and Propagation News, Volume 4, No. 1.

Upadhyaya, S. K., 2005. Payments for Environmental Services: Sharing Hydropower Benefits with Upland Communities, RUPES Working Paper 1, Winrock International

UNDP, 2001. Nepal Human Development Report, 2001, Poverty Reduction and Governance, United Nations Development Program

UNDP, 2007. Human Development Report 2007/2008. United Nations Development Program. 2007

Wallace (1981) "Solving Common-Property Resource Problem: Deforestation in Nepal". Unpublished PhD Dissertation, Harvard University, Cambridge, Massachusetts.

WECS: Water and Energy Commission Secretariat (WECS). 2002. Water Resources Strategy Nepal, Kathmandu.

World Bank, 1978. Nepal Staff Project Report and Appraisal of the Community Forestry Development and Training Project Document, World Bank: Washington, D.C.

World Bank, 1994. Forestry Sector Potential and Constraints: An Unpublished Report Prepared by J. Gayfer and P. Tamrakar. Kathmandu: World Bank

World Bank, 2001. World Development Report, New York: Oxford University Press

World Bank, 2006. Resilience amidst Conflict 2006

WWF Nepal, 2001. Strategic Plan 2002-2006), WWF Nepal Program, Kathmandu.

WWF-US, 2005. Ecosystem Profile: Eastern Himalayas Region. Critical Ecosystem partnership Fund, WWF, US, Washington, D.C.

Appendix A

Some Facts related to poverty and Natural Resources about SAARC Countries

Table A.1 HDI Trends in Nepal						
1975	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**
0.301	0.338	0.38	0.427	0.469	0.502	0.534
Source: UNDP. 2007.						

Table A.2 Population below income poverty in Nepal		
1 $ per day	2 $ per day	National Poverty Line
24%	68.5%	30.9%
Source: UNDP. 2007		

Table A.3 Poverty and Demography in South Asia

Country	HDI	GDP per capita in US $	Total Population In million in 2005	Population growth rate 1975-2005	Urban Population % of total in 2005
Sri Lanka	0.743	4505	19.1	1.1	15.1
India	0.619	3452	1134.4	2.0	29.7
Bhutan	0.579	Na	0.6	1.9	11.1
Pakistan	0.551	2370	156.1	2.6	34.9
Bangladesh	0.547	2053	153.3	2.2	25.1
Nepal	0.514	1550	27.1	2.3	15.3

Source: UNDP, 2007

Table A 5 Inequality in Income or Expenditure

	Year	Poorest 10 %	Poorest 20 %	Richest 20 %	Richest 10%
Sri Lanka	2002	3	7	48	32.7
Maldives					
India	2004/5	3.6	8.1	43.3	28.5
Bhutan					
Pakistan	2002	4	9.3	40.3	26.3
Nepal	03/04	2.6	6	54.6	40.6
Bangladesh	2002	3.3	8.6	42.7	27.9

Source: UNDP. 2007.

Table A 6 Priorities in Public Spending

Country	Public Exp. in Health % of GDP 2004	Public exp. on edu. % of GDP 2002-5	Military exp. % of GDP 2005
Sri Lanka	2	-	2.6
Maldives	6.3	7.1	-
India	0.9	3.8	2.8
Bhutan	3.0	5.6	-
Nepal	1.5	3.4	2.1
Pakistan	0.4	2.3	3.5
Bangladesh	0.9	2.5	1.0

Source: UNDP. 2007.

Table A 7 Employment by eco-activity

	Total	Agriculture	Industry	Services	Employment in informal sector		
					Both	Male	Femal3
Sri Lanka	6943	34	23	39			
Maldives	86	14	19	50			
India	308760	67	13	20	56	57	55
Pakistan	38882	42	21	37	70	66	70
Bangladesh	44322	52	14	35			
Nepal	7459		79	6	21		

Source: UNDP. 2007.

Table A 8 Energy and Environment

	Electricity consumption/ capita kilowatt	Population without electricity (million)	Forest Area of total land (%)	Forest area total '000 sq. km	Total change (sq. km) 1990-2005	Annual average change
Sri Lanka	420	6.7	29.9	19.3	-4.2	-1.2
Maldives	539	-	3			
India	618	487.2	22.8	677	37.6	0.4
Bhutan	229	-	68	32.2		
Pakistan	564	71.1	2.5	19	-6.3	-1.6
Bangladesh	154	96.2	6.7	8.7	-0.1	-0.1
Nepal	86	18.1	25.4	36.4	-11.8	-1.6

Source: UNDP. 2007.

Table A 9 Carbon Dioxide emissions

	Total (2004)	Share of world (total %)	Per capita (+co2)	Co2 from forest	Carbon stock in forest
Sri Lanka	11.5		0.6	3.2	40
Maldives	0.7		2.5		
India	1342.1	4.6	1.2	-40.8	2343.0
Bhutan	0.4		0.2	-7.3	345.0
Pakistan	125.6	0.4	0.8	22.2	31.0
Bangladesh	37.1	0.1	0.3	1.2	31.0
Nepal	3.0		0.1	-26.9	485.0

Appendix B Poverty related data for Nepal

Table45.1: Rate of Unemployment and Underemployment in Nepal

Source	Unemployment Rate			Underemployment Rate		
	Total	**Male**	**Female**	**Total**	**Male**	**Female**
NLFS1998/99 Nepal Rural Urban	 1.8 1.2 7.4	 2.0 1.5 5.9	 1.7 0.9 9.4	 27.5	 22.7	 32.3
CBS 1981 Nepal Rural Urban	 1.6 1.5 2.8	 1.9 1.8 3.0	 1.1 1.0 2.3			
NPC 1977 Nepal Rural Urban	 5.6 5.6 6.0	 5.3 5.5 4.5	 6.0 5.7 6.0	 - 63.1 44.7	 - 60.8 -	 - 68.7 -
NRB1984/85 Nepal Rural Urban	 3.1 2.7 8.2	 2.6 2.2 7.7	 3.6 3.2 9.0	 - 46.4 33.6	 - 41.8 23.8	 - 51.7 46.6
CDPS 1997 Nepal Rural Urban	 9.1 8.2 17.1	 11.0 9.9 21.1	 7.1 6.4 12.9	 26.0 25.8 28.3	 25.5 25.8 22.4	 26.5 25.8 34.0
NPC 2001 9th Plan Mid-term Review Nepal Rural Urban	 3.3 3.0 8.3	 3.8	 2.7			
NLSS 1996 Nepal Rural Urban	 4.6 4.1 12.8	 5.4 5.1 9.5	 3.8 3.2 17..4	 19.1 19.5 15.8	 14.2 14.6 9.1	 24.3 24.3 22.5
NLSS 2003/04 Nepal Rural Urban	 3.9 3.0 10..2	 4.1 3.6 7.0	 3.8 2.5 13.5	 20.5 21.2 17.7	 15.4 16.6 9.3	 25.7 25.7 26.1

Source: CBS 1981, NRB1984/85, NESAC 1998, CBS, 2005

Table 4.2: Level and Source of Household Income by Place of Residence in percentage

Region	Distribution of Average Income				Distribution of Average Income		
	Farm Income	Non farm Income	Remittance	Other Income*	Wage Income**	Self-employment Income	Other Income *
1984							
Rural	69.2	21.0	-	9.8	15.6	74.6	9.8
Urban	20.9	52.8	-	26.3	31.7	42	26.3
Nepal	64.4	24.1	-	11.5	17.3	71.2	11.5
1995-96							
Rural	58.6	21.9	8.1	11.4	30.9	57.6	11.4
Urban	12.1	55.1	3.8	28.9	31.9	39.0	28.7
Nepal	52.8	26.0	7.6	13.6	31.0	55.4	13.6
2003-04							
Rural	45.6	26.1	15.4	12.9	38.0	49.1	12.8
Urban	7.9	51.1	9.9	31.1	37.2	31.7	31.1
Nepal	34.8	33.3	13.4	18.1	37.8	44.2	18.1

*Other income includes income from property, housing and miscellaneous income

**Remittance is included in wage income

Source: NRB 1988, NLSS, 1995/96, NLSS 2003/04

Table 4.3 Source of Household income in Nepal[12]

	Mean Income (NRS per person per yr)			As a percent of the total income	
	1995-96	2003-04	% change	1995-96	2003-04
Farm Income	3123	2986	-4	47	39
Agri-wage income	672	547	-19	14	10
Non-agriculture wage income	1016	1883	85	14	17
Income from non-agriculture enterprise	859	1491	74	10	11
Property income	55	111	103	0	0
Remittance income	544	1402	157	6	10
Housing	758	1284	69	10	10
Other income	167	438	163	2	3
Total income	7193	10141	41	100	100

Source: CBS, 2005

Table 4.4 Inequality in per capita expenditure

	Gini coefficient
Nepal	
1995/96	34.2
2003/04	41.4
Urban areas	
1995/96	42.7
2003/04	43.6
Rural Areas	
1995/96	30.8
2003/04	34.9

Source: World Bank 2006, CBS, 2005

[12] Calculated as an average of household's income shares

Table 4.5 Annual Households and Per Capita Income

Area	1984		1996		2004	
	Average Household Income	Average Per capita Income	Average Household Income	Average Per capita Income	Average Household Income	Average Per capita Income
Urban (Total)	21420	3902	86797	16118	157550	32573
Kathmandu	-	-	118939	24084	222666	45816
Rural	14307	2323	40400	7075	65107	12124
Nepal	14801	2422	43732	7690	80111	15162

Source: NRB 1988, NLSS, 1996, and NLSS 2004 Volume II

Table 4.6: Distribution of Per Capita HH Income by Income Category and Place of Residence

(In Percent)

Income Group	All Nepal	Rural Areas			Urban Areas	
		Tarai	Hills	Mountains	Tarai	Hills
MPHBS, 1985						
Bottom 40%	23	24	23	33	27	24
Middle 50%	54	53	56	54	52	56
Top 10%	23	23	21	13	21	20
NLSS 1996	**All Nepal**	**Tarai**	**Hills**	**Mountains**	**Tarai**	**Hills**
Bottom 40%	11	15	7		18	2
Middle 50%	37	48	37		53	27
Top 10%	52	37	56		29	71
NLSS 2003-04	AlL Nepal					
Bottom 40%	14.2					
Middle 50%	48.1					
Top 10%	37.7					

Source: NESAC, 1998

Table 4.7: Distribution of Household Income by Farm Size and Region in Rural Areas in 1984

(Rs/Month)

Farm Size	Tarai	Hills	Mountain	Nepal
Large	3380	1882	1735	2024
Medium	1822	1218	1167	1316
Small	1210	923	875	1028
Marginal	787	674	631	736
Landless	633	764	871	683

Source: NESAC, 1998

Table 4.8: Households and Population below Poverty Line

Area	Minimum Subsistence Income		Minimum Subsistence Consumption	
	Households	Population	Households	Population
Rural	41.22	37.23	34.34	32.14
Urban	22.08	16.97	19.86	20.01
National	40.30	36.20	33.65	31.54

The minimum calorie intake is used as poverty line.

Source: NESAC, 1998

Table 4.9: Poverty Incidence by Rural Urban and Ecological Region

Region	Population Below Poverty Line		
	Poor	Ultra-poor	Total
Mountain	29.3	26.7	56.0
Hill	21.3	19.7	41.0
Tarai	28.7	13.3	42.0
Rural	26.4	17.6	44.0
Urban	13.2	9.8	23.0
Nepal	24.9	17.1	42.0

Source: NLSS, 1996

Table 4.10 Nepal 1995-96 and 2003-04, poverty measurement

	Head count rate P0			Poverty Gap P1			Squared Poverty Gap P2		
	1995-96	**2003-04**	**% change**	**1995-96**	**2003-04**	**% change**	**1995-96**	**2003-04**	**% change**
Nepal	41.76	30.85	-26	11.75	7.55	-36	4.67	2.7	-42
Urban	21.55	9.55	-56	6.54	2.18	-67	2.65	0.71	-73
Rural	43.27	34.62	-20	12.14	8.5	-30	4.83	3.05	-37

Source: CBS, 2005

Table 4.11 Poverty Measurement by geographical region

	Poverty Head count rate			**Distribution of the Poor**			**Distribution of the Population**		
	1995-96	**2003-04**	**% change**	**1995-96**	**2003-04**	**% change**	**1995-96**	**2003-04**	**% change**
Urban	21.6	9.6	-56	3.6	4.7	30	6.9	5.0	117
Rural	43.3	34.6	-20	96.4	95.3	-1	-93.1	85.0	-9
Kathmandu	4.3	3.3	-23	0.3	0.6	118	2.6	5.4	110
Other urban	31.6	13.0	-59	3.3	4.1	23	4.4	9.7	121
RW Hill	55.0	37.4	-32	32.7	23.6	-28	24.8	19.4	-22
RE Hill	36.1	42.9	19	19.4	29.4	51	22.4	21.1	-6
RW Terai	46.1	31.8	-17	18.4	18.9	3	16.7	15.3	-8
RE Terai	37.2	24.9	-33	25.9	23.5	-9	29.1	29.1	0
Devt. Regions									
Eastern	38.9	29.3	-25	21.0	23.4	12	22.5	24.7	10
Central	32.5	27.1	-17	26.9	32.2	20	34.6	36.6	6
Western	38.6	27.1	-30	18.7	16.7	-11	20.3	18.9	-7
Mid-Western	59.9	44.8	-25	18.5	17.7	-4	12.9	12.2	-5
Far-Western	63.9	41.0	-36	14.8	9.9	-33	9.7	7.5	-23
Ecological Belt									
Mountain	57.0	32.6	-43	10.7	7.5	-30	7.9	7.1	-10
Hill	40.7	34.5	-15	41.9	47.1	13	43.0	42.1	-2
Terai	40.3	27.6	-32	47.4	45.4	-4	49.2	50.8	3
Nepal	**41.8**	**30.8**	**-26**	**100**	**100**		**100**	**100**	

Source: CBS, 2005

Table 4.12 Income based poverty estimates

Year	1995/96	2003/04	Percentage
Urban	26.2	12.5	-52
Rural	48.8	38.8	-20
Kathmandu	6.8	4.7	-31
Other urban	37.4	16.8	-55
Rural Western Hill	62	43.6	-30
Rural Eastern Hill	54.1	45.7	-16
Rural Western Terai	41.8	33.8	-19
Rural Eastern Terai	37.4	33.3	-11
Nepal	47.2	34.9	-26

Source: CBS, 2005

Table 4.13: Land Distribution in Nepal

Census period	**Range**	**<0.5**	**<1.0**	**<2.0**	**<3.0**	**<4.0**	**<5.0**	**<10.0**	**>10**
1981/82	% of HH	50	67	84	91	95	97	99	100
	% of holdings	7	17	37	53	63	71	87	100
1991/92	% of HH	43	69	89	95	98	99	100	100
	% of holdings	11	31	58	74	81	86	94	100
2001/02	% of HH	46.9	74.1	91.6	96.3	97.8	98.4	99.1	100
	% of holdings	14.7	38.9	68.7	82.7	89.3	92.7	97.9	100

Source: CBS, National Sample Census of Agriculture, 1981, 1991 and 2001/02

Table 4.14 Selected Characteristics of Holdings, Nepal, 2001/02

Selected Characteristics	Size of holdings in hectares			
	Total	Less than 0.5 ha	0.5 - 2.0 Ha	2 and over Ha
All holdings (000)	**3364.1**	**1605.6**	**1504.3**	**254.2**
Average size of holdings (ha)	0.79	0.24	0.95	3.27
Average household size	5.9	5.2	6.2	7.8
Percent with agricultural credit	23.8	21.7	24.9	31
Holdings with land (000)	**3337.4**	**1578.9**	**1504.3**	**254.2**
Average size of holdings (ha)	0.8	0.25	0.95	3.27
Cropping intensity	1.83	1.94	1.85	1.73
Percent holding renting land	12.25	8.52	15.18	19.3
Percent of land rented	8.68	5.9	9	9.44
Percent irrigating	59.39	49.92	68.18	72.26
Percent using:				
Iron plough	26.08	17.5	29.88	56.89
Tractor	8.18	5.98	8.54	19.65
Pump set	6.3	3.11	6.83	23.04

Source: CBS, 2001/02

Table 4.15: Trends in Incidence of Poverty by Rural-urban Residence
(% of Population below Poverty Line)

Source	Year	Rural	Urban	Nepal	Poor Population in '000
NPC	1977	37.2	17	36.2	4897
MPHBS	1985	43.2	19.2	42.5	6852
World Bank/UNDP	1989	42	15	40	7694
CBS	1996	47	18	45	9507
NLSS I	1995-96	43.3	21.5	41.7	8809
NLSS-II	2003-04	34.6	9.5	30.8	7084

Source: NESAC, 1998

Table 4.16: Percentage Distribution of the Poor and Non-poor Farm Households by Farm Category

Deleted: ¶

Region	Landless/ Marginal	Small	Medium/Large	Total
Terai				
Poor	40	30	18	32
Non-Poor	60	70	82	68
Hill Region				
Poor	70	60	43	62
Non-Poor	30	40	57	38
Mountain Region				
Poor	77	58	24	62
Non-Poor	23	42	76	38

Source: Sharma, 2003:

Table 5.1 Contribution of forestry sector in national economy

Products	Timber and Fuel	NTFP	Protected Areas f	Total
Unit	Rs. in million	Rs. in million	Rs. in million	Rs. in million
2000/01 [a]	395.2	13.9	134.1	543.2
2001/2002 [b]	358.6	12.6	71.2	442.4
2002/2003 [c]	487.5	67.4	60.8	615.7
2003/04[d]	567.1	44.3	78.4	689.8
2004/05[e]	358.2	77.8	55.8	491.8
2005/06[g]	258.9	44.2		303.1

a: DoF, 2002. Hamro Ban. Department of Forests, Kathmandu, Nepal
b: DoF, 2003. Hamro Ban (Fiscal Year 2001/02). Department of Forests, Kathmandu, Nepal
c: DoF, 2004. Hamro Ban (Fiscal Year 2002/03). Department of Forests, Kathmandu, Nepal
d: DoF, 2005. Hamro Ban (Fiscal Year 2003/04). Department of Forests, Kathmandu, Nepal
e: DoF, 2006. Hamro Ban (Fiscal Year 2004/05). Department of Forests, Kathmandu, Nepal
f: DNPWC, 2004, Annual Report 2003/04. Department of National Parks and Wildlife Conservation
g: DNPWC, 2005, Annual Report 2004/05. Department of National Parks and Wildlife Conservation

Table 5.2 Contribution of selected NTFPs in Nepal

Resources	Resin	Taxus	Daphne	Argeli	Katha	Other MAPS	Other NTFP	Total
Unit	Kgs	Kgs	Kgs	Kgs	Kgs	Rs.	Rs.	Million Rs.
2000/01 [a]								13.93
2001/2002 [b]	6071.4	507.2	147.2		22.9	12592022.3	19322101.3	63.30
2002/2003 [c]	1774.4	285.4	144.6	11.3	1198.3	27905703.3	18501482.4	67.37
2003/04[d]	3836.2	78.5	134.8	10.1	658.4	15985202.7	6975226.7	51.11
2004/05[e]	1888.1	160.2	179.8	55.3	3066.0	13551200.8	13823979.4	77.84
2005/06[f]	4091.7	7.5	110.0	14.0	16.2	16987046.2	10714390.0	44.21

a. DoF, 2002. Hamro Ban (Fiscal Year 2000/01). Department of Forests, Kathmandu, Nepal
b: DoF, 2003. Hamro Ban (Fiscal Year 2001/02). Department of Forests, Kathmandu, Nepal
c: DoF, 2004. Hamro Ban (Fiscal Year 2002/03). Department of Forests, Kathmandu, Nepal
d: DoF, 2005. Hamro Ban (Fiscal Year 2003/04). Department of Forests, Kathmandu, Nepal
e: DoF, 2006. Hamro Ban (Fiscal Year 2004/05). Department of Forests, Kathmandu, Nepal
f: DoF, 2007. Official Record

Ecosystem Services and Poverty Alleviation Study in South Asia (ESPASSA): Pakistan Situation Analysis

Shaheen Rafi Khan

January 14, 2008

Sustainable Development Policy Institute

Acronyms

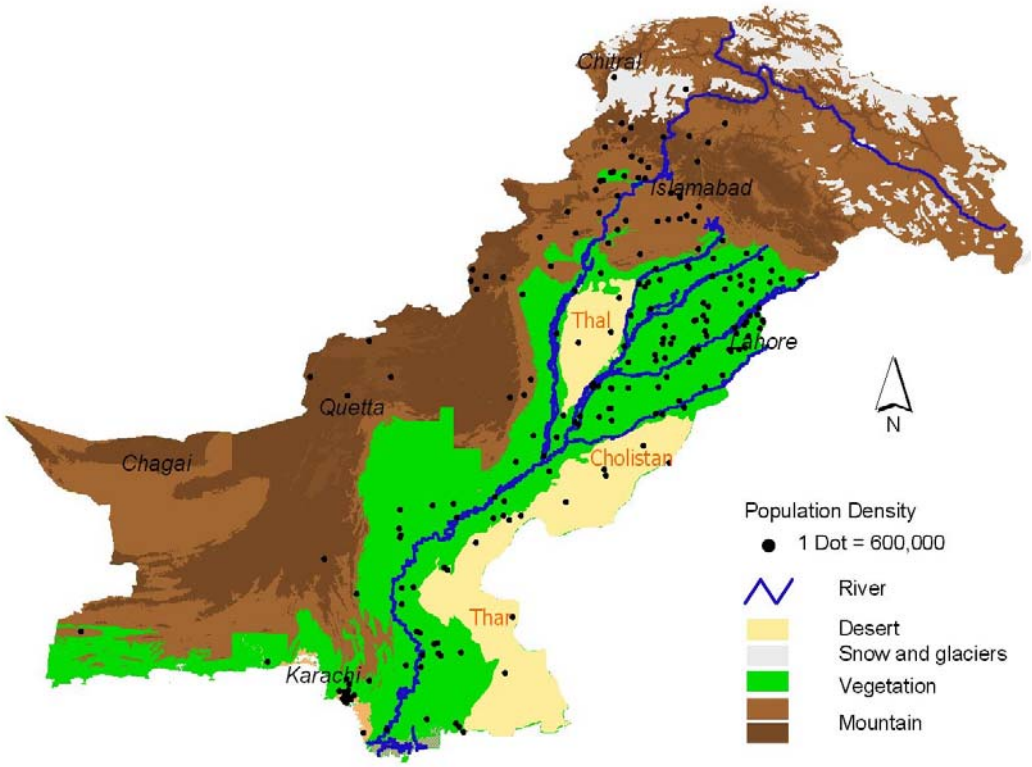
ADB	Asian Development Bank
BAP	Biodiversity Action Plan
DFID	Department for International Development
EEZ	Exclusive Economic Zone
ESPASSA	Ecosystem Services and Poverty Alleviation Study in South Asia
FBS	Federal Bureau of Statistics
FCS	Fish Cooperative Society
GDP	Gross domestic product
GOP	Government of Pakistan
HDI	Human Development index
HDR	Human Development Report
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
KFHA	Karachi Fish Harbor Authority
NWFP	North West Frontier Province
OLS	Ordinary least squares
PA	Protected areas
PATA	Provincially Administered Tribal Areas
SACEP	South Asia Co-operative Environment Programme
USD	United States Dollar
WB	World Bank

PART A: CHARACTERISTIC LANDSCAPES

1. Overview

Pakistan comprises a rectangular mass extending northeast to southwest over about 88 million hectares. Mountains and foothills on the north and west cover about half its area. The remaining half comprises the Indus Plain to the east, which intersects the Indus River and its tributaries. The country is largely arid, with 75 per cent receiving an annual precipitation of less than 250 mm, and the remaining 25 per cent less than 125 mm. Only about 10 percent of the area in the northern Himalayas and the Karakoram mountain ranges receive rainfall between 500 mm and 1500 mm. Pakistan's cultivated area accounts for about 37 per cent of its total area. Of this, 85 per cent is irrigated. A sizable 41 per cent is categorized as unfit for agricultural use. Forest cover is declared to be about 6.8 per cent, and about 2 per cent is under urban cover. (Government of Pakistan [GoP] 2003-2004)

Figure 1. Relief map of Pakistan



ecosystems, dividing them into 18 distinct ecological zones, with nine major vegetative or agro-ecological zones. These range from the permanent snowfields and cold deserts of the mountainous north to the mangrove forests of the Indus delta and the Arabian Sea coast. Pakistan's fauna is rich and varied. It is generally divided into several faunal regions - the Palearctic region in the mountains of the north and the west, the Oriental region east of Indus, the Indo-Malayan region, which constitutes the Indus Basin, and the Ethiopian region. (South Asia Co-operative Environment Programme [SACEP] 2005)

Although Pakistan is making efforts towards industrializing, agriculture remains its economic backbone, contributes 23% to the gross domestic product (GDP), about 70 per cent of all exports, and employs almost 60 percent of the work force (World Bank [WB] 2004). Much of Pakistan's industry, itself, relies on agricultural raw material. The main products are textiles, sugar, leather and edible oils. Pakistan maintained a respectable annual GDP growth rate of 5 percent over the period 1972–00. Over a relatively shorter period, 1991–00, this growth rate fell to 3 percent. It has however picked up in FY 2004, reaching 6 percent for the first time in seven years (Asian Development Bank [ADB] 2005). According to the Pakistan Economic Survey, GDP growth reached 8.4 per cent in 2004–05.

Unfortunately, social outcomes do not reflect these buoyant economic results. Pakistan's per capita income was USD 736 in 2004–05, placing it in the category of low to lower middle income countries (WB 2004). Its social and human indicators are unenviable - below those of most developing countries. Poverty, overpopulation, and illiteracy together create widespread malnutrition and disease, unemployment, and low productivity. Pakistan's human development index (HDI) stood at 0.527 in 2003, ranking it 135th of 177 countries and placing it in the medium human development category. The percentage of Pakistan's population living below the poverty line actually increased from 18% in 1987 to 34% in 2003 (Human Development Report [HDR] 2005). Access to land, water, and shelter is highly skewed. Not only is there a marked disparity between the rich and the poor in urban areas, but also rural access to schools, hospitals, piped water, and roads compares unfavourably with its urban counterparts. In turn, this is a source of health hazards, declining productivity, and environmental degradation.

2. Identifying characteristic landscapes

Pakistan's great habitat diversity, coupled with its location in a transition zone among three zoogeographical regions – the Palearctic, the Ethiopian and the Oriental, and the tremendously varied altitude gradients has resulted in a great diversity of biota. Up to 188 mammal species have been reported, of which three are endemic and there are a number of endemic and near-endemic sub-species. Of the 666 species of migratory and resident bird species recorded, one-third has Indo-Malayan affinities, and the remaining Palearctic. There are 174 listed species of reptiles and amphibians, of which 40 species are endemic. Pakistan has 177 native freshwater fish, predominantly South Asian in origin. In the invertebrate category, there are about 360 butterfly species, with high rates of endemism and about 2,000 species of insects. Over 5,600 species of vascular plants have been described, including both native and introduced species. There is high species diversity and the flora includes elements of six phytogeographic regions. Four monotypic genera and 400 species are endemic to Pakistan. In the category of fungi, there are 847 genera and 3,383 species (BAP, 2000).

Pakistan has ten ecosystems of particular value for their species richness and/or unique communities of flora and fauna.

Table 1. Major ecosystems in Pakistan

YSTEM	ACTERISTICS	FICANCE	ATS
Indus delta and coastal wetlands	Extensive mangroves and mudflats Inadequate protected area coverage	Rich avian and marine fauna Diverse mangrove habitat Marine turtle habitat	Reduced freshwater flow from diversions upstream Cutting mangroves for fuel wood Drainage of coastal wetlands
Indus river and wetlands	Extensive wetlands	Migratory flyway of global importance Habitat of Indus river dolphin	Water diversion/drainage Agricultural intensification Toxic pollutants
Chagai desert	A desert of great antiquity	Many endemic and unique species	Proposed mining Hunting parties from the Gulf
Balochistan Juniper forest	Huge and ancient Junipers	Largest remaining Juniper forest in the world Unique flora and fauna	Fuel wood cutting and overgrazing Habitat fragmentation
Chilghoza forest (Sulaiman Range)	Rock outcrops with shallow mountain soils	Important wildlife habitat for several species at risk	Fuel wood cutting and overgrazing Illegal hunting
Balochistan sub-tropical forests	Mid-altitude forests with sparse canopy but rich associated flora	Very few areas now remain Important wildlife habitat	Fuel wood cutting and overgrazing
Balochistan rivers	Not connected with the Indus river system	Unique aquatic fauna and flora with high levels of endemism	Water diversion/drainage Overfishing
Tropical deciduous forests (Himalayan foothills)	Extend from the Margalla Hills National Park east to Azad Kashmir	Perhaps the most floristically rich ecosystem of Pakistan	Fuel wood cutting and overgrazing
Moist and dry temperate Himalayan forests	Important forests tracts now becoming increasingly fragmented	Global hotspot for avian diversity; important wildlife habitat	Commercial logging Fuel wood cutting and overgrazing
Trans-Himalayan alps and plateaux	Spectacular mountain scenery	Unique flora and fauna; centre of endemism	Fuel wood cutting and overgrazing Illegal hunting Unregulated tourism Habitat fragmentation

Adapted from BAP 2000

2.1 Ecosystem services

The identified ecosystems provide a broad range of services, as indicated in Table 2. The assessment is qualitative and partly definitional. An attempt should be made to quantify these services, wherever possible. Equally important, there is a need to assess declining ecosystem delivery due to degradation.

Table 2. Ecosystem services

Ecosystem service component	Goods or service	Ecosystems									
Sustaining services		**Indus delta and coastal wetlands**	**Indus river and wetlands**	**Chagai desert**	**Balochistan Juniper forest**	**Chilghoza forest (Sulaiman Range)**	**Balochistan sub-tropical forests**	**Balochistan rivers**	**Tropical deciduous forests (Himalayan foothills)**	**Moist and dry temperate Himalayan forests**	**Trans-Himalayan alps and plateaux**
	Oxygen production	No	No	No	Yes	Yes	Yes	No	Yes	Yes	No
	Nutrient cycling and soil health	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Primary production	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
	Habitat provision	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Water cycling	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Carbon sequestration	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
	Pollination	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Goods		**Indus delta and coastal wetlands**	**Indus river and wetlands**	**Chagai desert**	**Balochistan Juniper forest**	**Chilghoza forest (Sulaiman Range)**	**Balochistan sub-tropical forests**	**Balochistan rivers**	**Tropical deciduous forests (Himalayan foothills)**	**Moist and dry temperate Himalayan forests**	**Trans-Himalayan alps and plateaux**
	Food and drink	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
	Fibre/construction	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
	Medicinal/cosmetic resources	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
	Ornamental products	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know
	Renewable energy products	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Genetic resources	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regulating services		**Indus delta and coastal wetlands**	**Indus river and wetlands**	**Chagai desert**	**Balochistan Juniper forest**	**Chilghoza forest (Sulaiman Range)**	**Balochistan sub-tropical forests**	**Balochistan rivers**	**Tropical deciduous forests (Himalayan foothills)**	**Moist and dry temperate Himalayan forests**	**Trans-Himalayan alps and plateaux**
	Filtration of air pollution	No	No	No	Yes	Yes	Yes	No	Yes	Yes	No
	Detoxification of water and sediment	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Local climate regulation	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
	Erosion control	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
	Flood risk mitigation	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
	Maintenance of surface water stores	No	Yes	No	No	No	No	Yes	No	No	Yes

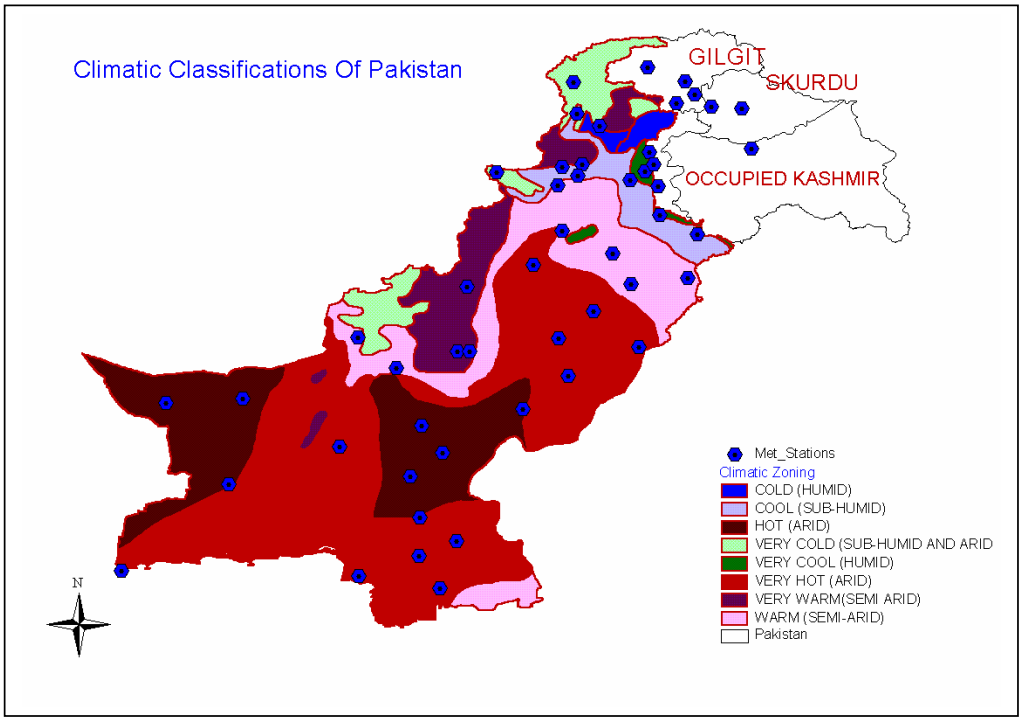
	Groundwater replenishment	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Crop pest regulation	No	No	No	No	No	No	No	No	No	No
	Human disease regulation	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know	Don't know
Cultural services		**Indus delta and coastal wetlands**	**Indus river and wetlands**	**Chagai desert**	**Balochistan Juniper forest**	**Chilghoza forest (Sulaiman Range)**	**Balochistan sub-tropical forests**	**Balochistan rivers**	**Tropical deciduous forests (Himalayan foothills)**	**Moist and dry temperate Himalayan forests**	**Trans-Himalayan alps and plateaux**
	Paleo-environmental records	No	No	No	No	No	No	No	No	No	No
	Archaeological preservation	No	No	No	No	No	No	No	No	No	No
	Recreation and eco-tourism	No	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes
	Physical health and well being	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Spiritual and religious values	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)	Yes (spiritual)

3. Pakistan's climate

Pakistan is located in South Asia at 24º to 37º north latitude, and 61º to 76º east longitude. Its different regions display immense climatic and physiographic diversity. This is visible in its high-altitude mountain ranges, its afforested zones, fertile agricultural plains, rocky plateaus, deserts, and coastal areas. Predominantly, however, Pakistan is an arid country: of its total area of 88 million hectares, three-quarters falls where plants lose more moisture through evapo-transpiration than is compensated for by rainfall. In fact, roughly half of this arid zone is best described as desert-like; particularly its western and south-eastern parts, which have as little as 25mm of average annual rainfall, and temperatures that rise frequently above 40 ºC in May and June. For several species of indigenous flora and fauna, these conditions represent the extremes of their temperature and water tolerance limits; their survival in these arid and desert ecosystems is, therefore, highly vulnerable to the slightest climatic change in an unfavorable direction.

Reflecting its diversity, climatic regimes are similarly disparate across regions. Temperatures range between 42°C in summer in the central arid plains and –26ºC in winter in the northern mountainous areas. Precipitation varies from an annual average of over 1700mm for the northeastern mountains to a mere 30mm in the southwestern plains. In general, the northern mountainous and sub-mountainous areas are colder and wetter than the southern areas of the country. Most of the country's annual precipitation occurs during the summer monsoon period from July to September. Smaller amounts of rain fall over winter, from eastward-moving, extra-tropical depressions.

Figure 2. Climate classifications

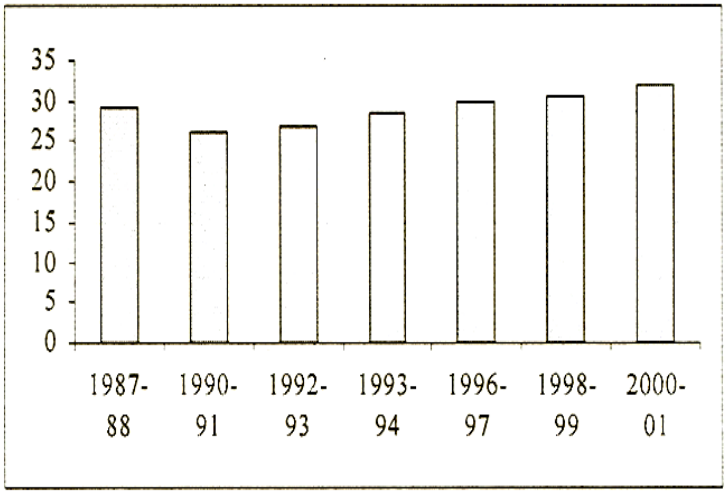


4. Poverty in Pakistan

Poverty and population growth are singled out as two key factors among many contributing to ecosystem degradation Pakistan. With regard to the first, there is a two-way causality, referred to in the literature as the poverty-environment nexus where this nexus is seen as a malign one and where poor communities are seen to be reluctant agents of degradation.

The general condition of poverty in Pakistan is at odds with its economic performance. The country achieved impressive aggregate economic growth, with GDP averaging in excess of 5 per cent over the past four and a half decades and ensuring a steady increase in per capita income.[13] There is some debate on whether this brought about an improvement in the consumption poverty status.[14] Tables 3 and 4 present aggregate and disaggregate trend data on various measures of poverty.

Figure 3. **Poverty Trend in Pakistan: Poverty Headcount (%)**



Source: Poverty Reduction Strategy Paper, Government of Pakistan.

[13] Currently assessed at $480.00 in real terms and at approximately $2,000.00 in purchasing power parity terms.
[14] Poverty is a multidimensional term. Consumption poverty refers to the extent to which the private consumption of individuals or households falls below the 'poverty line', the minimum acceptable standard of private consumption. Another important dimension focussing on human development, a term which captures improvements in education, health, water and sanitation and the provision of sustainable livelihoods.

Table 3. Measures of poverty						
		1984-85	1987-88	1990-91	1993-94	1998-99
Head count	Urban	38.2	30.7	28	17.2	24.2
	Rural	49.3	40.2	36.9	33.4	35.9
	Overall	46	37.4	34	28.6	32.6
Poverty gap	Urban	9.2	6.1	5.7	3	5
	Rural	11.9	8.3	7.8	6.4	7.9
	Overall	11.1	7.7	7.1	5.4	7
Severity of poverty	Urban	3.1	1.8	1.7	0.78	1.51
	Rural	4.1	2.5	2.4	1.87	2.51
	Overall	3.8	2.3	2.2	1.55	2.2

Source: World Bank Poverty Report, 2002, p.20

Table 4. Incidence Of Poverty by Province and Region During the1990s									
	Urban			Rural			Overall		
	90-91	93-94	98-99	90-91	93-94	98-99	90-91	93-94	98-99
Punjab	29.4	18.4	26.5	38.5	31.9	34.7	35.9	28.2	32.4
Sindh	24.1	13.9	19	30.8	31.5	37.1	27.6	23.4	29.2
NWFP	37	26.5	31.2	40.6	39.8	46.5	40	37.9	44.3
Balochistan*	26.7	16.5	28.4	20.9	37.5	24	22	35.2	24.6
Azad J & K	.	.	14.5	.	.	15.7	.	.	15.6
Areas	.	18.4	22.6	.	31.9	37.9	.	28.2	36.5
FATA	.	13.9	.	.	31.5	44.5	.	23.4	44.5
National	28	17.2	24.2	36.9	33.4	35.9	34	28.6	32.6
*May be less reliable than other estimates in table due to low density of population (SeeAnnex2.3)									
Data from "Poverty in Pakistan: Vulnerabilities, Social Gaps, and Rural Dynamics", World Bank Report, 2002.									

While the incidence of poverty defined by various measures declines appreciably during the eighties, it remained static during the nineties. Of further note is the annual fluctuation in these various measures and the widening rural-income disparity during this period. Currently, the government claims that the population below the poverty line has decreased to around 25 percent, 6-7 percent lower than estimates in 2000-01. The claim does not square with independent analysis; the Department for International Development (DFID) for instance, contends that the poverty count is as high as 40 percent. Further aggregate figures mask tremendous interprovincial and intersector disparities. The poverty context in Pakistan is characterized by a large poverty spread across the country's rural-urban divide, across its provinces and across its ethnic boundaries. In the aggregate, it is also uncertain whether the improvement in consumption poverty was accompanied by a reduction in the absolute number of people falling below the poverty line.[15] Finally taking a boarder definition of poverty, which incorporates the concept of vulnerability, it is highly probable that the incidence of poverty in Pakistan may be even higher than current estimates suggest.

Pakistan does not perform well either by another measure of poverty, namely, income inequality -- as represented by the Gini coefficient. It is an important factor in the discord and anomie that prevails in Pakistani society today. Understandably, the bottom line is the widening income gap on a low base, rather than some aggregate measure of poverty. Rural inequality has remained unchanged and, predictably, is lower than urban inequality, which has been increasing over time.

[15] This is an important issue because resources are finite.

Table 5: Income inequality – Gini coefficients (per equivalent adult consumption expenditures)

	1984-85	1987-88	1990-91	1992-93	1993-94	1996-97	1998-99
Urban	31.4	31.6	31.6	31.6	30.2	28.4	35.3
Rural	26.3	24.0	26.7	25.2	24.6	23.8	25.1
Overall	28.4	27.0	28.7	27.6	27.6	26.3	29.6

Data from "Poverty in Pakistan: Vulnerabilities, Social Gaps, and Rural Dynamics", World Bank Report, 2002.

Finally, Pakistan's performance is even less creditable with regard to human development. There are two aspects to this. First its social indicators are far below those of low-income countries with comparable or lower levels of per capita income. Furthermore, disparities across both provinces and the rural-urban divide are pronounced.

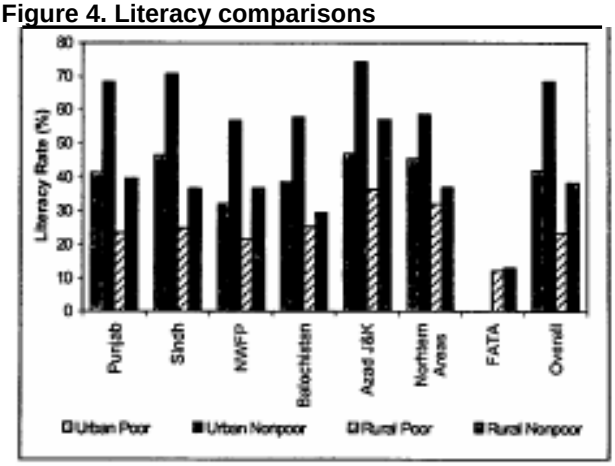
Table 6: Comparative Social Indicators: Cross-country Comparison

	Real GDP/capita 1995 GNP PPP$		Adult Literacy 1995 (%)		Total Fertility Rate (children /woman)	Contraceptive Prevalence Rate (%) 1990-95	Health Expenditure as % GNP of 1990	Piped Water Supply 1990-96 (% of population)
			M	F				
Pakistan	460	2209	50.0	24.4	5.3	18	0.7	28
Low Human Developed Countries	316	1362	63.0	38.3	4.3	31	1.5	71

UNDP: Human Development Report 1998
Adult Literacy Rate is for Population 15 Years and above.
PPP= Purchasing Power Parity

The World Bank report (2002), which updates the HDIs to 2002, echoes the same story in respect of cross-country comparisons. Referring to specific social indicators (literacy, enrolments, clean drinking water, sanitation, energy), it further highlights the gap in these services in relation to the poor and non-poor.

Figure 4. Literacy comparisons



Source: World Bank (2002)

The final and most comprehensive measure of poverty is vulnerability. The World Bank (2002) defines it as 'the probability that a household experiences at least one episode of poverty over a defined time period, and vulnerable households as those for whom that probability exceeds a threshold value.' The measurement unit is the 'variability of consumption expenditure.' Invoking climate variability as a measure of 'uninsured risk' the Bank then uses IFPRI panel data to assess rural vulnerability and compares it with chronic and transient poverty.

Table 7: Rural vulnerability and poverty by agro-climatic zones

	Percentage Households			
	Vulnerable	Poor: using measured expenditure	Chronically poor	Transienti y poor
Northern irrigated plains	29.1	47.2	34.3	12.9
Barani plains	46.1	42.0	25.9	16.1
Dry mountains	67.3	58.1	46.7	11.4
Southern irrigated plains	71.0	61.0	46.4	14.6
All	56.1	53.4	39.7	13.7

Source: World Bank (2002)
Note: using IFPRJ panel; poverty line=Rs. 2580, TimeHorizon =2 years)

5. Ecosystem-poverty mapping

The efforts at ecosystem poverty-mapping are basic. We have juxtaposed land cover maps with maps showing demographic characteristics and various aspects of poverty. A better attempt is made to overlay poverty, resource dependence and degradation in one of the case studies. Notwithstanding, this is an area of omission which future studies could attempt to rectify by producing digital maps and overlaying them accurately and at a higher level of detail.

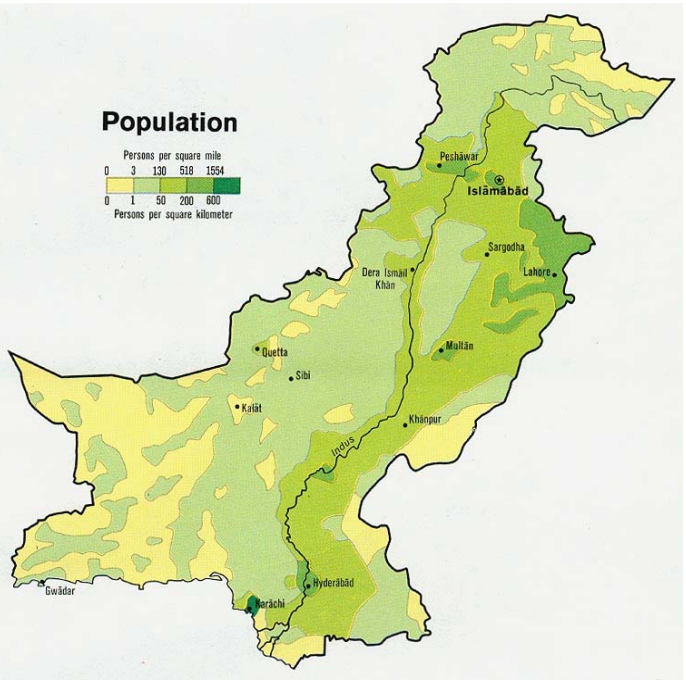
In relation to population, the mountain, desert and coastal landscapes are the least densely populated. While on the one hand this is encouraging in a comparative sense, on the other,

population density even in the sparsely populated landscapes has increased over time; demographically induced degradation has been recorded in several case studies (Khan 2006). Also, as evident in Figure 6, population density is highest in the agriculturally settled wheat growing areas.

While there is a visual correlation between mountain landscapes and poverty, the maps do not go into an adequate level of detail to indicate poverty in the coastal or freshwater ecosystems. Malnutrition is strongly in evidence in the desert landscapes of Balochistan and Sindh. It is high but relatively less so in the mountain landscapes.

There is also a correlation between ethnicity and deprivation. The Punjabis are settled in the richest irrigated agricultural zone.

Figure 5. Landcover and population



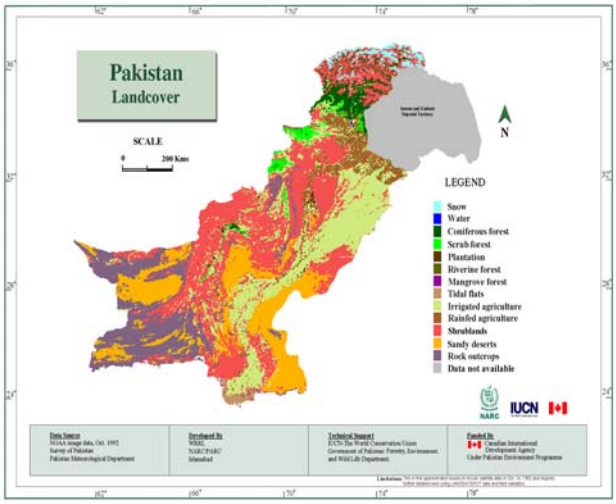
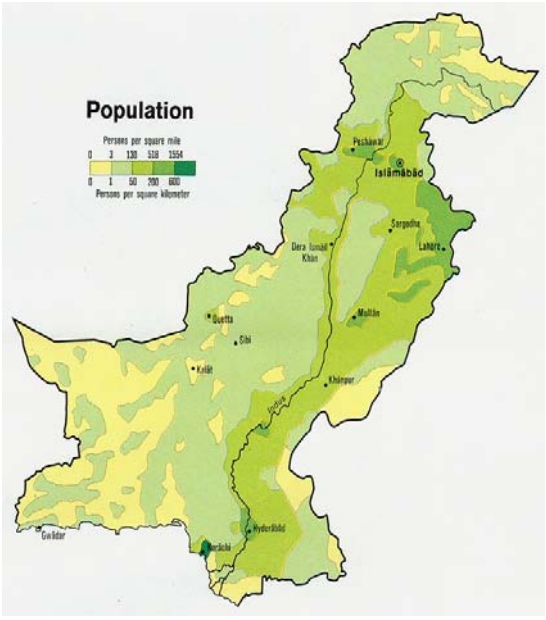


Figure 6. Population, agriculture and landuse



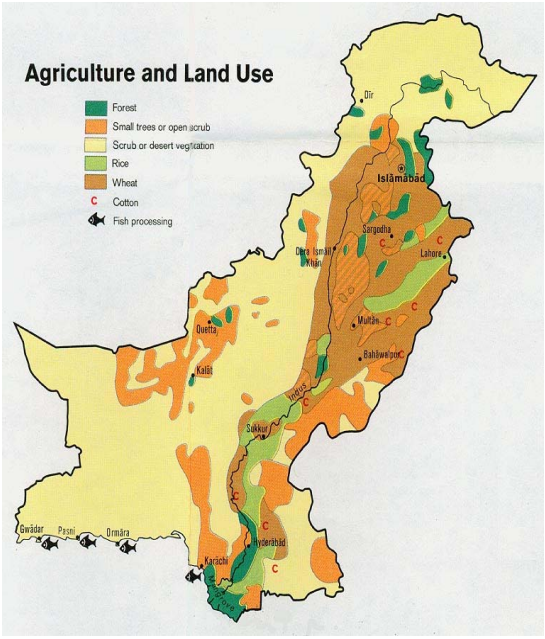


Figure 7. Land cover and incidence of poverty

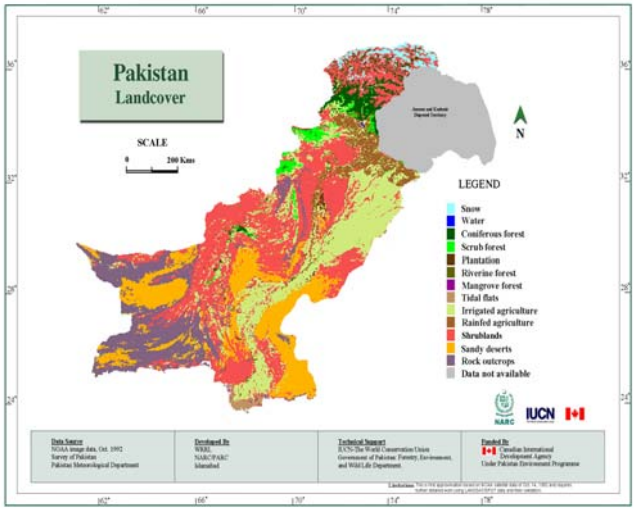
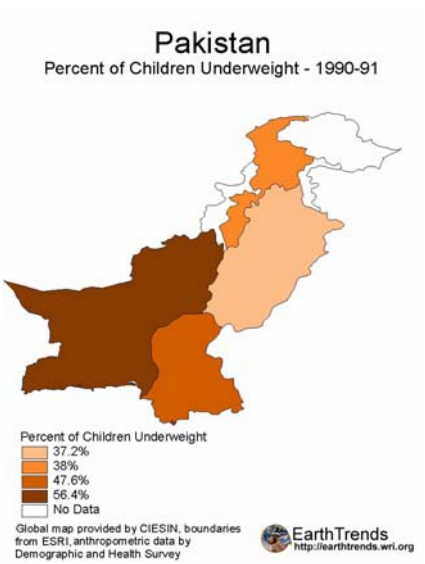


Figure 8. Landcover and malnutrition



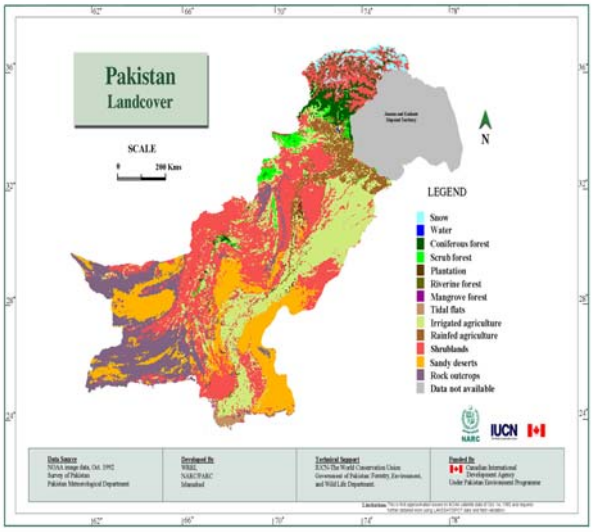
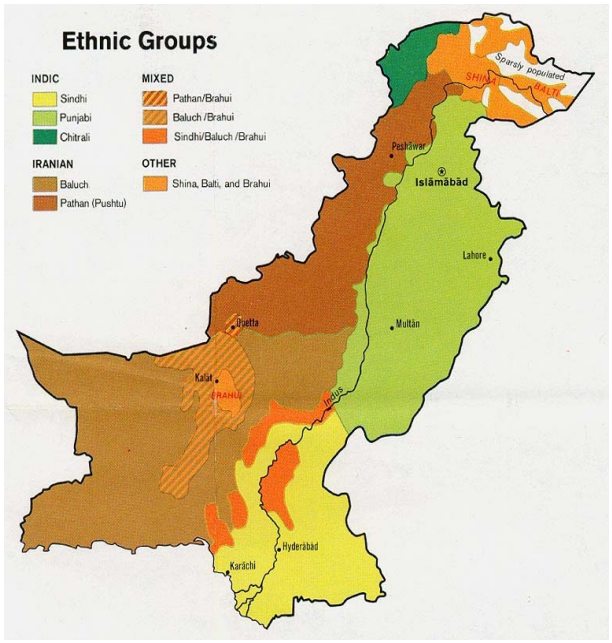
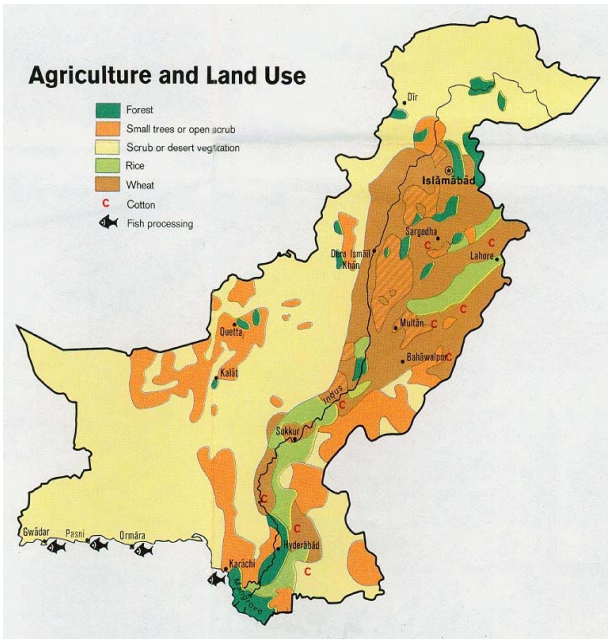


Figure 9. Ethnicity and Agriculture





6. Critically Threatened Ecosystems and Species

The widespread conversion of natural ecosystems to agriculture, the advanced and rapidly accelerating degradation of habitats, and the continuing depletion of species populations, has placed under critical threat all natural or modified ecosystems. At least 10 ecosystems (see Table 1) of particular value for their species richness and/or unique communities of flora and fauna are threatened with habitat loss and degradation. The IUCN Red List of Threatened Animals (IUCN 1996) lists 37 species and 14 sub-species of internationally threatened or near-threatened mammals as occurring in Pakistan. The critically endangered mammals are the Balochistan black bear and Chiltan goat. Endangered animals include the snow leopard, the Indus river dolphin, the markhor, the urial and the wooly flying squirrel. A critically endangered bird is the lesser florican while the Siberian crane and the great Indian bustard are listed as endangered. In addition some 500 plant species are believed to be nationally rare or threatened.

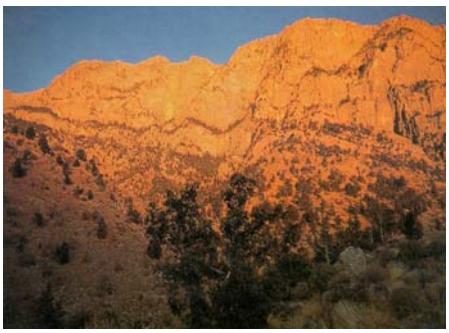
Table 8. Endangered species

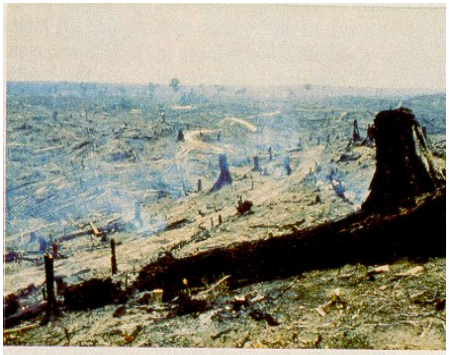
Extinct	Tiger Swamp deer Lion One-horned rhinoceros Asiatic cheetah Indian wild ass Hangul	
Internationally threatened		
Critically endangered	Balochistan black bear Chiltan goat	Lesser florican
Endangered	Snow leopard Indus river dolphin Urial Wooly flying squirrel	Siberian crane Great Indian bustard

Source: IUCN Red List, 1996

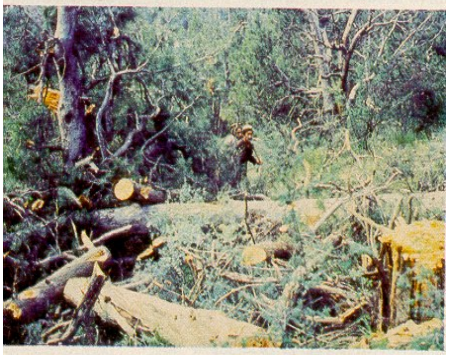
Note: Mammals: 37 species and 14 sub-species threatened or near-threatened
Birds: 25 threatened and 17 near-threatened
Reptiles: 7 threatened and 3 near-threatened

Figure 10. Chilghoza forests in Balochistan's Sulaiman range: A devastated ecosystem





How green was my valley?



Logging in the Chilgoza Forests of the Suleiman Range

A wounded Chilghoza pine tree

WWF/Hartmut Jungius

to
in
in
ch
ne
nd
g.
of

Guy Duke

largest known surviving population of western tragopans.

Fig. 5.5: The Indus dolphin and its fragmented habitat

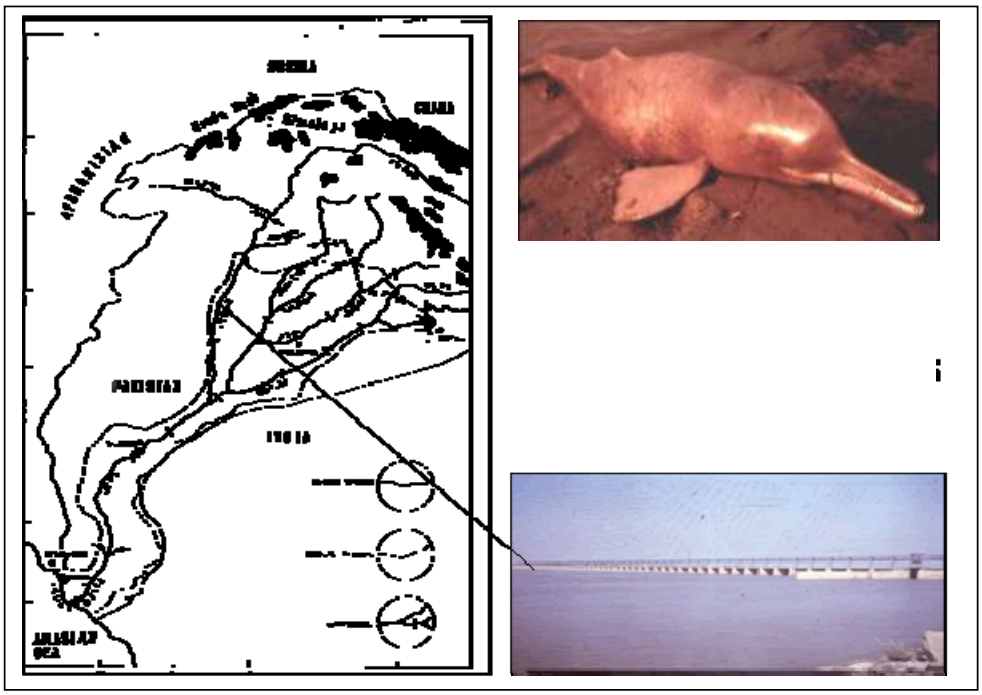


Fig.5.6: The snow leopard and its habitat

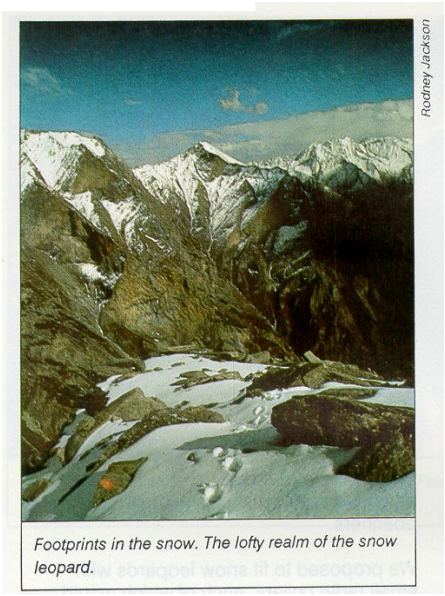
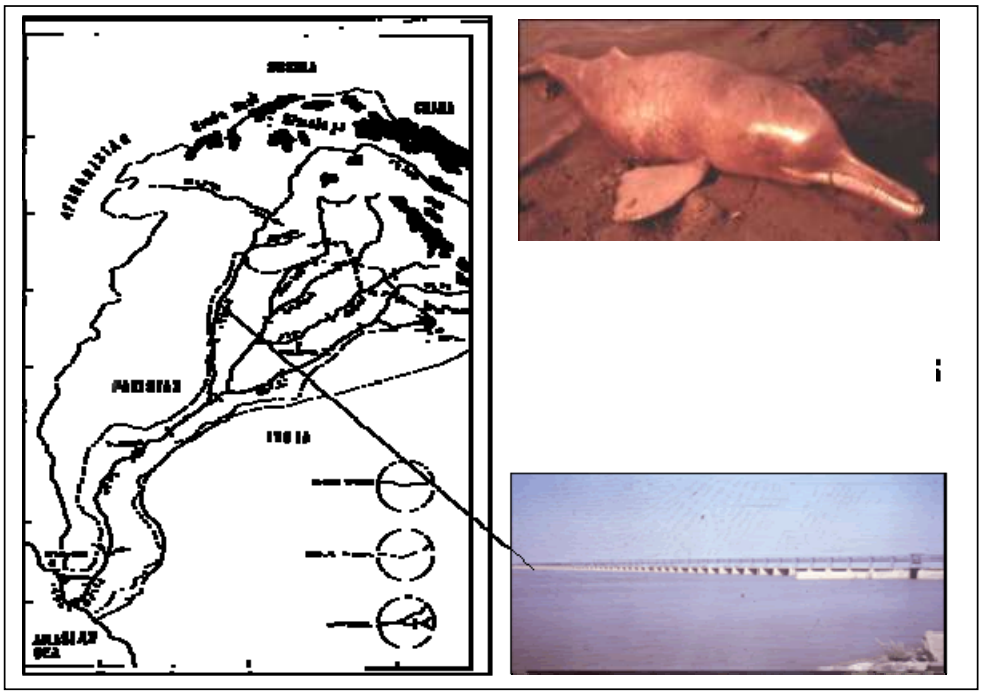


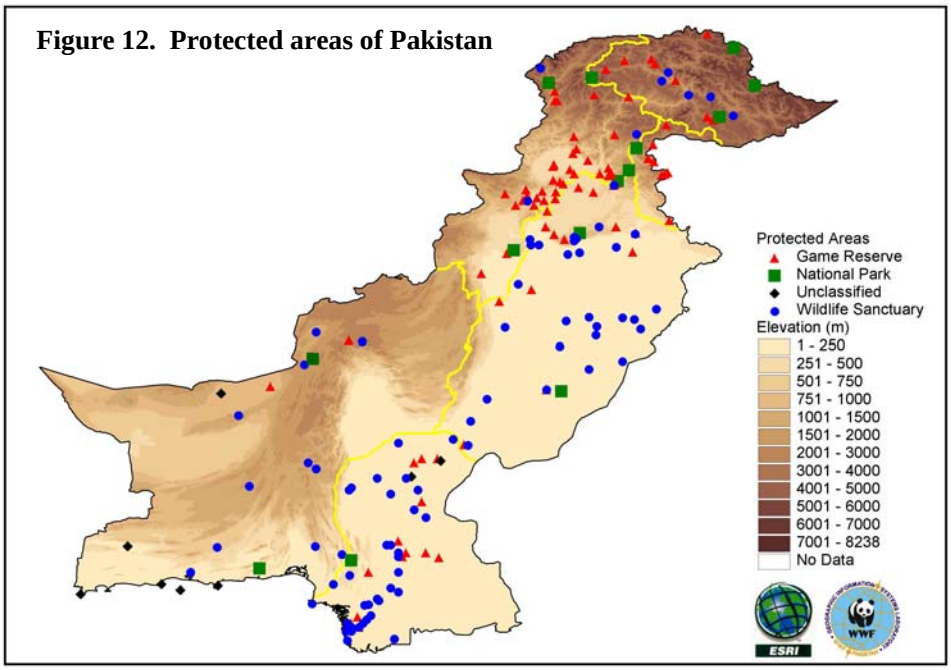
Figure 11. The flyway of migratory cranes



6.1 Status of Protected Areas in Pakistan

Protected areas are considered safe havens for biodiversity. However, the extent to which they fulfil their role depends on spatial aspects, ecological integrity and management norms. The allocation of protected areas in Pakistan is inadequate, both in the aggregate and distributionally. At first sight, the overall number of sites (225) and the percentage of the country considered protected (11.25 percent) is impressive. This figure, however, includes sites established without a basis in legislation. If only established under provincial and territorial wildlife acts and ordinances are considered, then their number drops to 200 areas: 14 national parks, 97 wildlife sanctuaries, and 89 game reserves. If one then considers national parks and wildlife sanctuaries as areas that afford protection to biodiversity in a more comprehensive manner than game reserves do, then the overall number of protected areas is further reduced to 111. The corresponding percentage of protected land drops from 11.25 percent to 6.5 percent. In that case, Pakistan lags behind other South Asian states, including Nepal, Sri Lanka, Bhutan, in terms of the total land area designated for conservation.

Figure 12. Protected areas of Pakistan



Currently listed protected areas are also distributed unevenly across the country. The majority of the areas are concentrated along the Indus Valley. Likewise there exists considerable provincial and territorial disparity in their distribution. For example, while over 16 percent of Punjab is protected under one of the three main PA categories, approximately only 6 percent of the NWFP and less than 6 percent of Balochistan are formally protected. It is, however, in these regions that much of Pakistan's remaining biodiversity is concentrated (EcoNexus: 1999).

Another anomaly is that the designated PAs include 100 percent of the Federal Territory, which can not be justified on any ecological criteria. The mismanagement of these protected areas, another overriding concern, is addressed in more detail later. However, it is appropriate to cite the case of the Kirthar National Park upfront, which is currently under a mining threat by Premier, an international oil company. The provincial wildlife act has been amended to suit its convenience.

6.2 Degradation of mountain landscapes

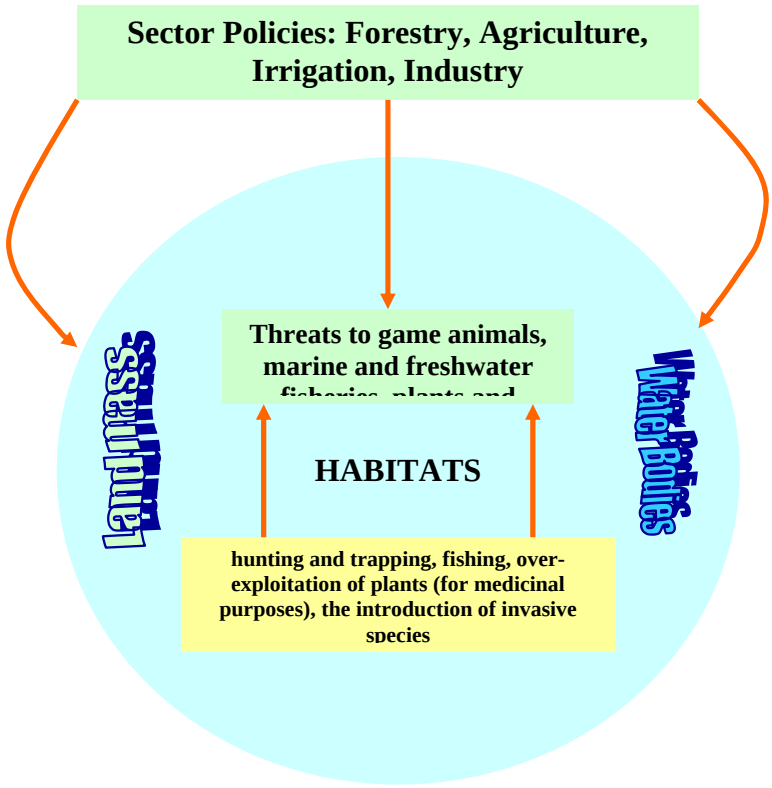
The Himalayan mountain ecosystem has been severely degraded, largely as a result of uncontrolled deforestation. According to the Forest Sector Master Plan (1992), forests, scrub and planted trees on farmlands cover 4.2 million hectares, or 4.8% of the country. If plantations and scrub forests are excluded, the coverage falls to 2.4 million hectares (2.7% coverage). More than nine-tenths of the remaining coniferous forests have less than 50% canopy cover. Good quality (50% coverage) forests constitute less than 400,000 hectares. Woody biomass is declining at the rate of 4%-6% per year and with consumption expected to grow in line with population growth (3% per year), this biomass could be totally consumed within the next ten years (BAP, 1999).

7. Drivers of Degradation

The drivers of degradation can be both anthropogenic and natural. Further, the pathways from environmental degradation to biodiversity loss (plant, animal species and micro-organisms) can be both direct and indirect. Habitat loss tends to occur via the indirect route. At source are sector activities, such as industrial and household emissions and effluents, agricultural intensification (chemical input applications), irrigation and drainage practices (water diversions and mismanagement) and energy combustion.

Activities, which cause biodiversity loss directly, are hunting and trapping, fishing, over-exploitation of plants (for medicinal purposes), the introduction of invasive species through trade or natural resource management efforts. Sector activities (agricultural and industrial) can also contribute directly to biodiversity loss. For instance, extensive planting of high-yielding hybrid varieties has displaced indigenous crop genes, and the use of chemical inputs has harmed soil microorganisms, invertebrate fauna and wildlife. A simple problem analytic is presented below.

Fig.13. Problem analytic: pathways to biodiversity loss



In the case of specific mountain landscapes, the direct causes of ecosystem degradation are logging, subsistence use of natural resources, land use changes, over grazing and fodder collection, soil erosion (water and wind), hunting and trapping and over-collection of plants. This has considerably reduced the ecosystem's ability to act as a water regulator. Biodiversity loss has also been recorded both due to habitat destruction and unregulated hunting of wildlife. A continuing decline in many native species of plants and animals is in evidence; some are already extinct, many are internationally threatened, and more still are of national concern. The severity of floods has increased over time and Tarbela Dam is silting up at an accelerated rate.

The root (indirect) sources of degradation are two-fold: the first relates to increasing demand for natural resources, the result of a growing population, economic growth, poverty and low primary productivity. Economic factors are the second source, with the most prominent being market failure, intervention failure, weak ownership, high discount rates and globalization of the world economy (international trade competition, international financial flows). Economic development has weakened reliance on local biodiversity resources, eroding the need and concern for sustainable use of these resources. Communities have been disempowered by state intervention in the management of community forests. And the free market, with its associated economic incentives, encourages a competitive race for natural resources at the expense of traditional sharing.

This section examines the drivers of degradation in some detail.

7.1 The poverty-environment nexus

Attempts to establish links empirically between poverty and degradation have yielded mixed results, as we will demonstrate in one of the two case studies we present later. Poverty, it is presumed, imposes short time horizons. Poor people have high pure rates of time preference; simply put, they eat into their savings and borrow whenever possible. In terms of land use, this means overgrazing of pastures, shortening of fallow periods and a reluctance to invest in land improvements where returns occur after a long gestation period. A related presumption -- one with stronger empirical grounds -- is that poor people are more risk averse. This is not an innate trait but one which stems from relegation to marginal areas which are already experiencing high levels of degradation and where future outcomes are uncertain; consequently there is a tendency to mine resources unsustainably. Also, the poor face greater constraints to managing their risks, with few assets and limited access to credit and insurance. A more doubtful conjecture is that poverty breeds fatalism, which leads to acceptance of a given situation rather than a desire and resultant efforts to change it.

However, such hypotheses have not been empirically validated. In fact, there is widespread evidence that in many areas currently facing severe environmental degradation, the resource users were poorer in the past and, yet, natural resource degradation was consciously prevented. The explanation of such paradoxes lies in:

> i) the nature and extent of the community's stake in the health and productivity of its environmental resources and; ii) the technological and institutional mechanisms at its command to safeguard the same. Dilution or disintegration of the community's stake and erosion or grass roots' level mechanisms to protect and augment it are the fundamental reasons behind environmental resource degradation, irrespective of poverty (Jodha: 1: 1998)

Essentially, the resource management problem is functionally linked with cognitive space, property regimes and scarcity. Exposure to market forces and the integration into the broader administrative and legal framework has weakened traditional management regimes and led to neglect and degradation of hereditary resource endowments.

In a broader sense, conventional forms of development drive a wedge between communities and the natural resource base leading, at best, to its neglect, at worst to management systems which are not attuned to its needs and, hence, degrade it. The other attributes of development, namely power, wealth and greed are even more pernicious; in combination with emerging perverse incentives and the market's inability to monetize costs of degradation, they engender a situation referred to as 'resource capture.'

> Resource capture occurs when population growth combines with a decline in the quantity and quality of renewable resources and the spread of market incentives to

encourage powerful groups to alter the distribution of resources in their favor. Resources are, in effect, appropriated by elites, increasing environmental scarcity among poorer or weaker groups as a result. The manner in which this is done is through conversion of land from customary tenure to formal land titling. Groups experiencing this scarcity are then often ecologically marginalized as they migrate to rural or urban areas that are ecologically fragile. The resulting high population densities in the receiving areas, along with the migrants' lack of capital and knowledge of how to protect local resources, act to generate further environmental damage and chronic poverty. As scarcities of resources such as forests and urban land worsen their prices increase which leads to more acquisitive behavior, in effect creating a self-perpetuating cycle. (Gizewski and Homer-Dixon: 1996: 9, 10).

7.2 The Economic Causes of Biodiversity Loss

Strengthening biodiversity-economics linkages are an integral part of efforts at both biodiversity conservation and remediation. The Biodiversity Action Plan (BAP, 2000) cites many cases where the market fails to capture adequately the value of biodiversity, or where existing economic policies and incentives lead to the predation of species and/or to the degradation of their habitat.

Intervention failures tend to reflect pricing distortions. Examples are subsidies on energy and irrigation water, pesticides and fertilizer, which, among other things, are a source of air and water pollution and land degradation. Counter measures include getting prices right (eliminating subsidies), or providing conservation-friendly incentives. Another instance of intervention failure is high discount rates which favor present rather than future consumption. The degradation tends to be most pronounced when such rates coincide with low biological growth rates, for instance, in the case of primary forests.

Market failure occurs when the market is unable to monetize environmental degradation or biodiversity losses. Two prominent examples of these are the extensive logging activities by the 'timber mafia' in the Northern watersheds in disregard of the resident losses to biodiversity and the downstream consequences, and industrial effluents, which pollute water bodies and harm aquatic life and vegetation. In the former case, high market prices for timber, low fines and penalties, and the royalty system combine to create perverse incentives to degrade. The latter case reflects the absence of charges for downstream water penalties as a constraining factor. Another way of putting this is a dichotomy between social and private costs and benefits.

The term market failure also includes missing markets. This is the case with species loss where global conservation imperatives are not reflected in economic inducements. Conversely, as in the case of biopiracy ('neem', 'basmati' rice) multinationals present threats to indigenous biodiversity.

7.3 Institutional drivers of degradation

Pakistan's record of natural resource conservation is linked with its history of conquest and colonization. Over the past millennia, successive waves of invaders poured through its northern passes into the fertile plains of the subcontinent to the southeast. Indigenous populations were forced into the mountains and foothills to eke out a bare subsistence which, among other things, entailed clearing of forests for agriculture and grazing. They eventually settled down as small scale farmers in the perennial stream-fed mid-elevations and as semi-transhumants in the higher altitudes (Khattak: Communities and Conservation, 1998). Living in close proximity to the forests, they foraged for fodder and extracted timber, fuelwood and other forest products. An equilibrium of sorts was restored, with the viability of

such patterns of dependence and extraction being underpinned by subsistence needs and low population pressure.

Events in the past 400 years of subcontinental history were particularly turbulent. This period witnessed degradation on a large scale, instigated by new forms of imperialist domination and associated commercialization of the economy. This was the era of British colonial rule, of large-scale infrastructure construction (railroads, canal networks, cantonments, bridges). Such developments were fuelled by depredations on a massive scale, namely, the commercial exploitation of coniferous forests, extensive land clearance and the alteration of river ecosystems, resulting in their fragmentation and the disappearance of riverain thorn forests. Shrinking habitats caused many animal species to become extinct.

The overarching legal and administrative framework for resource management was first laid down in forestry acts, introduced by the British in the mid-nineteenth century. Driven by the need to protect their commercial interests, these acts, namely the Hazara Forest Conservancy Rules in 1857 and the Forest Act of 1865 declared all forests the property of the government. As a result, existing community rights to forest resources became proscribed. Initially, all forests were declared reserve forests. Right holders were allowed to cut trees, collect fuelwood and clear land with the permission of the deputy commissioner, while grazing was freely allowed. Non-right holders had to pay a tax for similar privileges. Recognizing that communities would not take easily to their free access being circumscribed in this fashion, the concessions were increased. The amended Hazara Forest Regulation Act was enacted in 1873, creating a new category, the 'guzara (community)' forest. Although, ostensibly, returning large tracts of forest, grazing and waste land back to the communities, the management of 'guzara' lands continued to reside with the forest department which, furthermore, extracted seigniorage for any proceeds generated through sales of forest products.[16]

This form of colonial governance was effective only in so far as the administration did not misuse its powers and community needs were relatively limited. In a more fundamental sense, it was flawed. The top down, non-participatory approach drove a wedge between communities and their birthright by denying them say in its management and subjecting them to legal process, which was often, arbitrary. The unprecedented levels of degradation that the country is experiencing currently, partly has its roots in this. It has engendered conflict and a predatory mindset. Alienated from their resource base, communities are becoming profligate in its use.

The post-independence period (1947-1966) witnessed a further acceleration of the economic and social transformations underway in the colonial era. The commercialization of agriculture, industrial growth and the demographic explosion continued to exert relentless pressure on the stock of natural capital. Land use changes occurred on a large scale across the country, in the form of irrigation engineering, large dam construction, draining of wetlands, clearing of land for agriculture, industry, mining, roads and settlements. Forest and river ecosystems, already under threat during the colonial period, began to lose their self-sustaining capabilities. The physical threats to the environment were further exacerbated by the collapse of traditional social structures, as people moved in search of better economic opportunities, losing touch with their roots and traditions. A combination of poverty, diversified economic opportunities and the increased commercial value of natural resources

[16] A hybrid category, the ‘protected’ forest also emerged. Communities were allowed open access to resources in these forests, except for specific uses proscribed by the government. This was essentially intended to arrest the growing trend towards encroachments.

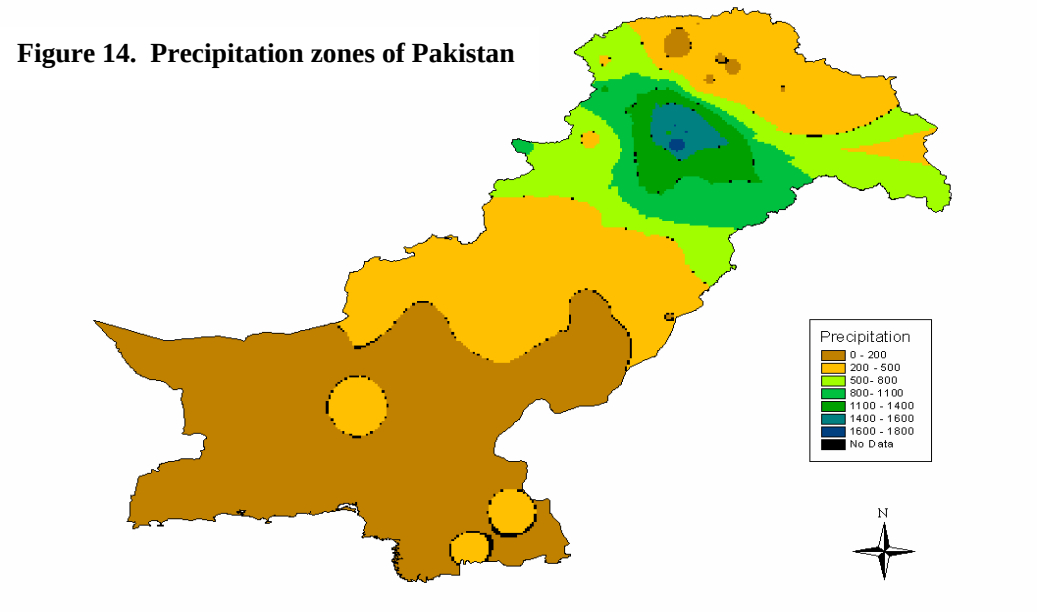
(timber, fuelwood, medicinal plants, and edibles) encouraged resource overuse rather than conservation.

The management system, designed for a specific purpose, was unable to cope with these changes. The multiple, and often conflicting interests of commercial loggers, private developers, government and military agencies, hunters and impoverished communities placed it under relentless strain. The administration tended to choose the path of least resistance, coming down with a heavy hand on the disempowered communities and colluding for personal gain and profit with vested interests. Rising prices of timber, fuelwood and forest products, an erosion in the standard of living of the forest custodians, fines and penalties that were selectively applied and failed to match the nature of the transgression, and royalties that were appropriated by the rich and powerful, combined to create a complex of perverse incentives antithetical to conservation. The irony is that the key inroads into forest resources began to be made by commercial and development groups which management was not in a position to oppose and -- in fact, cooperated with. On the other hand, it targeted communities, whose needs were of an essentially subsistence nature and who -- had their rights and traditions been honored -- could have collaborated with the authorities in the sustainable management of forest resources.

7.4 Climate Change

Meteorological data for the period 1931–90 show an inter-temporal increase of 0.5–1ºC in annual mean temperatures across the country, with the exception of the monsoon and southeastern coastal belts, where temperatures decreased. Precipitation trends over the same period differ widely for different regions. An increase in monsoon rainfall was seen in the coastal and monsoon belts, and in winter rainfall in the monsoon belt and high western plains of Balochistan. All other regions of the country registered either little change, or decreases in summer and winter rainfall.

Figure 14. Precipitation zones of Pakistan



Increasing monsoon rains on a base of increasing spring snowmelt have contributed to a higher frequency and intensity of flooding down the Indus River Basin. More floods have occurred in the Indus plain over the past 30 years than over the preceding 70 years.

Records for the last 100 years show that seven of the ten highest peak floods in the Ravi River occurred in the last 25 years. Arguably, however, climate change is not the only contributing agent; erosion caused by deforestation has contributed equally by increasing runoff in the Himalayan mountains and foothills.

The recent global preoccupation with climate change has special relevance for Pakistan in terms of the expected secular and cyclical impacts. In relation to the former, the primary concerns are with water availability and related crop stress. The latter relates to an increasing incidence and intensity of droughts and floods. The distinction between Pakistan's contribution to global warming and the impacts climate change is likely to have on its economy and its people is an important one. It can help focus policy priorities and ensure that Pakistan is not entirely sidetracked in a global dialogue which continues to be mitigation-centred.

7.4.1 Climate Change Scenarios for Pakistan

The latest climate change scenarios, generated by general circulation models (GCMs) for arid and semi-arid Asia are presented in Table 9. Although area-averaged annual mean precipitation is projected to increase in most parts of Asia, a decline in summer precipitation is likely over the central parts of arid and semi-arid Asia. This includes the Indo-Pakistan subcontinent almost entirely. Because the rainfall over this region is already low, severe water stress conditions – leading to expansion of deserts – are quite possible, with rises in surface air temperature and depletion of soil moisture. The largest reductions (precipitation reduced to <1 mm day^{-1}, 60% decline in soil moisture) are simulated in the arid regions of Pakistan. Drought disasters are more frequent during years following El Nino Southern Oscillation (ENSO) events.[17] At least half of the severe failures of the Indian summer monsoon since 1871 have occurred during El Nino years. In the event of advanced anomalous warming of the western equatorial Pacific Ocean, such as that observed during the El Nino, a higher frequency of intense extreme events (both droughts and floods) across all Asia is possible.

Table 9. Mean Annual Temperature and Rainfall for Asia

	Area-averaged annual mean warming		Area averaged annual mean rainfall	
Decade of	Without sulphate aerosols	With sulphate aerosols	Without sulphate aerosols	With sulphate aerosols
2050	3	2.5	7	3
2080	5	4	11	7

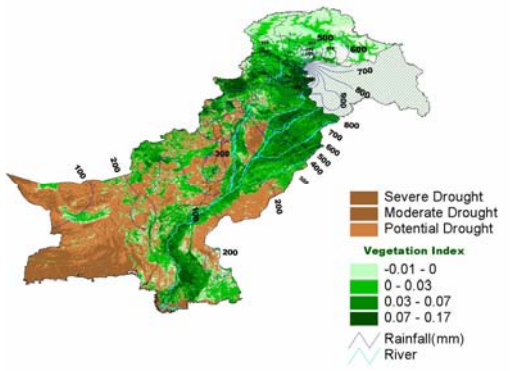
ce: IPCC, Third Assessment Report – Working
) II 2001

In fact, an increasing frequency and intensity of extreme events are likely to be the result of an interaction of diverse climatic factors: rising temperatures, the more frequent onset of El Nino and glacial melt. Some mountains in Asia have permanent glaciers that have vacated large areas during the past few decades, resulting in increases in glacial runoff. As mountain glaciers continue to disappear, the volume of summer runoff will eventually be reduced, as a loss of ice resources. Because the melting season of snow coincides with the summer monsoon season, any intensification of the monsoon is likely to contribute to flood disasters in the Himalayan catchments, especially in the western Himalayas, where snowmelt runoff is higher.

[17] The El Nino climatic phenomena originates in the Southern Pacific Ocean and is associated with extreme events in the shape of droughts. Its South Asian extension is referred to as the ENSO.

Recapitulating, a worst-case scenario for Pakistan, in particular, is characterized by rising temperature, reduced pre[illegible]r the long-term, increased water stress, a growing frequency and intensity of extreme events and sea level rise.

Fig 15. Drought Impacts



8. Information gaps

This overview relies mainly on various secondary statistical sources to take stock of the state of the environment. The following documents, published fairly regularly, are the main sources of information utilized in this report:

- Compendium of Environmental Statistics[18]
- Pakistan Economic Survey
- Agricultural Statistics of Pakistan
- Pakistan Statistical Yearbook
- Pakistan Energy Yearbook
- Various internal SDPI publications

Pakistan is at a severe disadvantage in not having a strong information technology base for data processing, modelling, and analysis. Outdated information on the environment hinders researchers and hence policy makers. Many indirect inferences have had to be made regarding pollution and degradation, especially where inter-temporal assessments are concerned. Our recommendation is that the collection of environmental statistics be an annual exercise. The Federal Bureau of Statistics (FBS) should update these statistics on a regular basis and make the Compendium on Environmental Statistics an annual publication. The ADB (1999) provides some excellent suggestions on the development of environment statistics.

[18] An important source in this regard is the *Compendium of Environmental Statistics* published by the Federal Bureau of Statistics (FBS) in 1998. Refer to Banuri and Khan (2001, pp. 39-46) for a useful account of the shortcomings of this compendium and Pakistani environmental data in general. In assessing this compendium in a regional context, ADB (1999) noted that data on greenhouse gases and ozone depleting substances, on a global, regional and local level, water resource use, water quality, forests, flora and fauna, coastal environment and solid waste management needed improvement. Only data on sanitation was deemed satisfactory among the various categories considered.

PART B: CASE STUDIES

I present two symptomatic case studies which span diverse yet linked ecosystems. The first case study is sited in the Mata Tehsil of the Swat district, a provincially administered tribal area (PATA). Some of best natural forests in the country are located here, but are subject to extensive degradation. Incidentally, Mata is also the present hub of a major army operation against the Al Qaeda-Taleban combine. The extensive shelling is further degrading the forests where the militants have taken refuge.

The second case study is sited along the 700 mile long coastal ecosystem of Sindh-Balochistan. The marginalized fishing communities have begun to feel the impoverishing effects of habitat destruction and species depletion. While most of the causes of degradation are *in situ*, some have their genesis in the natural forests in the north so the ecosystems are linked in a dependent relationship.

9. Case study 1: Assessing the Poverty-Environment Nexus Forest Degradation: Evidence from Swat, Pakistan

This case study contributes to the debate on the poverty-environment nexus; the view that due to poverty and the meeting of subsistence needs the poor use natural resources more intensively and cause them to degrade. Using the case of forest rich Swat district, Pakistan, the paper addresses the issue empirically, historically, and institutionally. We do not find empirical support for the poverty-environment nexus, in that the poor and other income groups are equally resource dependent and resource degradation is not associated with poverty. Our historical and institutional analyses provide alternative explanations for resource degradation.

We explore all the above hypotheses using complementary approaches. The poverty-environment nexus is deconstructed into two linked elements. First, we explore relative resource dependence by income group. If, as generally believed, the poor do indeed depend more on natural resources for their livelihoods, then in principle they could be contributing relatively more to resource degradation, even if not absolutely so. However this still needs to be established empirically or otherwise. We first explore resource dependence using quantitative evidence. Following this, we use visual methods (satellite imagery, land use maps, poverty and institutional maps) to explore the association of poverty and resource degradation.

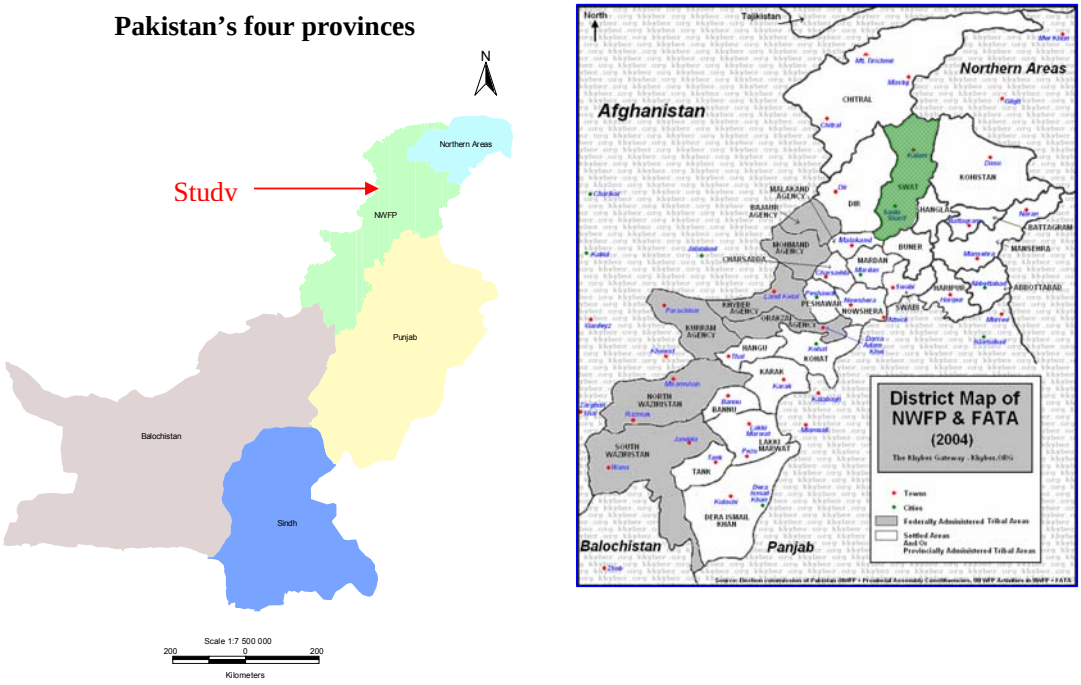
Our case study area is the region of Swat district, which is situated in Malakand Division in the North-West Frontier Province of Pakistan. Historically, it consisted of two tracts, Swat Kohistan, which is located on the upper reaches of the Swat river, and the main Swat Valley. In 1917, Swat was proclaimed a state, accessed to Pakistan in 1947 and, integrated administratively with the country in 1969. It is now referred to as Swat district.

The present district covers an area of 4,000 square miles. It borders the Gilgit agency in the Northeast, Chitral in the North and Dir in the West. In 1998, the district population was estimated at 1.26 million and the annual population increase lies between 3-4 percent. Literacy levels are generally low and far lower for women (25.2 percent male compared to 3.7 percent female). The Swat Valley has a *pathan* majority, most of which belongs to the *Akozai* branch of the *Yusufzai pathans*. Swat Kohistan is mainly inhabited by the indigenous ethnic group the *kohistanis*; these comprise the *Ghauri* tribe in the north and the *Torwali* tribe in the south. A large *gujjar* community (itinerant grazers) has also taken permanent residence in Swat. Agriculture and horticulture are the major source of income, followed by

wages and salaries, and local and foreign remittances. The most important cash and fruit crops in the district include wheat, maize, persimmon, tomato, onions, apple, and apricot.

The Swat Valley and Swat-Kohistan are extremely rich in natural resources. Swat once was credited for having the world's only virgin deodar (cedar) forests. Despite extensive deforestation, even today the district is rich in forest cover. Agricultural land, pastureland, rangeland are found throughout the area, while alpine pastures lie to the extreme north of the Swat Valley and Swat Kohistan.

Figure 16: Study location



The recent history of Swat begins with the Yusufzai Pathans who invaded and, subsequently, governed the region in the 16th century, defending it successfully against several waves of invaders. They maintained a tribal set-up and by the 20th century Swat was in a state of anarchy, with the local khans (chiefs) individually ruling the area that fell under their sphere of influence. A dramatic turn in Swat's history came about in September 1917, when Miangul Abdul Wadud, a Yusufzai Pathan, proclaimed Swat an independent state. The British, who ruled India at the time, did not recognize Abdul Wadud formally, but in 1926 agreed to accept him as the *wali*, or state ruler. Abdul Wadud abdicated in favor of his son, Miangul Jehanzeb, in December 1949.

The *walis* are credited with consolidating the state. They put efficient government machinery in place and undertook a large number of development projects. The first *wali*, Miangul Abdul Wadud, instituted a land settlement system and brought the forests under state management. He signed the Instrument of Accession in 1947 and the second *wali* signed the Supplementary Instrument of Accession in 1954 and Swat state was finally merged into Pakistan in 1969. Swat residents consider the rule of the *walis* as the golden period in the region's history.

9.1 Assessing poverty-environment linkages

We purposively selected Matta *tehsil (an administrative unit) in Swat,* which has three eco-zones (low, mid and high), defined by ecological, agricultural and altitudinal characteristics. For the analysis of resource dependence, information was collected on resource income (RI) as the dependent variable and the independent variables included income from other sources or non-resource income (NRI) and livestock numbers (LS), given their potential impact on resource degradation. Depending on the eco-zone, natural resources (firewood, timber, fodder and other forest products) are either purchased from the market or collected directly from the forests. The low eco-zone has a relatively high density of village settlements. Its location does not permit easy access to natural resources, with such resources being accessed indirectly via purchases from the market. The mid-zone is defined by extensive horticultural activities and lies in closer proximity to the forests, allowing households direct access to forest resources. This zone includes a mix of coniferous and deciduous forests. The high eco-zone falls along the upper valley ranges and includes largely coniferous forests, grazing lands and alpine pastures. The village households are located both on the forest fringes, as well as within the forests where land has been cleared for residential purposes, agriculture and livestock grazing.

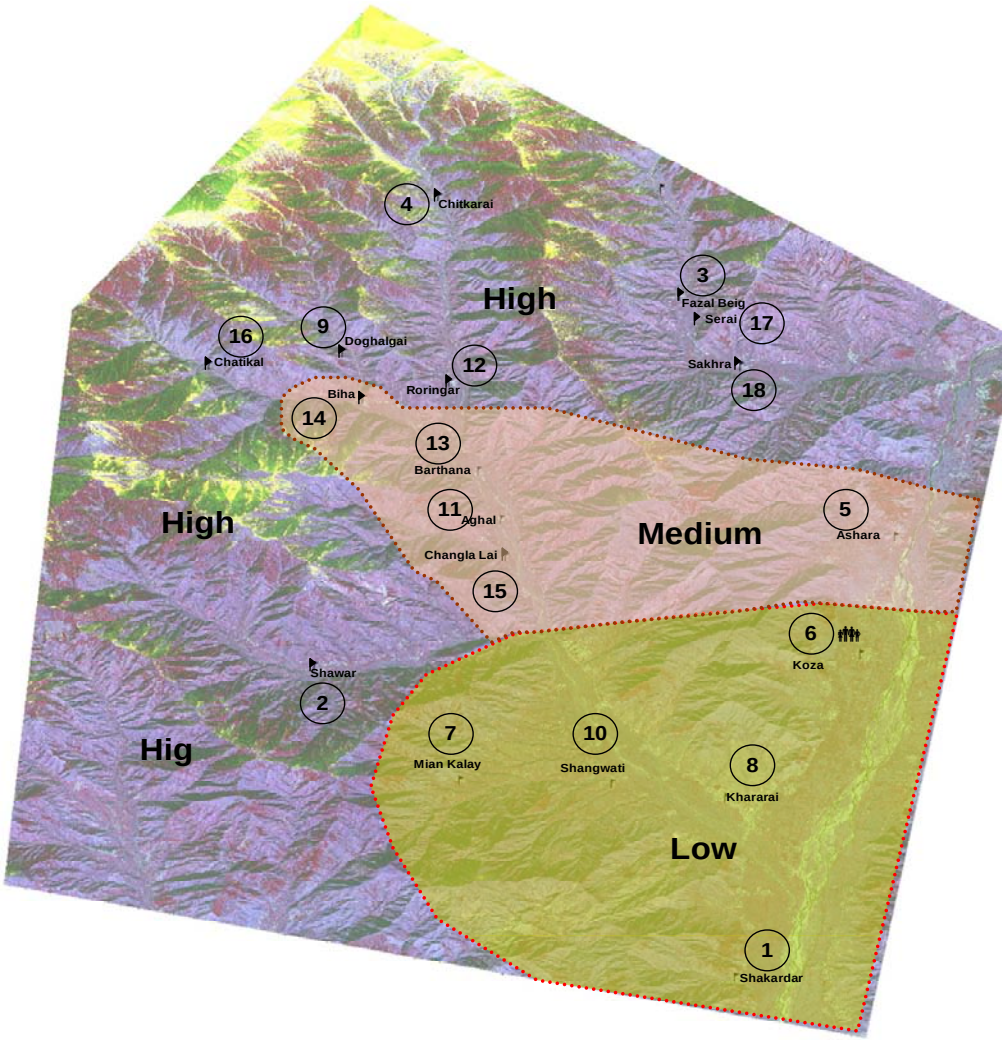
Our objective was to assess if resource use is inversely and significantly associated with other (non-resource) income, controlling for livestock ownership and eco-zones. Our ordinary least squares (OLS) result suggested that the income coefficient was insignificant. The OLS equation had a good fit with for cross sectional analysis with all included variables having the expected signs. The hypothesis that resource use varies inversely with household income was refuted. As expected, eco-zones had the expected signs, differences in magnitudes, and were highly significant. Also as expected, livestock owned had a positive and highly significant coefficient. We rejected the hypothesis that resource utilization was associated with income. This lack of association suggested that resource degradation in the case of Swat, Pakistan was unlikely to be mediated by income or resource dependency and moved to empirically explore the direct link between poverty and forest degradation.

9.2 Forest degradation and poverty mapping

In this empirical exercise, we started with identifying degraded resources and then explored their association with poverty. To do so, we generated a relative poverty ranking of villages and interfaced it with forest degradation. Thus the unit of analysis changed from the micro level of household and household resources to the more aggregate level of villages and community forests.

From a list of the most frequently used global poverty indicators, we selected those for which data had already been collected as part of our surveys. The individual villages were ranked for each indicator. We then arrived at the final ranking by taking the un-weighted average of the individual rankings with the lowest ranking representing the poorest village. To confirm or reject the presumed poverty-deforestation links, we superimposed the ranked villages on the land use map representing forest degradation.

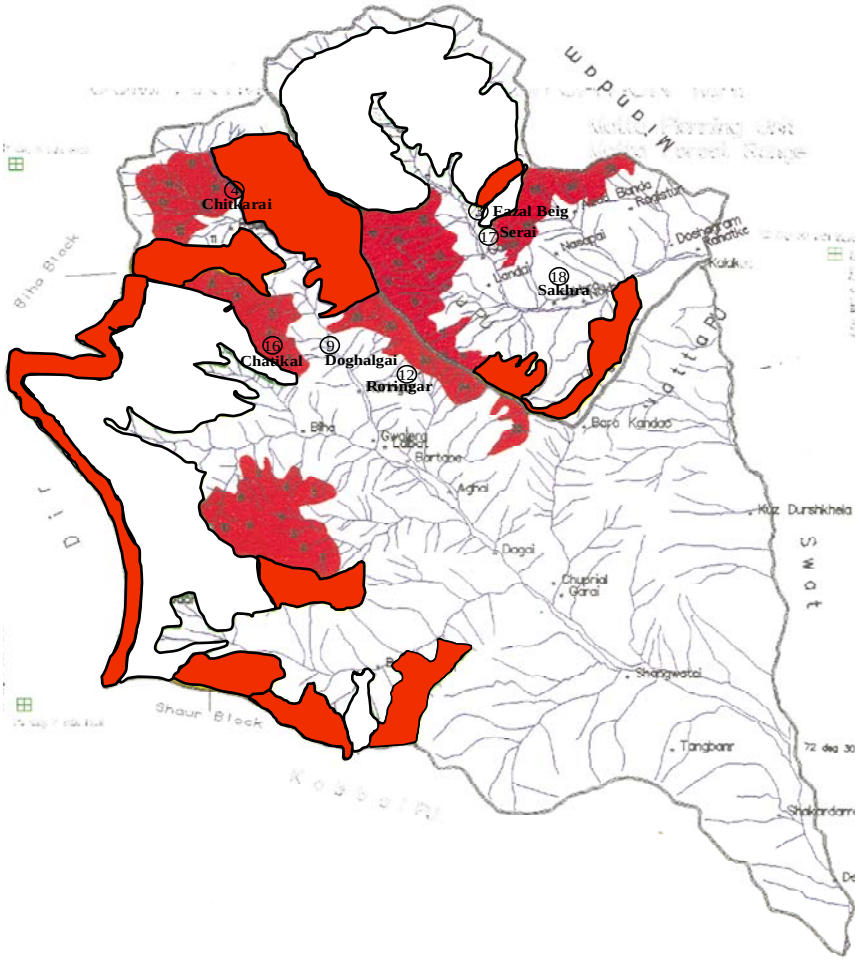
Figure 17. Poverty-environment mapping



There was little evidence of a correspondence between poverty and forest degradation. In fact, a large number of poor villages are found in the low zone where degradation is not an issue. Similarly, the mid zone has a concentration of rich villages, which is not surprising as most of the hereditary khans reside in this zone and have large land holdings and orchards.

Our main concern was the high zone where degradation is a serious problem. Here, we have a mix of both rich and poor villages, which is counter intuitive as one would, a priori, expect the more remote areas to be poor. There was once again no evidence of a poverty-environment nexus within the high zone. We further refined the exercise by mapping the villages on to degraded areas in the high zone. Again, the visuals confirmed the lack of correspondence between poverty and forest degradation. The absence of an explicit relationship between income and and resource dependence or resource use, combined with a lack of correspondence between zones of poverty and forest degradation, led us to explore historical-institutional explanations for such degradation.

Figure 18. Poverty-environment mapping in the high eco-zone



The system of resource rights in the main Swat Valley was established after the Yusufzai Pathans invaded the valley in the 16th century. Customary law governing rights to natural resources was rooted in a system introduced by a Yusufzai notable and revenue expert, Sheikh Malli. This system was known as *garzinda wesh*; translated literally, it means

moveable distribution. The rationale was that as land differed in composition, location/accessibility, fertility and availability of water, it was necessary to ensure equal sharing of its best and worst features. Land allotments were by village and re-allotments, by ballot, were carried out every 5, 7 or 10 years, as agreed mutually between the villages. The land allotments included a mix of agricultural land, forest (*zangal*), pasture (*warshoo*), and wasteland. While the system assured socio-economic justice, it relocated entire villages and took away the incentive to use natural resources in a sustainable manner.

Within the village allotments, the entitlements to common property resources (*shamilaat*) that included forests, pastures, rangelands, and water were in proportion to the size of private holdings of agricultural land. The holdings were referred to as *dawtar* and the owners as *dawtaris*. The sale and purchase of agricultural land meant that the *dawtars* varied over time and, commensurately, so did the common property entitlements within the village. Only the Yusufzais could be *dawtaris*, with ownership rights to agricultural land and hence to common pool resources. Non-*dawtaris* comprised different ethnic groups, tenants, and village artisans. They were required to pay *begar* (labor tax) and *qalang* (grazing tax) for tenancy and grazing rights. They were allowed use rights by *dawtaris* in the forests but, even as owners of purchased land, had no ownership rights in common property. Thus the resource rights regime differentiated clearly between the rights of owners and users.

9.3.2 Appropriation of community rights

When Swat state came into existence in 1917, the *wali* (ruler) claimed ownership and custodial rights over the forests. He established a forest department to manage the forests and sanctioned a 10 percent royalty from the commercial proceeds of timber. The *wali* also instituted two types of timber quotas. The local quota was meant for local residents requiring timber for domestic use. The *qaumi* (people's) quota applied to residents of areas where natural resources were not found in abundance. It was also used to acquire timber for public schemes. The *wesh* rotations were abolished, locking in private ownership and common property entitlements spatially and in terms of shares. In the sense that *dawtar* shares determined the division of royalties, historical ownership rights persisted. As in the pre-state days, the rights regime continued to differentiate between owners and users. In fact, the old system continued to prevail for all natural resources except forests. For instance, the practice of *begar* and *qalang* was left unaltered by the state. With regard to forests, the only change in terms of subsistence use was the *qaumi* quota; in other respects the old divisions and entitlements remained.

In 1926, the Swat State and the colonial administration of the Government of India entered into a formal agreement to manage and conserve forests. The agreement transferred administrative authority of these forests to the Government of India, but the de facto control and management remained with Swat State. While the rules and regulations were drawn up by the colonial government, the *wali* continued to exercise effective jurisdiction over the forests.

The independence of Pakistan in 1947, and the subsequent signing of the instrument of accession had no significant impact on natural resource management in Swat State. Resource rights remained unchanged for both owners and users. There were no efforts from either the Pakistani government (with whom the State had not merged at the time) or the *wali* to undertake any forest or land settlements in the main Swat Valley.

9.3.3 Governance collapse

A change in management practices came about after Swat State merged with Pakistan in 1969. The forests were declared provincial subjects under the sole jurisdiction of provincial governments. In 1975, the provincial government declared forests as protected, and converted them into state property. The local and *awami* quotas continued; the latter were

determined solely by the forest department that was susceptible to political influences. As a consequence, the quotas benefited a select few. Under the new system, traditional owners were to be compensated by providing them a share in royalties for timber extraction. Currently, the royalty share in Matta is fixed at 60 percent.

The period between 1969 and 1975 was marked by confusion regarding community resource entitlements. Pre-merger, the *wali's* rule was authoritative, the writ of law was well established, and resource rights for communities relatively well defined. The *walis* closely monitored the natural resources, the forests in particular, and ensured that no illegal felling took place. With their strict vigilance gone, and confusion surrounding the future rights of communities, natural resources began to be freely exploited.

Another major change in the ownership patterns also came about during the tenure of Prime Minister Zulfiqar Ali Bhutto (1972-77). At this time, the issue of de facto versus de jure ownership became important. The period saw large-scale purchases by resident Gujjars and land tenants of agricultural land and grazing land "*bandajaat*" from the landowners. The tenants and Gujjars also claimed the land they were cultivating and grazing, encouraged by the land and tenancy reforms instituted by the populist Bhutto government. This also triggered a willingness to sell by the absentee landlords. Prior to this development, any non-Pathan had to seek consensus of the *jirga* (council of village elders) or the consent of the khan (chief) to purchase land. The tenants had now become de jure owners and were relieved of their obligation to pay *begar* and *qalang* to the Pathans. Land settlements, which took place in 1986, further formalized this process.

9.4 An institutional analysis

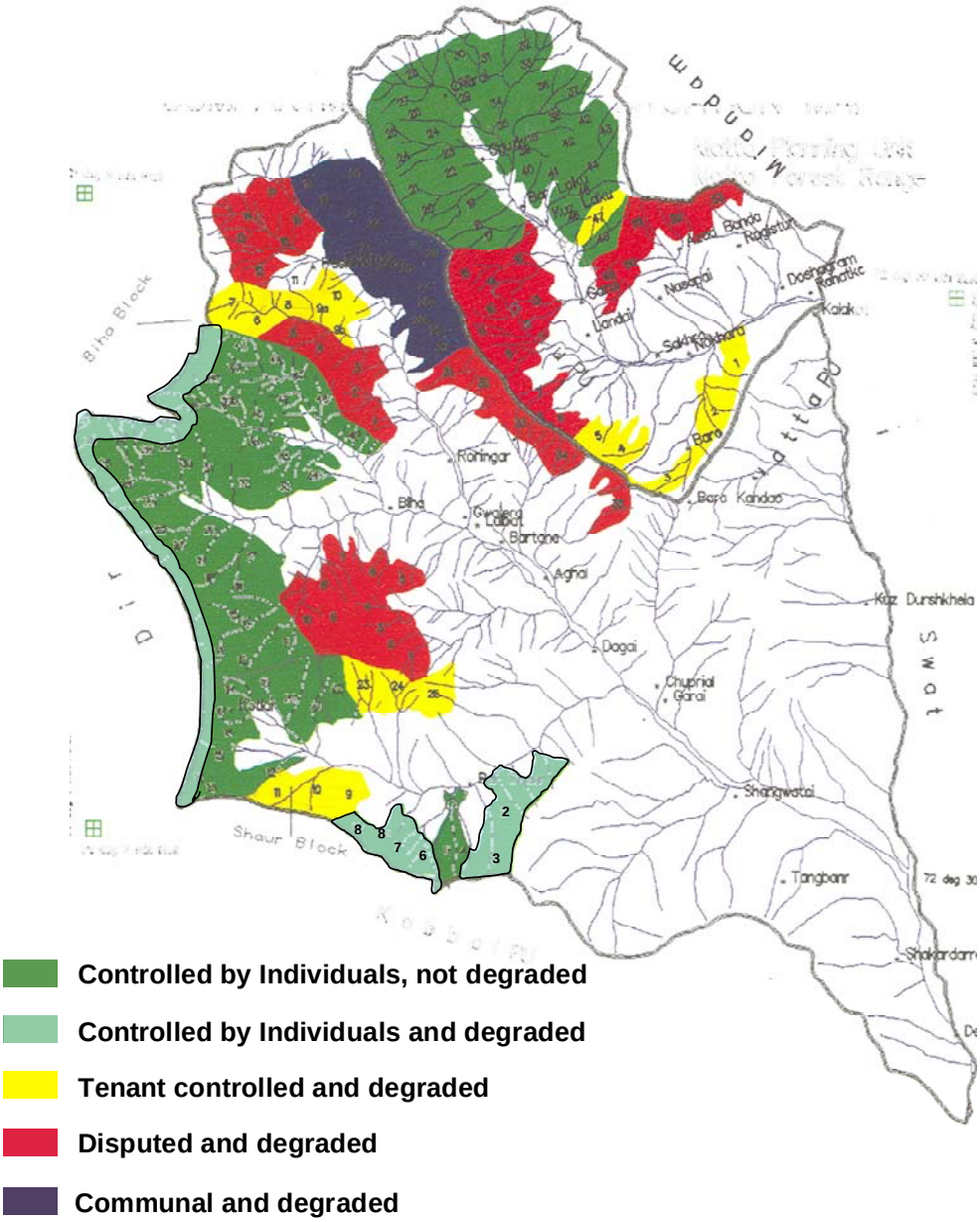
In failing to define resource rights clearly, the state has fostered tensions between communities with adverse effects on the forests. As mentioned above, the de jure owners sold the '*bandajat*' to de facto owners during the Bhutto era. The nature of the sale deed was such that any area under tree cover remained the property of the de jure owners while uncovered area became the entitlement of de facto owners. This provided an incentive to de facto owners to fell trees, thereby laying claim to additional land even though it was against the spirit of the sale deed. In addition, when the provincial government declared the forests as protected in 1975 and compensated the de jure owners with 60 percent share in royalty, the de facto owners received no rights. On the one hand, this led to significant deforestation and land use change (forests were converted to agricultural land) and on the other hand it increased tensions between de jure and de facto owners.

As indicated above, Swat's history of forest ownership and management is governed by the interrelationships of statutory and customary law that has created a complex system of resource rights. In this context, we identified four categories of forest "owners": forest department; communities with use rights; de jure owners living in close proximity to their forest holdings; de jure owners not living in close proximity to their forest holdings.

De jure owners living in close proximity to the land use the services of Gujjar tenants who normally pay *qalang* (grazing tax) and *begar* (free labor for using their land and forests) and they do not claim royalties. However, de jure owners not living in close proximity to their land create rival ownership claims by the long-resident Gujjars. In such situations, the latter do not pay *qalang* or *begar*, claim royalties and, effectively control the forests thereby becoming de facto owners. These forests are disputed and the subject of frequent litigation.

The ownership-degradation nexus is more pronounced and over rides poverty considerations. The spatial disjuncture between de jure and de facto ownership is a key factor in degradation. The degraded forests represent areas where de jure and de facto owners are different because de jure owners reside at a distance from the forests. Conversely, the well-protected forests are those where de jure and de facto owners are one and the same and live close to the forests. This is illustrated in the chart below which characterizes the interface between ownership conflict and forest degradation for four blocks.

Figure 19. Ownership and state of forests



Controlled by Individuals, not degraded

Controlled by Individuals and degraded

Tenant controlled and degraded

Disputed and degraded

Communal and degraded

Shaur Block consists of compartments 1 – 8 and 12 - 22 that are privately owned and well protected. By contrast, in compartments 9-11 and 23-25, where the de jure owners reside down country and the de facto owners (Gujjars) are proximate settlers, are in a degraded state.

In Biha Block, compartments 1-13 are contested by the Dir residents and are in a degraded state. The remaining compartments, 11-47, are privately owned and in relatively good shape. However, the watershed dividing the two districts is subject to frequent incursions by the Dir residents and this part of the private forests is also degraded.

Rohringar Block is the most degraded block in Matta tehsil. Compartments 1-5, 12-17 and 31-35 are disputed, compartments 7-11 are tenant controlled, and compartments 18-30 are communally owned. In each case, the ownership incentive for conserving the forests is weak.

Finally, in Lalku Block the Mians are the de jure and de facto owners of compartments 7-46, a well protected forest tract. In contrast, compartments 6-16 and 49-53 are disputed, while compartments 1-5 and 47 are tenant controlled. The two latter categories of forests are degraded.

9.4.1 Managerial inefficiency

Resource rights in the Matta *tehsil* are defined by customary and statutory law as explained above. Customary law was prevalent during the pre-*wali* era and the forests were owned and managed by the communities. Over time, the forests came progressively under state control and were managed under statutory writ - first, under the *walis* and later the federal government. Forest ownership, originally vested in the communities, was in time transferred to the state. While communities continue to retain rights in the forests they are now legally defined as “concessionists” rather than rights holders.

The transition from community to state ownership and customary to statutory law has engendered conditions detrimental to the forests and turned harmonious relations between communities and the state into exploitative and conflict-ridden ones. Good governance characterizes the *wali* era in that enforcement was both strict and fair. However, after the federal government takeover in 1969, governance failures have become endemic and forests have degraded both due to community and timber contractor inroads -- the latter aided in no small part by forest department officials and local elders. Thus the post-merger period resulted in a rapid increase in deforestation, stemming from institutional failure.

Community FGD (focus group discussions) indicate that the forest department is viewed as inefficient and corrupt. Collusion with the timber mafia and the selective application of fines and penalties for forest transgressions were cited as manifestations of such corruption. The deteriorating state of resources other than the forests, such as grazing lands, pastures and fisheries present an equally dismal picture and this is partly due to the opaque rights that presently govern these resources.

Customary law is by and large perceived in a positive light. Communities perceive the existence of a positive correlation between sustainable resource use and customary law. This is largely a result of the clarity of established norms, ownership and close monitoring of natural resources, which holds despite the fact that customary law puts no limit on the use of resources for subsistence.

For the most part, statutory law and the associated forest department mandate is perceived negatively. The reasons cited for this include excessive rent seeking practices, bureaucratic hurdles, and most importantly the loose writ of the forest department, which results in the failure to implement rules and regulations. Discretionary powers encourage corruption and collusion with timber contractors. The forest department is understaffed, with one forest guard being assigned to 4 villages. Delays in the release of royalties to communities have undermined the state's credibility. Further, the forest department is tardy in educating communities about sustainable forest practices and the potential benefits that could accrue as a result. The utility of such education is self-evident when the enforcement writ is weak and the resource needs many.

9.5 Summary and Conclusions

In this case study, we explore the debates around poverty-environment linkages; that the poor are more resource dependent or have a greater resource use and consequently contribute relatively more to resource degradation. Our quantitative results show no clear association between income and resource dependence or resource use. Utilizing satellite imagery and poverty mapping, we also demonstrate that there is no necessary interface between poverty and forest degradation. We turned to a historical-institutional analysis to explain forest degradation.

Our historical analysis starting with the 17th century indicates that selective and rotating ownership patterns provided limited incentive for resource conservation. However, once the *walis* of Swat took control in the early 20th century, ownership was frozen and resources were protected by stringent oversight of the forest department they created.

When Swat was administratively merged into Pakistan in 1969, the government declared forests protected and created tensions between customary and statutory law. They also did not invest in developing the managerial ability required to protect resources. Given the rapid rise in timber prices, the forest department officials have more incentive to collude with "forest mafias" than to protect community resources.

Furthermore, the populist government that absorbed Swat exacerbated the conflict between de jure owners with property rights and tenants or de facto owners. Unless de jure owners were also de facto owners, the nature of contracts resulted in tension and forest degradation.
Swat district residents depend substantially on natural resources for subsistence use and as an income source. Such dependence underscores the need both for defining the rights to these resources clearly based on an understanding of local culture, history and institutional evolution. It also requires instituting sound management systems that avoid perverse incentives. Only with such policies in place can the current rapid rate of deforestation be avoided and sustainable resource use ensured.

10. Case Study 2: Compliance with International Standards in the Marine Fisheries Sector: A Supply Chain Analysis from Pakistan

10.1 Overview

Pakistan's marine resources are a direct source of livelihood for over a million people and have supported fishing communities for generations. These communities are dispersed along a 700 mile coast line, lying between Sir Creek in Sindh and Jiwani in Balochistan[19]. The bulk of the fishing population resides in the Karachi division. The other concentrations are in Thatta, Sindh, and Gwadar and Pasni, Balochistan.

[19] Birwani, Z. Ercelawn, Aly. Shah, M A. "Sustainable and Just Livelihoods For Coastal Fisherfolk: Securing Rights in Environmental Law and Policy", Pakistan Institute of Labour Education and Research. 1999

Figure 20 Coastal map of Pakistan

More than 15,000 fishing vessels of various sizes, ranging from small to medium-sized boats, large launches and trawlers engage in fishing. Almost one third are shrimp trawlers; the bulk of these are owned by investors outside the community. Boat and shore fishing is done in creeks and within the 12 miles territorial limit which falls under provincial jurisdiction. The larger launches go further off shore into deeper waters on extended fishing excursions, some reaching as far as the Somalian coast.

The analysis addresses the scope for compliance with international food safety (SPS) and sustainable harvesting (MSC) standards. Food safety standards cover both pre-processing and processing activities. Compliance with such standards is key to Pakistan's fish exports and foreign exchange earnings and to ensuring livelihoods for the coastal fishing communities. A gap analysis illustrates that processing plants tend to comply with food safety standards, primarily due to the threat of loss of market share. However, exporters/processors have less control over pre-processing and harvesting activities further up the supply chain, even though these activities, ultimately, affect their ability to export. Pre-processing is the responsibility of the harbor authorities and entails food safety interventions at three stages: on board the fishing vessels; at the fishing docks and in transit to the processing plants. Compliance lapses at the pre-processing stage are frequent.

Our focus here is on fish harvesting the first step in the supply chain, where poverty-environment links are strongly in evidence. The policy, social, economic and ecological dynamics are difficult and the perverse interplay of these variables has led to a sustained degradation of Pakistan's coastal fisheries, extending well beyond its territorial waters with adverse consequences for the livelihoods of coastal fishing communities. Degradation, here, refers to stock reduction due to both over fishing and to habitat destruction. In the following section we examine the economic, poverty, environmental and policy drivers of degradation

10.2 Evidence of degradation

Table 10: Fish Species with Declining Yearly Catch (metric tons.)

Local Name	*English Name*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*
Boi	Mullet	21,620	18,439	16,567	16,622	17,678	16,392	11,367
Tarli	Indian oil Sardinella	73,960	50,543	45,231	42,611	44,410	38,110	25,100
Padon	Thryssas	29,260	18,111	17,564	14,091	16,113	13,165	15,154
Palli	Clupeoidei nei	40,210	31,198	21,615	21,982	20,100	19,209	21,103
Kiddi	Kiddi shrimp	18,210	15,121	12,289	13,171	15,912	13,854	12,121

Source: Handbook of Fisheries Statistics of Pakistan" Volume 18, 2002

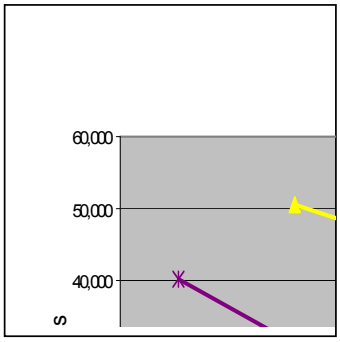


Figure 21. Declining fish catches in Sindh

10.3 Causes of degradation

Degradation of the marine resources has contributed to reduced fish catch and depletion of fish stocks. The degradation has occurred for various reasons. In this section we look at their major causes and effects.

10.3.1 Returns to fishermen: The vicious circle of indebtedness

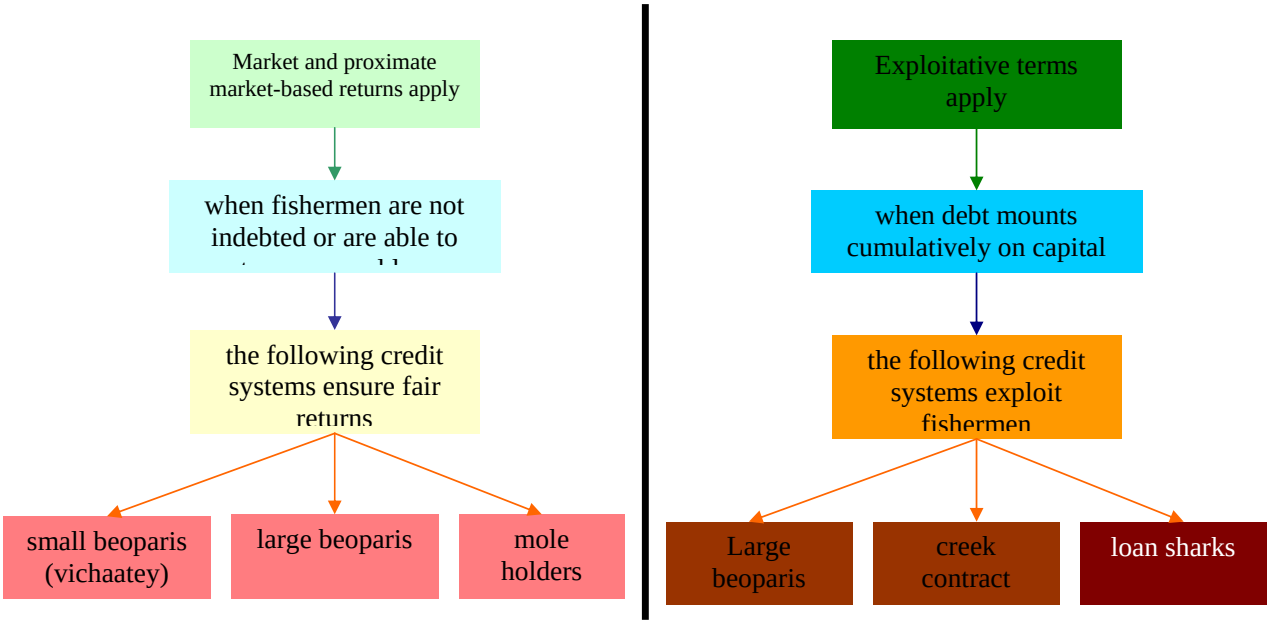
A combination of technology upgrades and rising costs have made local fishermen increasingly dependent on loans to finance their expenditures, which fall into two categories:

- Capital expenditures: which include loans taken to purchase boats, launches, nets and engines
- Running expenses, which include boat, net and engine repairs, ice fuel and food

In the absence of institutional credit, the fisherman's only recourse is the informal credit system. The repayment conditions are similar for the two types of loans. In either case, the fisherman pays commission until he pays off his entire debt. However, there is no deduction for the principal which is required to be paid separately. The system has five variants, all of them exploitative but in differing degrees. Exploitation is explained in terms of the difference between market and realized returns.

The debt-return linkage is profiled in Figure 21

Figure 21. The debt-return linkage



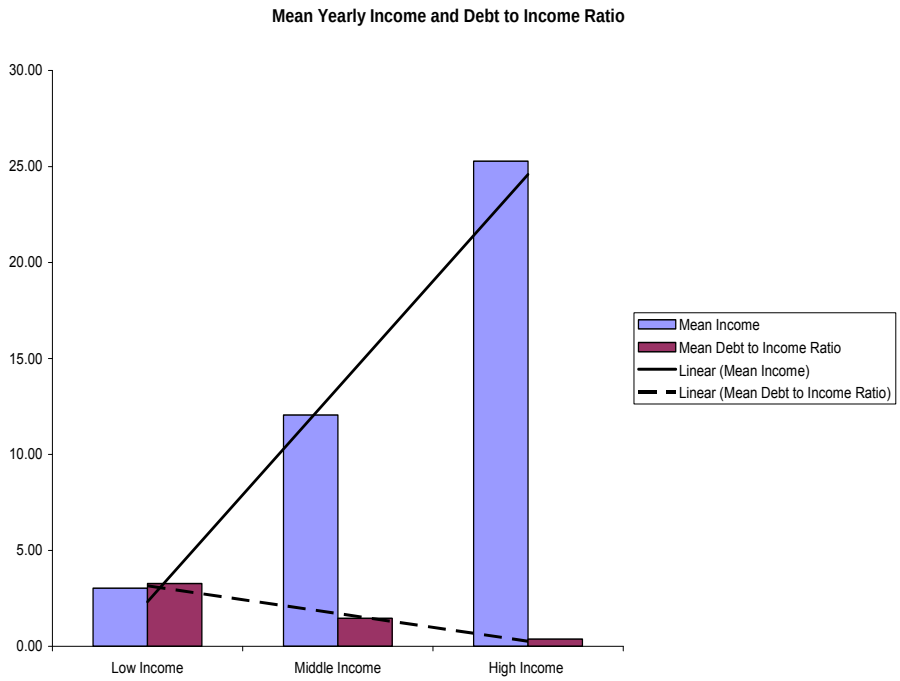
We observed an empirical link between poverty and indebtedness. Even the smallest boats require substantial capital and running cost outlays. For example, the poorest fisherman, who owns a small boat, first spends Rs. 200,000/- to Rs. 300,000/- to construct the boat and spends Rs. 500-600 on every fishing trip. During the fishing season, he makes at least 20 such one-day trips, averaging about Rs.10,000 per month. Rising costs and decreasing catches have resulted in falling income levels and increased indebtedness. We plotted household income levels against the level of debt for 27 households across Sindh and Balochistan, for which we were able to gather complete data. It suggests an inverse relationship between the two variables, as shown in Figure 22.

Table 11 Mean Comparisons

	Mean Yearly Income in PKR ($x10^5$)	Mean Debt to Income Ratio
Low Income	3.03	3.27
Middle Income	12.04	1.46
High Income	25.28	0.38

Source: SDPI in-house calculation

Figure 22. Income-debt comparisons



The data suggests indebtedness is acute among low-income groups in both Balochistan and Sindh. The absence of policies aimed at stemming degradation, limited occupational choices for fishermen and the exploitative terms they get for their catch, have locked them into a cycle of debt dependence and made their livelihoods extremely precarious.

10.3.1.1 Consequence of indebtedness: Unsustainable fishing methods

A major reason for unsustainable harvesting and a direct consequence of indebtedness is the rapid influx of new fishing methods, which have begun to replace traditional practices. Large trawlers and launches are most prone to use these methods, in an effort increase commercial catches and with damaging consequences for the ecology. Faced with declining catches and the need to pay off their debts poor fishermen have no option but to follow suit.

Environmentally harmful nets, inducted in an effort to increase fish catches, are made of nylon, have a fine mesh and catch small fry. The translucent nylon allows fishing both by day and night time. The smaller nets are prone to rip off on undersea coral, washing up later on the beach. Stationary fishing methods have made way for trawling which scrapes the ocean floor and damages fish habitat. The mechanization of boats and launches has both facilitated the use of these nets as well as permitting mobility. The increasing use of winches has accelerated the pace of fishing and encouraged the use of bigger nets. Some examples of the nets being used are:

- *Bhulo gujja* (tidal trap net). A fine mesh cone net made of nylon, with the mesh getting finer towards the cone. The net is tied by wire cords to two iron rods, which are embedded in the creek mouth. Meant for shrimp, small fry get trapped in the fine mesh and decompose. The net was introduced by migrant Bangladeshi fishermen but the uptake by local fishermen has been rapid. A variant is the chappal gujja, which is tied along the seashore near mangroves. It catches juvenile and small shrimp.[20]
- Launch *gujja.* This is a larger version of the bhulo gujja and is used on medium size and large boats (20-35 feet) and launches. It is a drag or trawling net made of thicker nylon but the mesh is still fine and traps fry. The net scrapes the ocean floor and damages fish habitat. This net was first introduced here in 1951 and is rapidly replacing the gill net. The use of these nets and winches has earned these traditional launches the pseudonym of “mini deep-sea launches.”
- *Qatra* (fine mesh net, also referred to as a wire net). This net is used in medium and large sized boats and launches to catch trash fish, mostly sardines, which are converted to chicken feed.
- Plastic nets. This is the term used for fine mesh nylon nets used in Balochistan. They come in all sizes and are used in small and medium sized boats. They were originally introduced about three years ago by the migrant Bangladeshi community, working under contract to the processing plants to catch Indian mackerel, ribbon fish and sole for export largely to the Far East. In time, they have been assimilated more widely.
- Deep sea trawler nets. Deep sea trawlers use a variety of nets; trawl liners, bag type trawl nets that scrape the ocean floor, hooked rope nets (used by long liners). The combination of these nets and winches causes considerable ecological damage. Also, the trend towards target fishing results in unwanted dead fish being thrown back into the sea, which is both wasteful and harmful to the ocean ecology.

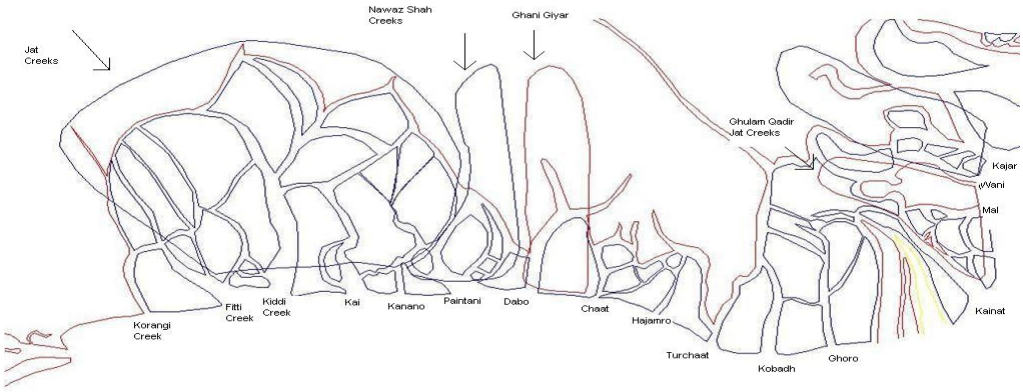
[20] The Sindh coast has 17 large and hundreds of small creeks, which are actually branches of the larger creeks.

10.3.2 Vulnerability: Resource rights and the poverty-environment nexus

Poverty contributes to resource degradation and vice versa. This vicious cycle defined in the literature (see Khan et al, 1999) as the poverty-environment nexus is an appropriate context for the behavior of poor coastal fishing communities. The Bangladeshis, by virtue of their migrant status and consequent vulnerability, are captive to contractors of the sea lords, the processing plants and to maritime agencies. The environmentally destructive practices they have introduced, in particular, the *bhulo gujja*, the *qatra* (plastic net) and the off-season shrimp fishing can be seen as an effort to stay afloat under highly adverse conditions. These conditions reflect a combination of distress prices for their catch, declining fish catches and illegal payoffs.[21] The indebtedness of poor fishermen we referred to in an earlier section is a more pervasive condition, which also explains the rapid uptake of these destructive fishing practices.

The increasing poverty of fishermen is linked in important ways with the deprivation of their resource rights (open access). There are three manifestations of resource capture. First, sea lords claim ownership over the coastal creeks (see map).

Figure 22. Sea lord claims over creeks



These sea lords, formerly owners of the inundated agricultural lands, have taken possession of these creeks by virtue of their prior status as landlords. They link permission to fish the creeks to the sale of their catch to designated beoparis. It is not difficult to see the connection between the resultant distress pricing and the use of harmful nets. Second, as fish stocks in the Sindh waters have dwindled, launch owners have begun to intrude into Balochistan's territorial waters. This practice, as we noted, is facilitated by the Fisheries Department and the Maritime Security Agency. Not only do these launches catch fish illegally, their drag nets cut the smaller stationary nets of the boat fishermen. On occasion, communities have resorted to violent action to assert their resource rights. For instance, the Pasni fishermen reported violations to the authorities. Absent a response, they took matters

[21] Near the Indian border, coastal rangers demand pay-offs from local fishermen in exchange for permission to fish the creeks.

into their own hands and impounded the fishing nets of the Sindhi launches.[22] Third, resource capture is embedded in existing fishing policies. The institution and revocation of zoning laws has allowed trawler intrusions into coastal fishing waters. As another example, dredging in the Gwadar port has destroyed rich shrimp breeding grounds. Also, the Maritime Security Agency now requires prior security clearances to allow fishermen access to waters around the port.

While the analysis above suggests that poor fishing communities do degrade resources, it also suggests strongly that this is an induced response, rather than a deliberate or wanton act. It is induced by commercial pressures which, in turn, are supported by policies. Federal and provincial fishing policies, through both intent and default, support commercial interests at the expense of environmental and livelihood concerns. Zoning laws and price manipulation by the processing plants, middlemen and the sea lords leads to reduced catches and low returns on these. Consequently, poor fishermen resort to environmentally harmful technologies to sustain themselves. However, these cause relatively less harm than these technologies employed on a much larger scale by deep sea trawlers and launches.

10.3.3 Policy enforcement failure

10.3.3.1 Stock assessment

A prerequisite for a sustainable marine fishing policy is regular and accurate stock assessments. This was last carried out in 1980 and there has been no revaluation since then. The provincial and federal governments have acted on the premise of adequate stocks, setting no limits on the number of fishing vessels, restricting catch sizes or protecting threatened species. The absence of a stock survey is convenient as well, as it avoids hard policy and enforcement choices, which the government may not be able to make in the face of powerful opposition. Based on the 1980 stock survey, the prescribed number of launches was 70, however the policy was revised in 1995 and the number was increased to 120. Similarly, 500 fishing boats were recommended as opposed to the 15000 currently registered with the FCS and the KFHA. Many of these vessels are not in operation. [23]

A stock assessment is also in order in view of the evidence of decreasing catch size in certain species, such as Indian mackerel. The data in Table 10 shows trends in fish catch for the most important species caught in Pakistan waters (both coastal and offshore), over the period 1993 to 1999. Figure 21 presents the same information graphically.

10.3.3.2 Zoning

A second aspect of policy failure pertains both to arbitrary changes in zoning laws, as well as to weak enforcement. Until recently, the fishing waters off the Sindh and Balochistan coasts were divided into three zones. The territorial waters (also known as the coastal zone) extend up to 12 nautical miles and come under provincial jurisdiction. The continental or buffer zone falls between 12-35 nautical miles. The waters beyond and up to 200 nautical miles are designated as the exclusive economic zone (EEZ), and are fished largely by deep sea trawlers. Both the buffer zone and the EEZ fall in the federal government's policy remit. The buffer zone was established to protect fish stocks in territorial waters. In 2001, the federal government abolished this zone and, subsequently, trawlers have begun to ingress into territorial waters. The local fishermen complain they denude fish stocks by intercepting the inbound fish spawning runs, and degrade the ocean habitat with their drag nets. In promoting trawler fishing, federal policy is at odds with provincial concerns.

---

[22] In conversations with the Pasni fishermen, they claimed they were asserting their rights under customary law.
[23] The fact that there are more vessels registered than in use indicates monitoring lapses.

The lack of enforcement also has an inter-provincial aspect. Overfishing in the Sindh coastal waters has encouraged local launch owners to intrude into the more productive Balochi waters. The federal and provincial maritime agencies and departments are known to collude in this by taking informal pay-offs (between USD 500-650 per trip).[24]

10.3.4 Fresh water retention

This sub-section illustrates the linkages between two ecosystems. Degradation of the Indus delta ecosystem as a result of reduced fresh water outflows is already a highly visible phenomenon. The present level of silt discharge, estimated at 100 million tons per year, is a four-fold reduction from the original level before the rivers were dammed. The combination of salt-water intrusion (some reports show this as 30 km inland), and reduced silt and nutrient flows has changed the geomorphology and hydrology of the delta considerably[25]. The area of active growth of the delta has reduced from an original estimate of 2600 sq. km (growing at 34metres per year) to about 260 sq. km. Freshwater reaches only a few of the creeks and others have become blocked. The delta is being transformed by strong wave erosion, an increasing dominance of sand at the delta front and an increase in wind-blown sand deposits as a result of losses in vegetation.

The consequent ravages to the ecosystem have been exceptionally severe, in particular to the mangroves which are its mainstay. One of the major causes of degradation and (possible) reduction in fish stock is the degradation and depletion on mangrove forests in Indus delta. The degradation has taken primarily because of state negligence. The National Commission on Agriculture in its report published in 1988 observed that mangrove forests were most seriously threatened than any other forests in the country[26]. A WWF report on mangrove forests in Pakistan observes that Pakistan has lost 1700 sq. km. of mangrove forest area in past 50 years. [27] The report notes that the Indus delta had eight different species of mangroves, most of which are not found in Pakistan today.

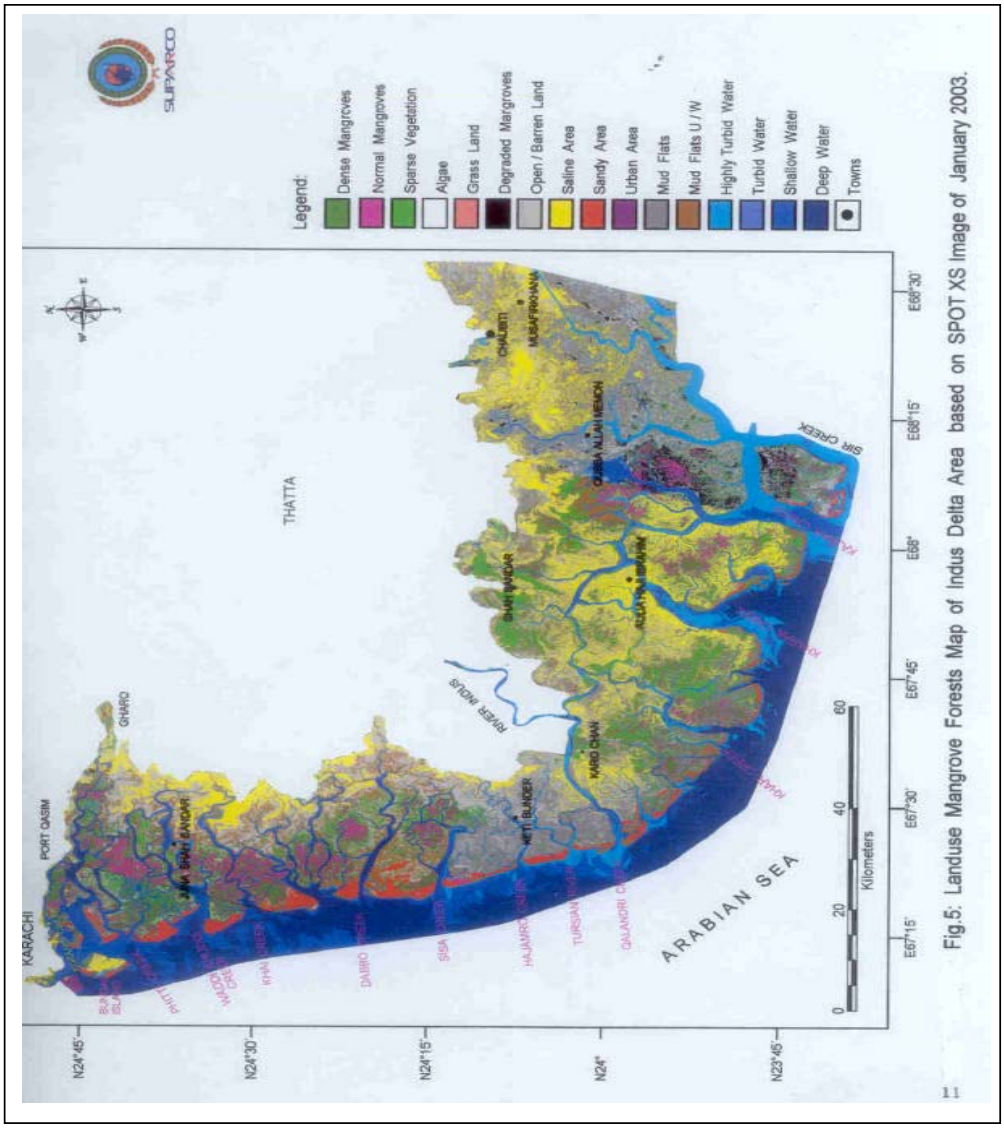
[24] Reportedly, these agencies are the federal Maritime Security Agency and the Balochistan Fisheries Department

25 In theory the change in parts per million of sodium concentration would cause a shift in species diversity and impact breeding patterns and success. However, there is no documentation available to validate this.

26 pg 27, "Regional Technical Assistance for Coastal and Marine Resources Management and Poverty Reduction in South Asia - Pakistan Component" Asian Development Bank IUCN – The World Conservation Union Pakistan JUNE 2003

27 www.panda.org/downloads/policy/rcpakistan.doc (cited on 14 November 2005)

Figure 23: Satellite Image of Indus Delta depicting mangrove forests



Mangroves are important as they sustain fisheries through their role as breeding grounds, act as natural barriers against sea and storm surges, keep bank erosion in check and are a source of fuelwood, timber, fodder and forest products, a refuge for wildlife and a potential source of tourism. Without mangroves and the nutrients they recycle and the protection they provide, other components of the ecosystem would not survive.

The health of mangroves is directly linked to fresh water outflows. Releases below Kotri barrage average 34 Million Acre Feet (MAF). Of this, about 10 MAF actually reaches the mangroves, and that, too, between the kharif months of July and September. The rest is lost due to evaporation or diversions. According to the Sindh Forestry Department, about 27 MAF is required to maintain the existing 260,000 ha. of mangroves in reasonably healthy condition. This is 7 MAF more than currently available, a situation which has contributed to ecosystem instability and mangrove loss. Within the framework of the Indus Water Accord, the intent is to divert an additional 11 MAF for upstream dam construction – including

Kalabagh, to meet agricultural and hydropower needs. This would result in a further reduction in existing sub-optimal flows and aggravate an already critical situation.

Land reclamation works have also contributed to mangrove depletion, closing the creeks and the destruction of fishing grounds. Such construction suggests the need for a coastal zone management law akin to the one in India which prohibits construction anywhere within a distance of 500 metres from the shore.

10.4 Summary and conclusions

This report discusses primarily issues in compliance with international standards in Pakistan's marine fisheries sector. The compliance with international standards has been analyzed in the context of a supply chain analysis at three different stages namely, harvesting, pre-processing and processing. The harvesting standards are basically covered by the MSC principles discussed in earlier sections. Although, the standards are purely voluntary, there is a possibility of their becoming an "international norm" in future years. Similarly, the processing standards are spelled out in Codex Alimentarius and implemented through HACCP guidelines. The standards chiefly deal with processing of sea food, however, they spill over to harvesting by including on-board processing standards.

In contrast, there is weak compliance with harvesting (voluntary or otherwise) and pre-processing standards. This is largely due to the absence of institutional mechanisms capabilities to cope with this requirement. Similarly, deep sea fishing policies introduced since 1980 have focussed on the commercializing aspects of fishing without much regard to quality control and fisheries management. Underscoring this problem is the perception of marine fisheries as an open-access resource. As a result the sector has witnessed severe over-fishing and the threat of species depletion.

The lapses at the harvesting stage signal two messages: first, a sustainable fisheries policy needs to be formulated and; second, in the interim, the good aspects of existing policies need to be implemented. With regard to the first, policies need to recognize the interdependence between fishing methods and conditions of fisherfolk communities. Aguero and Costello[28] (1986) state that:

> If fisheries management is to be integral, it must be based on information data and interpretation which is also integral. The need is for research leading to an integral analysis and understanding of the fisheries sector where biological, technological, socioeconomic, cultural and institutional factors are properly accounted for in active interaction with other components. (p819)

Similarly, Smith [29](1983) states:

> The fishery is seen as encompassing input supply, production, and distribution sectors, with linkages to other sectors in rural areas. Changes in the resource base and the heterogeneity of fishermen and fishing communities require projects that are "locale-specific' and that recognize the needs that fishermen themselves identify. Such projects should also appreciate the vertical and horizontal linkages that fisheries and fishing communities have with other sectors and institutions. (p.2)

We therefore recommend the following policy measures:

---

[28] As Quoted in John, Joshua. 1994 "Managing Redundancy in Overexploited Fisheries" World Bank Discussion Papers 240, Fisheries Series. Washington

[29] Ibid., 27

- Formulation of a sustainable fisheries policy that focuses not only on ecosystem management but also includes economic uplift of fisherfolk communities
- Restricting access rights to the marine fishery resources
- A complete ban on industrial fishing and use of destructive fishing gear by both local and foreign fishing vessels. Adequate resources and manpower allocated for enforcement.
- An improved marketing system that ensures just prices and immediate payments to small fishermen
- Micro-credit schemes, supported through the PFF.
  Reduction of fishing capacity by imparting training in other skills to local fishermen and provision of alternative livelihoods

11. Recommendations

Will be inserted after the stakeholder workshop

Bibliography

Jamal, H. et al (2003), 'Mapping the spatial deprivation of Pakistan', The Pakistan Development Review, 42:2, Islamabad, pp. 91-111

Birdsall, N. et al (2005), 'Poverty and the social sectors: The World Bank in Pakistan' 1990-2003', Center for Global Development, Washington DC

World Bank (2002), Pakistan poverty assessment: Vulnerabilities, social gaps and rural dynamics, Poverty Reduction and Economic Management Sector Unit

Khan, S.R. et al (2006) *State of the Environment Report for Pakistan,* Unpublished report, Sustainable Development Policy Institute

Khan S.R. et al (2006) 'Do the poor degrade forests? Empirical and historical-institutional analyses for Swat, Pakistan', Unpublished paper, Sustainable Development Policy Institute

Khan, S.R. et al (2005) 'Compliance with International Standards in the Marine Fisheries Sector: A Supply Chain Analysis from Pakistan', International Institute for Sustainable Development (IISD), Canada

Annex 1: Moisture indices during kharif (winter) and rabi (summer) growing seasons