

ECOSYSTEM SERVICES AND POVERTY ALLEVIATION STUDY IN SOUTH ASIA (ESPASSA): A SITUATION ANALYSIS FOR INDIA AND THE HINDU KUSH HIMALAYAN REGION



Regional Analysis

Annexure 3

**A Project Report Prepared for
NERC, DFID, and ESRC by the
ESPASSA Consortium
25 April 2008**



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Discussion papers

Analyzing Linkages between Ecosystem Services and* Poverty: South Asian Perspectives

Surender Kumar**

I. Introduction

About half of the world's poor surviving on less than US\$ 1 a day reside in South Asia.¹³ The region has witnessed rapid economic growth since 1990, averaging 5.4 percent a year. The economic growth has helped in reducing the poverty in the region. India has reduced its poverty rate by 5-10 percent since 1990; most other countries registered reduction in poverty over the period, except for Pakistan, where poverty has stagnated at around 33 percent. The region has also some success story in reducing infant mortality and increasing the schools enrolments. However, the challenges remain in the areas such as child malnutrition¹⁴, primary and secondary education completion rates, maternal mortality, and gender balance in education and health. The resurgence of tuberculosis and the threat of HIV/AIDS are also a cause for concern. The degradation of ecosystems is a significant barrier to the achievement of the Millennium Development Goals (MDGs) related to reduction of poverty, hunger and disease.

Ecosystems provide private as well as public good type of services. They provide private goods like food, fresh water, wood and fiber and fuel, which people could buy from the market. In addition to supporting all life and regulating natural systems, they supply public good type of services like preserving bio-diversity, nutrient cycling, soil formation, controlling diseases and floods, avoiding climatic change problems, and aesthetic, spiritual and recreational benefits. The markets for the public good type of services are absent and everybody gets the benefits of conservation of ecosystems. Equally everybody receives the damages from the degraded ecosystems. While both rich and poor gain from the conservation of ecosystems, the poor are relatively more affected from their degradation.¹⁵ The Millennium Ecosystem Assessment (MA) reported that 15 of the 23 ecosystem services are affected due to resource degradation.

Dasgupta (2007) warns that if nothing substantial is done to prevent the degradation of ecosystems, the average per capita consumption level at the world level may decline. Moreover, the impact of human activities on earth's ecosystems can be measured as the fraction of the net primary production (NPP)¹⁶ that is appropriated by the humans for their own use. Imhoff et al

*This paper forms part of the ongoing project on 'Ecosystem Services and Poverty Alleviation: A Situation Analysis of India and Hindukush Region' sponsored by the NERC-ESRC-DFID.

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¹³ Our analysis is restricted to Indian subcontinent only, i.e., it covers India, Pakistan, Nepal, Bhutan and Bangladesh.

¹⁴ About half of all children under the age of five are malnourished in Bangladesh and Nepal.

¹⁵ This point is discussed in detail in Section IV which shows that the dependence of the poor on ecosystem services decreases with the increase in income levels.

¹⁶ " Net primary production- the net amount of solar energy converted to plant organic matter through photosynthesis- can be measured in units of elemental carbon and represents the primary food energy source for the world's ecosystems. Human appropriation of net primary production, apart

(2004) shows that South Central Asia consumes more than 80 percent of its regional NPP. The on-going growth and consumption pattern in South Asia is likely to impoverish local ecosystems and diminish the important services they provide (Imhoff et al., 2004).

Moreover, Dasgupta (2007) finds that economic development during 1970-2000 in the Indian subcontinent was either unsustainable or barely sustainable when the productive base of the countries is taken into account, though the per capita GDP is increasing and HDI is improving in all the countries under study (Table 1). Productive base is its stock of capital assets and institutions. Capital assets consist manufactured capital, human capital and knowledge, and also natural capital (Dasgupta, 2007). Therefore, to make the development to sustain and to be inclusive, it is necessary to understand the relationships between ecosystem services and human well being since the poor are most dependent on ecosystem services and vulnerable to their degradation.

Table 1: The economic progress of nations

	% Annual growth rate 1970–2000					
Country	I/Y (%) [*]	Population	TFP [†]	Productive base (per head)	GDP (per head)	Δ HDI ^{††}
Bangladesh	7.1	2.2	0.7	0.1	1.9	+
India	9.5	2.0	0.6	0.4	3.0	+
Nepal	13.3	2.2	0.5	0.6	1.9	+
Pakistan	8.8	2.7	0.4	−0.7	2.2	+

The first column the estimates of average inclusive investment as a proportion of GDP, expressed as percentages. The second column gives the average annual population growth rate. The third column gives estimates of annual growth rates of total factor productivity, which we are interpreting here as the annual percentage rate of change in a combined index of knowledge and institutions. The figures in the first three columns have been used to estimate the annual percentage rate of change in the productive base per capita, given in the fourth column.

**Inclusive investment as a share of GDP (average over 1970–2000); †total factor productivity; ††change in HDI between 1970 and 2000.*

Source: Dasgupta 2007

The remaining part of this chapter is organized as follows: Section II and III describe the concepts of poverty and well-being, and ecosystems and their services respectively. Section IV discusses the extent of the dependence of the poor on ecosystem services. Section V explains the links between poverty and environmental degradation and highlights the causes of environmental degradation. Section VI discusses the issues of considering the ecosystems as natural capital and the role of local institutions in preventing the degradation of ecosystems and alleviating poverty.

II. Defining Poverty and Well-being

Conventionally poverty is defined on the basis of household income or consumption, people are considered poor if their level of consumption falls below a given poverty line. Poverty is measured either as a minimum flow of real income per capita, or as a bundle of 'basic needs', which may be quantified. These single dimension based definitions of poverty fail to take into consideration the multi-dimension nature of well-being; well-being and the poverty are the two extreme of a multidimensional continuum. The World Development Report 2000-01 defined poverty as "the pronounced deprivation of well-being" (World Bank 2001). Well-being depends on basic material needs of a good life, experience of freedom, personal security and good social relations. Moreover, the expression or experience of well-being or poverty depends on context and situation, reflecting local physical, social, and personal factors such as geography, environment, age, gender, and culture (MA, 2005).

The Human Development Index (HDI) draws on a bundle of indicators referring to general standards of health, education, and wealth, which may be used to indicate general levels of development (Ravallion, 1992; Reardon and Vosti, 1995). The HDI types of measures of poverty are aggregate measures and suffer from a number of weaknesses. These measures are based on arbitrary selection of components and their weights. They are being aggregative, may hide small-scale variations that may have significant implications for certain social groups. Moreover, they may not provide policymakers with sufficient guidance for specific local problems (Lipton, 1991). The processes of impoverishment need to be disaggregated to show such differences as well as those linked to particular ecological conditions or diminished access to key environmental goods or services (Forsyth and Leach, 1998).

The income/consumption-based definitions of poverty or aggregate measures such as HDI do not include the factors like vulnerability, physical weakness and powerlessness, which may be interlinked and mutually enforcing. Vulnerability raises the importance of net asset position rather than flows of income, and of shocks (short-term impacts) rather than stresses (longer-term threats to income) (Chambers, 1983). The concept of vulnerability is of central importance in notions of livelihood, and where environmental resources may take on particular importance as security. Moreover, the conventional measures of poverty fail to take into account the people's (especially poor's) gain from public assets.

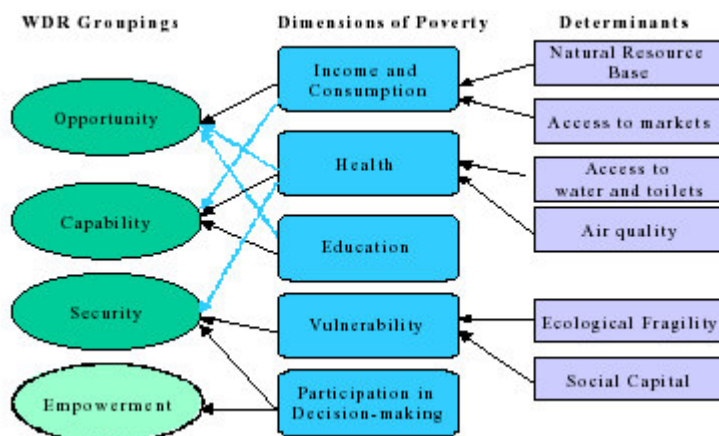
The 'asset vulnerability framework' groups these various dimension of poverty and includes labor, human capital (health and education), household assets (such as housing), household relations (mechanisms for pooling income and sharing consumption within the household) and social capital (potential for reciprocity within communities and between households) (Moser 1998). Other authors mention "geographic capital" to capture the evidence that certain geographic areas are persistently poor (Ravallion 1996).

The recent research considers poverty as a process rather than as a state and considers entitlement as a tool for reducing the poverty. Process-based conceptualizations also emphasize the roles of institutions in shaping outcomes (Forsyth and Leach, 1998). Much work on food security, following Sen, has focused attention on formal legal institutions and the role of the market in shaping well-being. In contrast, others have emphasized the importance of informal institutions such as kinship networks in guaranteeing well-being (e.g. Swift 1989).

Entitlements-based approaches have figured with specific reference to food security and the processes by which people's food entitlements (through exchange, production or other means) may decline or fail (e.g. Sen 1981), or with reference to other notions of vulnerability, and the experiences of particular social groups (e.g. Kabeer 1994).

The World Development Report 2000-01 groups the different dimensions of poverty as opportunity, empowerment, and security. Figure 1 shows how different factors or determinants can influence different dimensions of poverty, affecting people's opportunity, capability, security, and empowerment in many different ways.

Figure 1: Schematic representation of dimensions of poverty



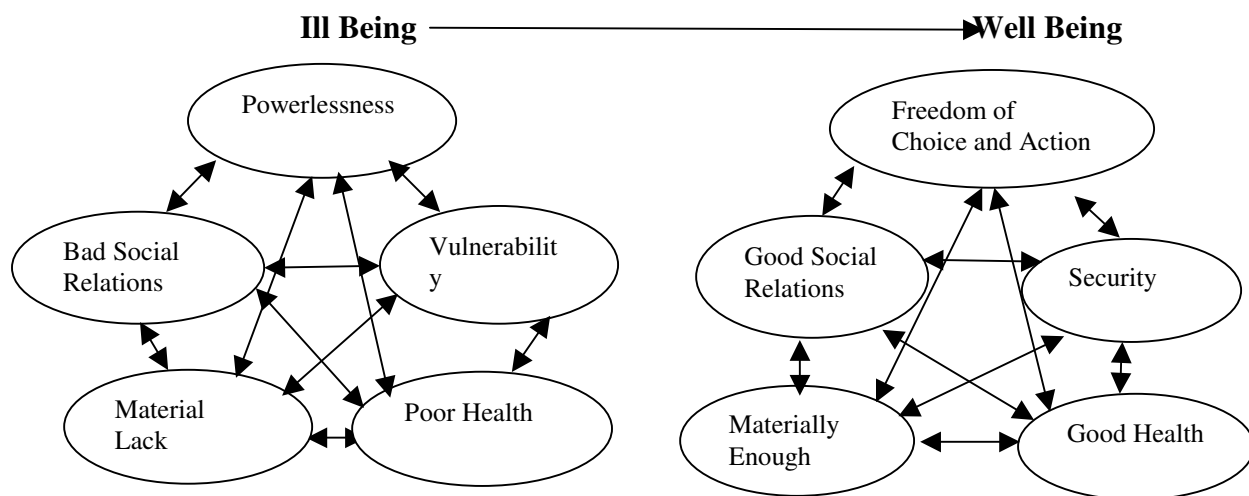
Source: Bucknall et al., 2000

Subjective assessments of well-being can highlight the significance of key environmental endowments and entitlements which conventional definitions of poverty might have overlooked. The 'Voices of the Poor' project (Narayan et al., 1999, 2000) shows the concepts of well-being and poverty are complex and value laden. In this project the people in 23 countries were asked to reflect, analyze and express their ideas about the good and the bad life. The project indicated five interlinked components of well-being:

- the necessary material for a good life (including secure and adequate livelihoods, income and assets, enough food at all times, shelter, furniture, clothing, and access to goods);
- health (including being strong, feeling well, and having a healthy physical environment);
- good social relations (including social cohesion, mutual respect, good gender and family relations, and the ability to help others and provide for children);
- security (including secure access to natural and other resources, safety of person and possessions, and living in a predictable and controllable environment with security from natural and human-made disasters); and
- freedom and choice (including having control over what happens and being able to achieve what a person values doing or being).

All the five dimensions of well-being or ill-being are interdependent on each other either positively or negatively (Figure 2). The objective of the public policy should be the enhancement of well-being, i.e., transition of those who are deprived, from the conditions of ill being to well-being. Thus, the poverty can be said to be a function of individual characteristics (such as age, gender, ethnicity), household characteristics (dependency ratio, number of adults), asset endowments: natural, human, physical, financial, and social capital, and the productivity of asset endowments. Generally the productivity of the assets owned by the poor people is low. The reason behind the low productivity of the assets can be attributed to the factors such as market failures, institutional gaps, public goods deficits and unfavorable public policies (Dasgupta, 1998).

Figure 2: The main dimensions of Ill-being and its obverse, Well-being



Source: MA, 2005

III. Dependence of the Poor on Ecosystem Services

In South Asia, nearly 70% population lives in rural areas (World Bank, 2004). Many rural poor households rely directly on ecosystems for food, fuel and fresh water. Also, loss of ecosystem functions could result in the reduced supply of these goods in the market resulting in the rising of market prices. Therefore, poor are affected from the degradation of ecosystems on both counts: reduced direct access for food and fuel from the ecosystems and unaffordable market prices.

The poor are more vulnerable to the loss of ecosystems functions restricting the supply of public good type of services. The burden of diseases from air and water pollution, property damages and loss of life from floods and changes in climatic patterns will be more on poor than on rich.

The experience in South Asia shows that poor could not afford to adopt coping up strategies by spending on mitigation and defensive activities for minimizing the damages from the environmental degradation.

There is an asymmetry in the distribution of benefits (damages) from the ecological conservation (degradation) between the rich and the poor. The rich benefit more than poor from the ecological conservation while the poor suffer more damages than the rich from the degradation. The well being of poor in terms of their accessibility to basic necessities like food, fuel, fiber and shelter and the non-vulnerability to the disease and death is directly linked to the ecosystem services.

Recognizing the dependence of rural populations for their livelihood on ecosystem services has raised the policy relevant question whether protecting the ecosystems from further degradation can help in poverty alleviation in developing countries. Researchers have tried to quantify the dependence on ecosystem services of rural households with varying levels of income, where dependence is usually defined as the share of overall income derived from natural-resource use or time spend on collecting the products from the adjacent ecosystems.

In South Asian countries, households are directly much more dependent on the local resource base. Jodha (1986), based on data from 502 households in 21 Indian villages, finds that poor rural households derive on average between 9% and 26% of their annual income from common-property natural resources, while (relatively) rich households derive only between 1% and 4% of their annual income from the commons. Similarly, Reddy and Chakravarty (1999), based on data from 232 households in 12 Himalayan villages, observe that dependence on resources decreases from 23% for the poor to 4% for the rich. However, Adhikari (2005), based on data from 330 households in 8 “forest user groups” in Nepal, finds that dependence increases with income, from 14% for the poor to 22% for the rich. Moreover, these studies also examine the relationship between income and the absolute level of resource use. Jodha finds that use decreases with income, Reddy and Chakravarty find an initial slight increase followed by a decrease, and Adhikari find an increase throughout.

Jodha (1986) suggests three specific reasons for explaining the dependence of poor households on natural resources: (1) substitutability between natural resource and private assets. The poor people acquire fuel and fodder from the common lands since they can not collect these services from the private lands; (2) the poor people have only one asset which is their labour time and it is in surplus, and collection of fuel and fodder is usually labour intensive activity; and (3) the activities of collecting fuel and folder from natural resources are generally not very attractive in terms of returns.

A recent study by Narain et al. (2007), based on data from 535 households in 60 Indian villages, also examine the relationship between rural household incomes and natural resources in a greater detail. By collecting data on village-level biomass availability, this study examines the impact of changes in biomass on resource use and dependence at different income levels. This study find that, i) the U-shaped relationship between dependence and income for the subsample of 399 collecting households and ii) the inversely U-shaped probability of being in that subsample—results in a declining relationship of dependence with income for the sample as a whole, i.e., for the 535 collecting and non-collecting households combined. Moreover, it also

examine the relationship between availability of biomass and the dependence. It finds that overall resource use and dependence increases with overall biomass availability for all households, at all levels of income. From the policy perspective this study also concurs with the observations of Jodha (1986). The study also finds that, except in the case of particularly rich households, there is no substitutability between private assets and common-pool resources, the private asset of livestock in fact complements common resources. This also suggests that improvements in the quality of ecosystems have the potential to benefit all sections of rural populations.

All the above-mentioned studies show the dependence of the poor on ecosystem services and suggest improvement in the quality of ecosystems have potential for reducing the poverty. These studies are concerned only with the provision services of ecosystems. Ecosystems also provide other services such as hydrological control, regulation of the microclimate, and waste assimilation, which are even of more importance for the well being of the people living there.

Poor people use natural resources directly for food and other subsistence needs and are dependent upon environment for income generation. Environmental degradation reduces the stock of natural capital and limits or denies the poor their income generation capability and in turn makes them more dependent on environment.

Environmental degradation raises the risk of natural hazards and extreme events which in turn affects the poor more adversely. Poor have less coping capacity, adaptation capability and resilience as compared to non-poor to deal with natural hazards. For example degradation of ecosystems increases exposure to floods, storms, and impact poor directly. Similarly, decline in soil organic matters reduces retention of soil moisture, therefore, requires more irrigation, affects agricultural production, and impact the income of the poor.

Environmental or ecological conditions directly impact health of the people in the ecosystem. There is a direct relationship between many diseases and ecological conditions. A direct causality has been established between malaria –or “man-made malaria” as specialists call it –and deteriorating ecosystems. The disease is known to flare up in ecological systems which have their regulation component altered by irrigation projects, dams, construction sites, standing water, poorly drained areas. Ecological damage has been found to be the cause of increasing prevalence of diseases in many developing countries (Duraiappa, 2004).

Similarly air pollution, water pollution is the cause of many illnesses and affects poor people more adversely. Poor people because of lack of resources live in areas with higher than average air pollution, toxicity. The low level of nutrition and inadequate health care make them more prone to diseases as compared to non-poor. At the same time poor lack any skills and their livelihood is dependent upon their capability to do manual work. Poverty prevents people from getting adequate health care and cure fully from any illness in a short time and hence it reduces their ability to work and earn. As a result throws them in the poverty trap. This in turn makes them more dependent on ecosystem for subsistence needs and livelihood. Global warming and deforestation are expected to contribute to an additional 50-80 million malaria cases per year by 2100 (Donhoe, 2003). Ettling et al report that the direct and indirect costs from malaria consume approximately 33% of the household income of the poor as compared to 4.2% for the rich (Duraiappa, 2004).

Environmental degradation increases the scarcity of natural resources and increases the cost of production of such goods. For example deforestation results in less firewood available, thus

increases time required to fetch the same amount of wood (cost of energy). Over-extraction from aquifers or of ground water increases the time required to fetch water (cost of water).

The poor, however, derive their sustenance and livelihoods from healthy ecosystems such as grasslands, forests, and cropland. Why do they degrade the very assets that are the source of their own present and future incomes? Does their poverty make them barter the future for the present? Studies in the past decade from many parts of the developing world show that this usually happens when local social institutions that govern the use of “the commons” break down (Chopra et al. 1990). This may be due to the operation of a combination of factors, including commercialization, population pressure, and bad governance. When appropriate sets of property rights are put in force, the process can be contained.

IV. Protecting Ecosystems for Alleviating Poverty

Increased recognition that rural households in South Asia and Africa depend significantly on ecosystem services for their livelihoods has led to a perception that ecosystems in effect serve as a public asset for poor households, substituting for the private assets (land, livestock, farm capital, human capital, financial wealth) that they lack. This, in turn, has raised the policy question of whether improved natural resource management can form the basis of poverty alleviation policies. Attempts to answer this question have given rise to a growing literature on poverty-environment interactions (for reviews, see Reardon and Vosti, 1995, Duraipappah, 1998 etc).

Poverty induces people to focus their attention on satisfying immediate needs rather than achieving future security in resources.

The poor living at the subsistence level choose projects or investments with low risk and hence, with low return. Because in case of loss in a high risk (hence, high return) project, there is threat to their survival and meeting of subsistence needs. Poor lack surplus funds for investment, and prefer not to invest on conservation, and as a result the stock of environmental resources does not increase. This combination of risk aversion, low investment on conservation of resources again induces high discount rate for the poor.

V. Concluding Remarks

In the South Asia, poverty and environmental degradation co-exist, i.e., environmental degradation is found more in those areas where the poor live. Various reasons were cited in the previous sections for the co-existence and need is to reverse the trend which may be done through different routes, but the two are of worth mentioning. First, considering the ecosystems as capital infrastructure. Second, the imprudent use of ecosystems can be prevented by empowering local people and preventing the degradation of local institutions.

Ecosystems as Capital Infrastructure

The extraction of natural resources is accounted for their value if the marketed price of these resources reflects their scarcity value. But the market prices of these resources are generally non-existent and therefore these resources are used more than their socially optimal quantity. This excessive use of natural resources in human use results in the problems such as deforestation, depletion of natural resources, depletion of underground water tables etc.

Moreover, during the production of marketed commodities, the non-marketed outputs such as air, water and land pollutants are produced. Alternatively one can say that during the production process we use sink facilities of the environment. If the release of these pollutants is beyond a certain limit fixed by the carrying capacity of the environment, it leads to degradation of environment.

It should be recognized that there is limited substitutability between different factors of production. In the absence of ecosystems capital we cannot produce the goods and services that produces human welfare, i.e., the level of human welfare would be zero in the absence of natural capital. Moreover, it should also be recognized that natural capital is a dynamic factor of production possessing discontinuities and thresholds implying that the ecological system is not a fixed stock that generates a flow of renewable resources infinitely or in a linear fashion.

The significance and value of the ecosystems and their dynamics as capital infrastructure has received little attention in economics. Capital, in general is defined as the stock of material or information at a point of time and it generates a flow of services, either autonomously or used in combination of other factors of production, to transform materials. Ecosystem services are the flow of services from the ecosystems which help in enhancing human welfare when used in combination of the services of manufactured and human capital, i.e., the ecosystems can be considered as capital stock like manufactured or human capital. Moreover, there are many trade-offs in the use of ecosystem services and to resolve these tradeoffs, Daily (1999) suggests for consideration of ecosystems as capital assets so that a sustainable yield can be obtained from these resources.

The ways in which the ecosystems can enter into the production processes are potentially quite varied. Ecosystems influence the produced output by changing the productivity of other factor inputs, by altering output that has been produced, or by reducing the effective supply of other factor inputs.

Murty and Kumar (2006) in a study of Indian manufacturing industries find that the use of natural environment as factor input has positive marginal productivity and it contributes positively to the production of marketed outputs. Similarly in another study, Richmond et al (2007) find that ecosystems services contribute positively in the production of GDP. They use net primary product as a proxy for the ecosystem services.

In the production processes, the original capital stock may or may not remain intact, i.e., the capital stocks may depreciate during the production. If the capital stock is depreciating, to keep the output intact or for increasing the level of output, it is necessary to keep investing in the capital stock.

Chichilnisky and Heal (1998) provides the best-case favouring investment in natural capital rather than in physical capital on economic grounds. In 1996, the city of New York was faced with the choice of restoring the integrity of the Catskill ecosystems to restore natural water purification services through investing about \$1 billion - \$1.5 billion in natural capital or of building a filtration plant at a capital cost of \$6 billion-\$8 billion, plus running costs of the order of \$300 million annually. The city invested in natural capital with the expectations of getting an internal rate of return of 90-170% in a payback period of 4-7 years which is an order of magnitude higher than is usually available, particularly on relatively risk-free investments. These calculations are conservative, as they consider only one watershed service, though these ecosystems provide many other ecosystem services.

Chichilnisky and Heal (1998) provide many examples that show that the returns from investing in natural capital are higher than investing in physical capital, and for certain types of ecosystem services securitization are possibility. The securitization helps in realizing the economic value of ecosystems and provides enough incentives for their conservation. Securitization can take many forms and compensations for conservation of ecosystems to the natives (who are generally poor) helps in reducing the poverty.

Role of Institutions and Common Property Resources

The conventional economics literature cites the free riding as the cause of the degradation of natural resources (e.g., Hardin, 1968). This may be true in the context of open access resources but it is not true in the context of common property resources. In the common property resources the group of users is generally well defined and these resources can, in principle, be managed efficiently by the users themselves and there is no need of state intervention or privatization of the resources, and it is lack of incentives that prompt the poor to over use the resource base (Dasgupta, 1998).

The poor have fewer incentives for conservation of resources due to institutional failures. Dasgupta (1998) cites various reasons for the breakdown of institutions. The political economy reasons which favour modern resource intensives technologies, insecure property rights, breakdown of communication norms, increasing populations, ineffective public policies, predatory governments and thieving aristocracies. The failure of institutions can be corrected by giving an appropriate fraction of the rents earned through the extraction of ecosystem services to the customary users of these resources.

It is not always true that poor are unaware or careless about environmental degradation. There are several instances when poor have come to the forefront for protection of the environment. One such example is the Chipko movement where the a group of peasants in the Uttaranchal of India acted to prevent the felling of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department.

Duraiappah (2004) favours providing various kind of freedoms for changing the existence of poverty and environmental degradation conundrum; economic facilities, social opportunities, transparency guarantees, ecological security, protective security, and participative freedom.

Ecological security ensures the provision of ecological safety nets to individuals who depend on ecosystem services. It asks for establishing formal institutions, building capacities among the local communities, which can protect and ensure fair distribution of the safety nets established by the communities themselves. Ecological security also requires coherence among multilateral environmental agreements with national and local environmental policies

Environmental protection and conservation policies and investment should be made at the local, national and global level. Traditional technologies and traditional knowledge should be encourages for conservation and management (agro forestry, traditional farming, natural fertilizers and pesticides). The poor should be provided required know-how and technology for income generation with environmental protection and conservation that can pull them out of poverty and at the same time protect the environment. Involving participation of the poor in resource management like common property resources makes them responsible and interested in protection of environment.

To prevent the degradation of ecosystems and to alleviate poverty it is not only essential to correct the market failures related to credits and insurances through providing access to credits to the poor, but also to find an institutional mechanism which can protect the ecosystems without compromising the efficiency of these markets.

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What are ecosystems and their services? – a discussion paper

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1. Ecosystems and ecosystem services

1.1 The definition of an *ecosystem* as “a dynamic complex of plant, animal and microorganism communities and their nonliving environment interacting as a functional unit” was adopted for use by the Millennium Ecosystem Assessment (MEA, 2003) following the Convention on Biological Diversity, (UN 1992). Historically, the definition of this term has evolved from a physical entity (Tansley’s (1935) ‘unit of vegetation interacting with its environment’) through to the concept of a system characterized by flows (e.g. energy, molecules, genes) with system properties such as resilience and stability (Odum 1969). For many authors the term remains a conceptualization as opposed to a factual entity. Indeed because the MEA definition does not lend itself easily to usage, for instance either in the physical mapping of ecosystems (Mace, Masundire et al. 2005) or to measures and indicators of their function and value (Carpenter, DeFries et al. 2006).

1.2 In contrast, the term *ecosystem services*, introduced in 1970 by Holdren and Ehrlich in the sense of the ‘public service function of the global environment’ and adopted by the MEA, identifies planetary resources derived from, and through, the presence of biodiversity, that have fuelled civilization and on which humanity depends.

1.2.1 The MEA classified ecosystem services into four categories :

- Firstly, the provisioning function of ecosystems that supply goods and services that sustain various aspects of human well-being; for instance provisioning services that generate goods as food, fiber, and other products, shortage of which have adverse effects on human well-being, via both direct and indirect pathways.
- Second, the regulating functions of ecosystems that affect human well-being in multiple ways. These include the purification of air, fresh water, reduced risk of flooding or drought, stabilization of local and regional climate, and checks and balances that control the range and transmission of certain diseases, including some that are vector-borne. Changes to an ecosystem’s regulatory function may have consequences for human health and other components of well-being.
- Third, the cultural services which are provided by the ecosystems that influence human experience in terms of aesthetic, recreational, educational, cultural, and spiritual aspects of life. These include totemic species, sacred groves, trees, scenic landscapes, geological formations, or rivers and lakes. Any change in ecosystems, through processes of disruption, contamination,

depletion, and extinction, therefore has negative impacts on cultural life and human experience.

- Fourth, the supporting services that are essential for sustaining each of the other three other services. Hence there is an inherent indirect linkage between supporting services and human well-being.

1.3 The MEA has led to considerable debate over methods of valuation of ecosystem services and indeed these services are so interlinked that any classification of them is somewhat arbitrary. Boyd and Banzhaf (2006) have pointed to the diversity of definition of ecosystem services (e.g. Daily, 1997; Costanza, d'Arge et al., 1997; Ekins, 2003; MEA, 2003) and the current lack of a commonly agreed definition. Such terms as ecosystem / ecological and goods / services are sometimes used as synonyms in combination (e.g. de Groot 1992; Costanza et al., 1997; Daily, 1997). The difficulties in defining and valuing ecosystem goods and services (Boyd and Banzhaf, 2006; Hartje, Klaphake et al., 2003) are not only compounded by what constitutes an ecosystem in terms of ecological structures and functions but also by what features of the system that stakeholder groups (scientists, managers, policy makers, public bodies, interest groups) consider are relevant. However as Potschin and Haines-Young, (2007) following Maltby (1999) argue, the benefit of adopting a 'goods and services' approach is that it can focus definition on the operational unit represented by 'the ecosystem' and help to structure discussion about the multiple objectives of ecosystem management, otherwise known as the Ecosystem Approach, (Maltby 2000).

1.4 The Ecosystem Approach is increasingly been adopted by governments and scientific institutions (Kline, 2006; DEFRA, 2007; Proctor, Cork et al. 2002) as a platform from which to :

- identify researchable issues in terms of measurable entities and valuation of ecosystem services;
- assess trade-offs amongst suites of goods and services resulting from management interventions; and
- ensure a mechanism for wide stakeholder engagement in terms of evaluation of sectoral interest and priority setting.

2.0 Biodiversity

2.1 Biodiversity both within and between ecosystems is fundamental to ecosystem functioning and hence to the delivery of all of the MEA ecosystem services. Biotic factors, in particular species abundance, distribution, spatial and temporal dynamics, and functional variation within and amongst communities and across

food chains, determine the magnitude and variability of ecosystem processes, such as biomass production or decomposition.

2.2 In the wider context of climate and geophysical constraints, these biotic factors determine the structure of characteristic biomes¹⁷ such as grasslands, savanna, forests and aquatic systems.

2.3 Where anthropogenic disturbance has occurred, biomes are typically fragmented in the landscape and comprise different terrestrial and aquatic biotic communities often dominated by particular vegetation. In the literature these are often referred to as *habitats* for instance forest, swamp, rice field habitats. The size and stability of these habitats depends on amongst others, the metapopulation dynamics of individual species, scale-dependent biotic community dynamics, succession and ecological responses to disturbance. Ecosystems as defined by the MEA do not simply lend themselves to geospatial analysis.

2.4 Despite the inherently intrinsic linkage between biodiversity and ecosystem services and the fact that ecosystem services are often mentioned in conservation assessments, services themselves have rarely been critically assessed in such assessments (Benis, Mathieu et al. 2007). Moreover whilst a range of biodiversity indices have been developed and applied, there is no common index or set of indices which have been applied over large geographic regions in a manner that enables regional assessment of biodiversity directly.

3.0 Linkage of ecosystem services and poverty alleviation

3.1 The distinction between assets, goods and services (Haines-Young and Potschin, 2007) is key to both the social and economic assessment of ecosystem services, but is also dependent on stakeholder perspectives (Boyd and Banzhaf, 2006).

3.2 Following these authors, for this situation analysis we have adopted the following definition of ecosystem services : 'ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being' (Boyd and Banzhaf 2006). This definition makes the distinction between consumptive goods on the hand and services on the other that can be considered in terms of transformations of energy and mass.

¹⁷ Large groupings in the flora and fauna of the world, distributed with respect to temperature and precipitation (Whittaker, 1975; Begon et al, 1990)

In this regard, three types of transformation (Figure 1., following Cork, Shelton et al. 2001) which map to the interlinked categories of ecosystem service identified in the MEA, allows the flow of ecosystem goods and services to be operationalised into :

- 1) transformations of natural assets into products valued economically and in other ways by people in an area (exploitable 'natural' products); - provisioning *sensu* MEA;
- 2) transformations of the by-products of goods from ecosystem services back into natural assets;- sustaining *sensu* MEA;
- 3) internal transformations among natural assets to maintain those assets;- regulating *sensu* MEA.

The use of this approach allows:

- 1) the distinction between natural assets and consumptive/exploitable goods, e.g. self sustaining forests which support harvestable timber. Goods may or may not be privatized.
- 2) the distinction between natural assets and the services that regulate and maintain those assets. Services may be inherent to a particular biotic community, as evidenced by predator-prey relationships in complex invertebrate communities that result in pest control; or operate at a landscape level for example where upland forests regulate water cycling in a river catchment and reduce flooding risk in lower reaches of the catchment.
- 3) the potential to experimentally measure the services (as transformations, or flows), the goods as market valued products, and the asset stock.
- 4) common consideration of ecosystem goods and services at different spatial scales.

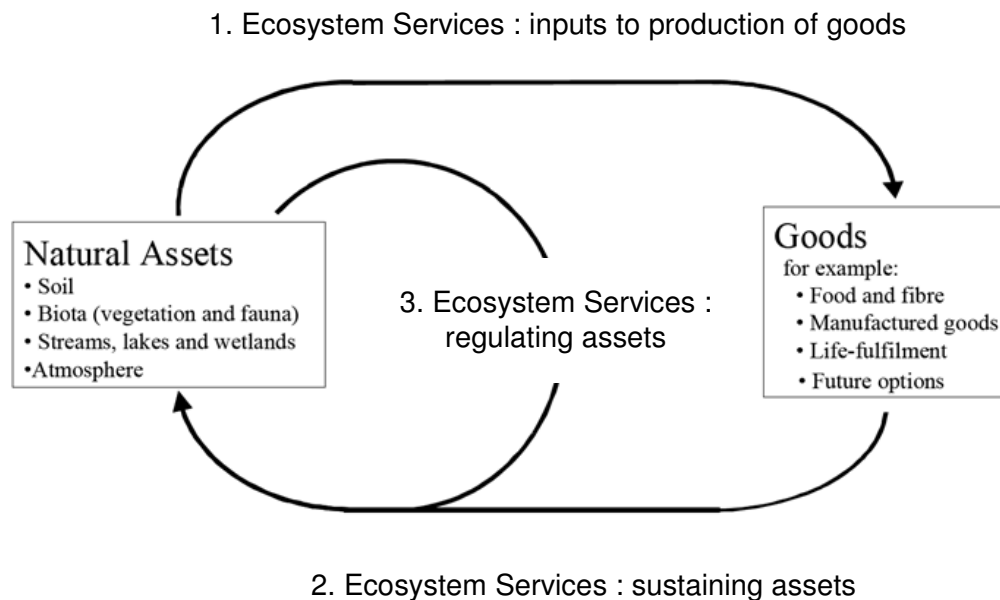


Figure 1. A conceptual framework defining ecosystem services in terms of three types of transformations (see text for details). Following Cork et al. 2001.

3.3 The multi-dimensional nature of poverty requires the linkage between poverty alleviation and ecosystem services to be approached in a number of ways.

3.3.1 Taking a sustainable livelihoods approach (DfID, 1999), the predominantly sedentary rural community poor may depend upon goods and services provided simultaneously from several biotic communities within the landscape. For example freshwater and forest communities may provide different seasonal contributions (fish and fuel) to livelihood. In this context the assessment of ecosystem services at the landscape level is important because changes at this level may impact on goods and services in relation to existing structural habitat diversity and its vulnerability and resilience to changes resulting from both direct and indirect drivers.

3.3.2 Measuring poverty by agglomerative indices (Coudouel et al, 2002) and linkage to individual limiting resources essential to human well-being (Sullivan, 2002) is an alternative approach (Sullivan and Meigh, 2007). See also Chapter 3.

3.3 In this situation analysis (SA) the term *landscape* provides an operational definition of a land surface providing ecosystem goods and services (Table 2). It may be either natural or derived and maintained by anthropogenic processes (e.g. agricultural landscapes) and may comprise several habitats (sensu 2.3).

4.0 Approach

4.1 For the purposes of the SA, we will :

- a) Identify characteristic landscapes as defined above in the region (Table 1)
- b) Identify where possible the extent to which poverty (income of < \$1 per day per capita) is associated with particular landscapes, by mapping.
- c) Examine the ecosystem goods and services provided within selected landscapes (Table 2) and the reliance based upon them by the poor, through available case history analysis.
- d) Evaluate the linkages of ecosystem services at local, subregional and regional levels
- e) Evaluate direct and indirect drivers of change in ecosystem services
- f) Identify the opportunities for poverty alleviation through improvement/protection of ecosystem services by policy interventions.

Table 1. Poverty mapping by landscape at the country level (illustrative approach).

Location	Type of Landscape	% area in country	% of poor	Land cover categories %
				(see example below)
Coastal	Mangrove swamps			
	Estuaries / Deltas			
Terrestrial	Uplands - forested			
	Uplands - deforested			
	Cropped rainfed lowlands			Secondary forest x%; grassland %, arable land %
	Cropped irrigated lowlands			
	Arid lands			
	Wetlands - riverine			
	Wetlands - lake			

Table 2. Illustrative goods and services (Figure 1) in relation to landscapes that will be assessed by case study analysis. Interconnectivity and scale dependency amongst landscapes (e.g. Forested uplands, irrigated lowlands and mangroves) will be evaluated through individual service components.

Ecosystem service component	Goods or Service	Mangrove	Estuaries Deltas	Forested Uplands	Deforested Uplands	Cropped Irrigated Lowlands	Cropped Rainfed Lowlands	Arid Lands	Riverine Wetlands	Lake wetlands
Sustaining Services	Oxygen Production	●		●					●	●
	Nutrient Cycling and Soil Health	●	●	●		●	●		●	●
	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	●	●	●						●
	Maintenance of surface water stores			●						●
	Groundwater replenishment			●						●
	Crop Pest regulation								●	
	Human Disease Regulation								□	□
Cultural Services	Paleo-environmental records	●	●							
	Archaeological Preservation									
	Recreation and Ecotourism	●	●	●					●	●
	Physical health and well being					●	●		●	●
	Spiritual and religious values			●					●	●

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How is ecosystem valuation relevant for policy making?

Pushpam Kumar

10.1 Rationale: Management of ecosystem services is a priority matter given that their provision by natural ecosystems worldwide is declining, due to human interventions. For example, more land was converted to cropland since 1945 than in the 18th and 19th centuries combined; 25% of the world's coral reefs were badly degraded or destroyed in the last decades; 35% of mangrove area has been lost in this time; the amount of water in reservoirs quadrupled since 1960 and withdrawals from rivers and lakes doubled since 1960 (MA, 2005). Valuation of ecosystem services has been sought as effective tools that enable the decision makers in designing the cost effective response policies for management of ecosystems towards alleviating the poverty especially in economically poor region like South Asia.

The unique feature of most of the services emanating from ecosystems is that they although acknowledged by people, is unaccounted, unpriced and therefore remains outside the domain of the market. Such problems are treated as externalities where market fails, and decision makers try to correct the market failure by creating market like situation. Subsequently they obtain the value of services through various valuation techniques based on stated preference of the people. In case of regulating services of ecosystem like climate regulation, waste treatment capacity, nutrient management and various watershed functions, classic situations of market failure appears. The missing market for the ecosystem services adds to the problem because most of the vulnerable section of society in Bangladesh, Bhutan, India, Nepal and Pakistan depends upon those services directly or indirectly for their livelihood. Therefore, any decision proves to be inefficient and infeasible from social perspective causing problem for sustainability and human well-being. In recent years, there have been added focuses on creating a situation where market can be created and a desired outcome can be achieved in of terms implications of different decisions culminating through the impact on ecosystems and in turn human well being.

10.2 Ecosystems, Economic Values and Valuation Techniques

All ecosystems whether it is forest, wetlands, mountain, coastal, marine or desert are like any capital stock. They through their ecological production function analogous to engineering production function in production economics, provide ecosystem services. Forest providing the ground water augmentation and carbon sequestration, wetlands providing the bioremediation and water storage function, mountain yielding hydrological services are some of the examples of ecological services which are beneficial to the society through enabling of production and consumption processes. Various market and non market based valuation methods capture the ecological services in monetary terms enabling them to be incorporated in the box –'values'. There are direct benefits of ecosystems known as intrinsic values or bequest values they directly enter into the 'values' box. Formation of values will be influenced by how robust and accurate the valuation methodologies are in capturing the services from the ecological production functions. Values in turn, would determine the human choices (Kumar and Kumar, 2007). For example, decision making criteria like costs benefits or multi criteria method

would depend upon the values arrived through the valuation methods. These decision making criteria would influence the choice which subsequently would impact the condition and trend of the ecosystem in consideration. Here it is very clear that value determine the human choice and the human choice would determine the fate of ecosystem and their services. A chain thus gets established. Valuation of ecosystem plays a pivotal role in the designing the appropriate response option.

10.3 Underlying assumptions in valuation of ecosystem services: In valuation of ecosystem services, the utility that an individual derives from a given ecosystem service is assumed to be dependent upon that individual's preferences. The utilitarian approach, therefore, bases its notion of value on attempts to measure the specific utility that individual or the society derive from a given service, and then aggregates across all individuals, weighting them all equally.

Utility cannot be measured directly. In order to provide a common metric in which to express the benefits of diverse services provided by ecosystems, the utilitarian approach usually attempts to measure all services in monetary terms. This is purely a matter of convenience, in that it uses units that are widely recognized, saves the effort of having to convert values already expressed in monetary terms into some other unit, and facilitates comparison with other activities that also contribute to societal well being. It explicitly does not mean that only services that generate monetary benefits are taken into consideration in the valuation process. On the contrary, practically all work on valuation of environmental and natural resources has been, in essence, to find ways to measure benefits which do not enter markets and so have no directly observable monetary benefits.

The issue of valuation is inseparable from the choices and decisions we have to make about ecological systems. There are some views advocating that valuation of ecosystems is either impossible or unwise, that we can't place a value on such "intangibles" or long-term ecological benefits. Valuation of ecosystems services are not out of luxurious and leisurely activities, it is under dire need for coming out with efficient choice bettering off the state of ecosystems and people dependent upon it. Invariably, the valuation of ecological system is done when decision makers are confronted with the situation of trade off, and competing resources. Valuation has a limited objective to achieve and it will be pity if the exercise of valuation is thrown to the dilemma of ethics, intergenerational / intra-generational equity and other value loaded issues of philosophy and ethics.

10.4 Major valuation methodologies: While ecosystem valuation is certainly difficult, the one choice we do not have is whether or not to do it. The valuations are simply the relative weights given to the various aspects of the decision-making problem. When we value the services of ecosystems and decision-makers take these values into account when making policies, a framework for distinguishing and grouping these values is also required. The concept of Total Economic Value (TEV) provides one such framework and there is an increasing consensus that it is the most appropriate framework to use. Total economic valuation distinguishes between use values and non-use values, the latter referring to those current or future (potential) values that are unrelated to use (Pearce and Warford, 1993). Typically, use values involve some human 'interaction' with the resource whereas non-use values do not. Use values are grouped according to whether they are direct or indirect. Former refers to those uses, which are most familiar to us. Harvesting of fish, collection of fuel wood and use of the wetlands are examples which could involve both commercial and non-commercial activities, with some of the latter being important for the subsistence needs of local populations in developing countries. Commercial uses may be important for both domestic and international markets. In general, the value of marketed products (and services) of different ecosystems is easier to measure than the value of non-commercial and subsistence direct uses. As noted above, this is one reason why policy makers often fail to consider these non-marketed uses of ecosystems in many

development decisions. A special category of value is option value, which arises because an individual may be uncertain about his or her future demand for a resource and/or the availability of its services in the future. In most cases, the preferred approach for incorporating option values into the analysis is through determining the difference between ex ante and ex post valuation. If an individual is uncertain about the future value of a service, but believes it may be high or that current exploitation and conversion may be irreversible, then there may be quasi-option value derived from delaying the development activities. Quasi-option value is simply the expected value of the information derived from delaying the use of services today. In contrast, however, there are individuals who do not currently make use of the ecosystem services but nevertheless wish to see them conserved 'in their own right'. Such an 'intrinsic' value is often referred to as existence value. It is a form of non-use value that is extremely difficult to measure, as existence value involves subjective valuations by individuals unrelated to their own or others' use, whether current or future. An important subset of non-use or preservation values is bequest value, which results from individuals placing a high value on the conservation of any ecosystem for instance tropical wetlands for future generations to use. Bequest values may be particularly high among the local populations currently using a wetland, in that they would like to see the wetland and their way of life that has evolved in conjugation with it passed on to their heirs and future generations in general.

The non-existence of markets for many biological resources and the public good nature of ecosystems make the valuation far from trivial. These issues imply that the social value of biological resources can't be derived from simple aggregation of their values to individuals in society. A possible summary of the valuation techniques would look like the following¹⁸:

Table 10.1: Scope of using economic valuation methods			
Valuation method	Affected population captured	Value basis	Natural environment / ecosystem service
Market price proxies	Users only	TEV – use values	Marketed products from the natural environment or their market substitutes; all ecosystem services but limited to their contribution to marketed products (e.g. agriculture, forestry, fisheries, genetic information); estimating avoided damage (e.g. from flooding, coastal erosion); their marketed substitutes (e.g. cost of coastal defense, cost of water treatment) and tangible impacts (e.g. cost of illness)
Revealed preference methods			
Hedonic property pricing	Users only	TEV – use values	Landscape, amenities, air quality, peace and quiet, and hence all ecosystem services that provide these
Travel cost	Users only	TEV – use values	Recreation and all hence all ecosystem services that contribute to recreational opportunities
Random	Users only	TEV – use	Recreation and all hence all ecosystem

utility model		values	services that contribute to recreational opportunities
Stated preference methods			
Contingent valuation	Users and non-users	TEV – use and non-use	All natural environment categories and hence all ecosystem services that contribute to these
Choice modeling	Users and non-users	TEV – use and non-use	All natural environment categories and hence all ecosystem services that contribute to these

The non-existence of markets for many biological resources and the public good nature of ecosystems make the valuation far from trivial. These issues imply that the social value of biological resources can't be derived from simple aggregation of their values to individuals in society, the sum of their private values.

Generally economists follow one of two alternate strategies to obtain behavioral observations directly from markets for environmental resources. The first referred to as stated preference method avoids conventional markets and searches simulated markets (Carson, 1991). By this we mean a survey instrument in which a market-like situation is created. Respondents are asked some hypothetical questions and the data so collected are used to value environmental amenities and other goods or services. It is called 'direct' or stated preference, because the analysis is based on direct tastes and preferences.

The second strategy is to infer values from data on behavioral changes in actual markets related in some way to the missing markets for environmental resources. Travel cost, hedonic valuation, and production function approaches are some examples. Here for instance, though there may be no market value for a wilderness area, its value can still be derived by analyzing the demand for trips to the area, by those who face different costs per trip.

There is a whole range of examples where the one or several components of the ecological systems like forest; wetlands, coastal ecosystems and their contributions have been estimated. In the past there have been several attempts to value the contributions of the world's ecosystem. Costanza et al (1997) estimate the current economic value of 17 ecosystem services for 16 biomes. They do it on the basis of already published research and find that the value comes to be around USD 33 trillion. Of course their estimate relies upon some simplified assumptions and thumb rule approximations; this value not only created a furor among ecologists but also invited very sharp criticism from the fellow economists (Arrow et al, 1998) as well. The methodology adopted by Costanza et al was primarily focused on total values instead of marginal one.

The following section highlights the lacunae in approaches of conventional environmental economics. It offers a fresh perspective on some of the fundamental assumptions of economic sciences that are applied in the valuation of ecosystem services.

Table10.2: Application of Main Economic Valuation Techniques from the Region

Methodology	Approach	Applications	Example
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Change in productivity	Trace impact of change in environmental services on produced goods	Any impact that affects produced goods (e.g. declines in soil quality affecting agricultural production)	Valuation of Mangroves in Gujarat by Hirway and Goswami (2006)
Cost of illness, human capital	Trace impact of change in environmental services on morbidity and mortality	Any impact that affects health (e.g. air or water pollution)	Costs of Vulture Decline in India by Markandya et al.. (2006)
Replacement cost	Use cost of replacing the lost good or service	Any loss of goods or services (e.g. previously clean water that now has to be purified in a plant)	Valuation of decline in Agricultural Productivity caused by Soil Erosion in Dehradun by Pushpam Kumar (2003)
Travel cost method	Derive demand curve from data on actual travel costs	Recreation, tourism	Valuation of KD park in Bharatpur by Chopra and Adhikari (2004)
Hedonic prices	Extract effect of environmental factors on price of goods that include those factors	Air quality, scenic beauty, cultural benefits (e.g. the higher market value of waterfront property, or houses next to green spaces)	Valuation of property prices due to Cleaning of the Ganges River by Markandya et al (2006)
Contingent valuation	Ask respondents directly their willingness to pay for a specified service	Any service (e.g. willingness to pay to keep a local forest intact)	Estimation of Arsenic free Water in Bangladesh by Ahmad et al (2005)
Benefits transfer	Use results obtained in one context in a different context	Any service for which suitable comparison studies are available	Valuation of carbon benefits of Indian Forests by Atkinson and Haripriya (2006)

The above table lists the available methodologies which can be applied to a particular ecosystem service depending upon data availability, unit of benefits, types of beneficiaries and expertise existing in using that particular methodology. What is important and the key to the success of these methods that, the whole application issue is essentially interdisciplinary in nature. Economist must learn and interact with ecologist if they want to apply their tools meaningfully. Economist would need to learn about the ecological production functions by interacting with limnologist (wetland), plant taxonomist (biodiversity), hydrologist (water recharge) and many other similar professionals found typically outside the circle of economists.

For each typical ecological models starting from individual level to ecosystem levels and corresponding ecological outputs translated into ecosystem services (provisioning, regulating, cultural and supporting), there would be economic tools (valuation techniques). Following diagram 2.2 provide the glimpse of the whole scheme

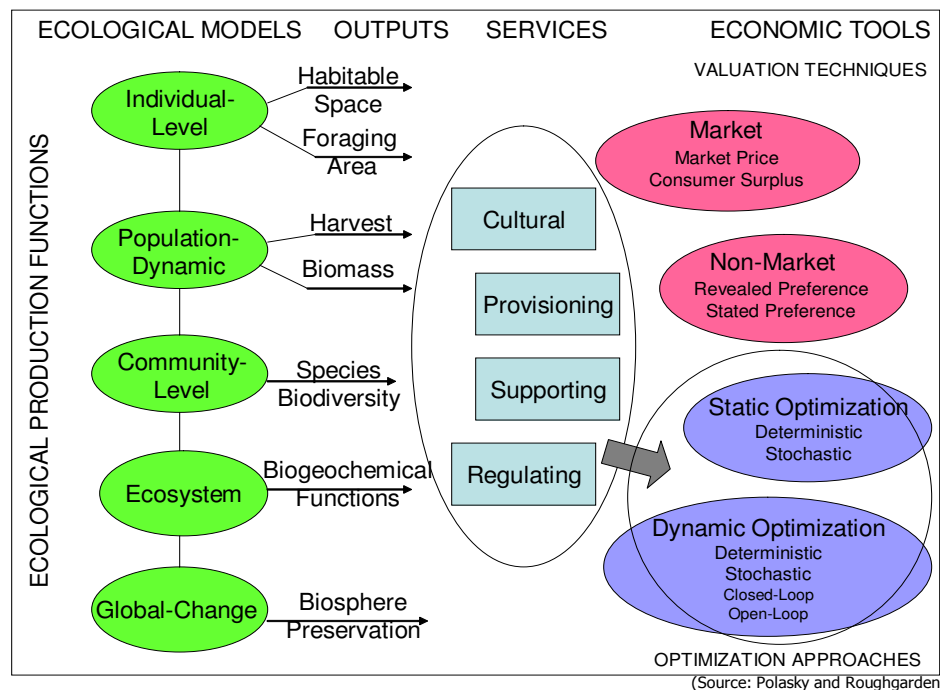


Diagram 10.1: Ecological models and valuation tools

Here it should be clear that as we move from provisioning to regulating to cultural services, valuation methods move from market to non market method. Benefits become public and to capture them into monetary term becomes increasingly difficult. Understanding the ecological production function through collaborative effort along with ecologists would provide the necessary information on issues critical for carrying out the valuation exercise. Some of the relevant issues would be:

- Initial condition of the ecosystem and corresponding ecological production function
- Drivers of change and its impact on the ecosystem affecting its flow of services
- Unites and measurement of ecological services , ecologists can easily provide that as this happens to be their terrain
- Additional perturbances creating changes in flow of ecological services (basically marginal change in ecosystem benefits as a response to marginal change in drivers)
- Ecological scale of change and relevant scale of time
- Who are the gainers and losers in the process of ecosystem changes
- Property rights for the ecosystem services

10.5 Challenges in valuation of ecosystem services: Several issues pertinent to valuation of ecosystem services and application to decision making have emerged especially with a better understanding of the mechanisms of ecosystem functioning. The relevance of the state of ecosystem functioning has not been given adequate emphasis in derivation of ecosystem values, thereby rendering the values of little worth, when one is examining issues, especially related to sustainability.

In order to provide a true and meaningful scarcity indicator of ecosystem values and functions, economic valuation should account for the state of ecosystem. Though, ecosystems can recuperate from some shocks and disturbances through an inherent property of resilience, there are several circumstances under which the ecosystem shifts to an entirely new state of equilibrium (Gunderson and Holling, 2001). Standard economic theory based concepts deriving ecosystem values based on marginal analytic methods are limited to situations when ecosystems are relatively intact and functioning in normal bounds far away from any bifurcation. This is of particular significance to developing countries, wherein significant tradeoffs exist between conservation and economic development, and decisions often favor the latter. The second issue primarily deals with aggregation of individual values to arrive at larger values, viz. "societal values". Ecosystem goods and services, by definition, are public in nature, meaning thereby that several benefits accrue to society as a whole, apart from the benefits provided to individuals (Daily, 1997; Heal 2000; Wilson and Howarth, 2002, Daily and Ellison 2004)). The theoretical fundamentals of development of economic valuation methodology rest on the axiomatic approaches of individual preferences and individual utility maximization, which does not justify the public good characteristic of ecosystem services. Valuation methodologies, viz. contingent valuation utilize individual preferences as basis of deriving values subsequently used for resource allocation of goods largely public by character. A considerable body of recent literature therefore favors adoption of a discourse-based valuation (Wilson and Howarth, 2002). The primary focus of these approaches is to utilize a discourse based valuation approach to come up with a consensus societal value of scarcity indicator, derived through a participatory process, to be used for allocation of ecological services, largely falling into the public domain.

Application of conventional fundamentals of economic valuation becomes further constrained when sustainability and social equity are also included as goals along with economic efficiency for ecosystem management (Costanza and Folke, 1997). While the methodologies for deriving values with economic efficiency as goals is comparatively well developed, integrating equity and sustainability requires a better understanding of functional relationships between various parameters and phenomena responsible for provisioning of the services in the first place and the social processes governing the mechanism of value formation (discourse based valuation being one such approach).

In the whole discussion of valuation of ecosystem services useful for human well-being and societal welfare, the assumptions of rational economic agents, well functioning markets, consistent preference, straighten choice, learning about the services of ecosystems, and speculations about future seem to be critical. However these assumptions are far from resolved and need serious attention if the value is to be comprehensive and acceptable to all types of professionals. In the past, assumptions of economic theory have maintained distance from behavioral science especially psychology. Economists whether dealing with the issues of valuation or forecasting seem to be functioning independent of the psychological dimension, which is quintessential to the entire exercise of economic analysis of ecosystems.

10.6 Uncertainty in Ecosystem Service and Natural Capital Valuation

Economic valuation can be defined as the attempt to assign quantitative values to the goods and services provided by environmental resources. The economic value of any good or service is generally measured in term of what we are willing to pay for the commodity less what it costs to supply it. Sometimes, it is construed that economist's approach is to put a dollar value to every natural resources which in any case the society has been considering worthy enough. That is not the case in reality. Economist make an attempt to assess how much society would to have to forego for saving a little more of the ecosystems. Obviously, economists are talking about the marginal values of the ecosystem services. There are popular methods of 'Total Economic Value' (TEV) of ecosystems which is essential on marginality yardstick but for several functions, an ecosystem is capable of providing top the society. Valuation of world's ecosystem in the range of USD17-53 trillion is example of such TEV (Costanza, 1997).

Valuation is only one element in the effort to improve the management of ecosystems and their services. Economic valuation may help inform management decisions, but only if decision-makers are aware of the overall objectives and limitations of valuation. The main objective of valuation of ecosystem services is to generally indicate the overall economic efficiency of the various competing uses of a particular ecosystem. That is, the underlying assumption is ecosystem resources should be allocated to those uses that yield an overall net gain to society, as measured through valuation in term of the economic benefit of each use adjusted by its costs.

In the domain of ecosystem- poverty linkages, human well being should also be assessed and evaluated comprehensively. Economic valuation is another way to measure the impacts of decisions or policies on human well-being. Economic valuation involves expressing inputs to well-being in monetary units, and can be used to provide information to examine distributional, equity and intergenerational aspects of well-being in a readily understood format.

10.7 Synthesis and Key Messages for Decision Makers:

Some of the key messages emerging from the analysis are

- i. Market and non market valuation methods for valuation of ecosystem services can capture some of the 'out of market' services.
- ii. Valuation does not intend to establish the importance of ecosystem for the humans, they help the decision makers in a situation of trade off and alternate course of action
- iii. Valuation of ecosystem services has to be context specific, ecosystem specific and guided by the perception of beneficiaries
- iv. Total valuation evaluated the whole catchments, landscape, mapping unit while marginality valuation evaluates the incremental changes in ecosystem services as a consequent of measured pressure on the ecosystem in consideration
- v. More and more focus should be on the valuation of marginal changes of ecosystem rather the value of 'total' ecosystem
- vi. Initial condition and state of the ecosystem is important in valuation of ecosystems
- vii. Valuation should be done for ecosystem services assuming they are independent of each other
- viii. Establishing property rights for the ecosystem is critically important for valuation
- ix. While doing valuation, issues of irreversibility and resilience must be kept in mind
- x. Clear cut Bio physical linkages and relationships would not only facilitate the valuation exercise but would ensure its credibility in the public policy

- xi. Uncertainty is one of the key challenges in valuation of ecosystem services and therefore a sensitivity analysis would be liked by the decision makers.
- xii. Participatory exercises such as representativeness of the sample, ensuring participation, and embedding outcomes in the institutional processes would enable the valuation more authentic and acceptable to the decision makers
- xiii. Valuation has the potential to clear the clouds of conflicting goals in terms of political, social and economic feasibility of the policies but it might not be the last word.
- xiv. In the context of sectoral and project policies, valuation of ecosystem services would clearly strengthen the environmental impact assessment and the make the appraisal criteria more acceptable, transparent and credible.

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Anthropogenic Drivers of Ecosystem Change in South Asia: An Overview*

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I. Introduction

Over the past half century, the South Asia has experienced dramatic ecosystems changes — deforestation, desertification, increase in atmospheric pollution, melting of glaciers etc. Large-scale changes in ecosystems produce consequent effects with repercussions for livelihood of poor people, global climate, wildlife habitat and a host of other policy issues. What has caused the changes in ecosystems that have occurred in the South Asia over the decades? What has been the role of the public policies? We investigate the influences of different socio-economic and policy factors on ecosystem changes.

This chapter discusses the ‘indirect drivers’ of changes in ecosystem services in the South Asian region. The MEA (Millennium Ecosystem Assessment, 2005) defines a driver as any natural or human induced factor that directly or indirectly causes a change in ecosystem. A direct driver unequivocally influences ecosystem processes. An indirect driver operates more diffusely, by altering one or more direct drivers.¹⁹ The identified important direct drivers are changes in climate, plant nutrient use, land conversion, diseases and invasive species; these are the factors which affect the bio-geophysical character of the ecosystem. Demographic, economic, socio-political, scientific and technological, cultural and religious factors are classified as indirect drivers of ecosystem change. Changes in ecosystem conditions and ecosystem services thereof are a result of interaction of multitudes of direct and indirect drivers at various spatial, temporal and organizational scales. The above-mentioned direct and indirect drivers are primarily human induced.

It is important to emphasize at the outset that this chapter remain confined to the indirect drivers of ecosystem change and does not discuss natural drivers such as climate change, weather events or volcanic eruptions. We do not discuss interactions among the drivers also in any detail. Moreover, we do not discuss the relationships and how changes in drivers actually affect ecosystems.

South Asia is a vast geographic area with numerous types of ecosystems and types of population dependent on these ecosystems. In this chapter the following five countries are discussed under South Asia: Bangladesh, Bhutan, India, Nepal and Pakistan. The next section of this paper discusses some measurement techniques of theories of environmental impacts. The trends and current conditions of indirect drivers in the five South Asian countries are described in Section III. The chapter wraps up with some concluding remarks in Section IV.

* This paper forms part of the ongoing project on ‘Ecosystem Services and Poverty Alleviation: A Situation Analysis of India and Hindukush Region’ sponsored by the NERC-ESRC-DFID.

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II. Ecosystems Impact Theories and Measurement Techniques

It has become increasingly apparent that humans are modifying the ecosystems on an unprecedented scale; the dynamics of the anthropogenic (human induced) drivers of ecosystems change have yet to be fully understood (US National Research Council, 1999; York et al., 2003a). A major factor inhibiting social scientific inquiry into the human-environment relationship is a paucity of appropriate analytic techniques and models. In the literature there are various theories on the relationship between ecosystem changes and their determinants and these environmental impact theories fall into three general perspectives: human ecology, modernization, and political economy. Human ecological theories stress that the human behaviour is always bounded by the limits imposed by ecological conditions, and hence these theories, like neo-Malthusian perspectives, stress the importance of population size, growth, density and structure in explaining ecosystem changes (Catton, 1980; Harrison, 1993; Dietz and Rosa, 1994; York et al., 2003a). These theories also incorporate biophysical factors (direct drivers) such as climate and biogeography in combination to human factors (indirect drivers) as drivers of ecosystem changes. These theories recognized interaction between direct and indirect drivers, i.e., the role of direct drivers in influencing economic and social developments that are consequential in understanding ecosystem changes.

The underlying assumption of modernization theories is that environmental problems can be solved through existing and/or slightly modified social, political and economic institutions without sacrificing economic growth, capitalism and globalisation (York et al. 2003a). These theories suggest that higher economic growth and modernisation may alleviate environmental degradation. In addition to growth in per capita income, the ecologists use urbanisation as an indicator of modernisation since it is associated with many of the institutions of modernity. Moreover, the structural changes in the composition of income such as rise in service economy increase in the levels of political and civil liberties and state environmentalism are expected to lower the environmental impacts (York et al. 2003a).

Environmental economists acknowledge that there is an 'inverted U' shaped relationship between economic growth and environmental impacts (Grossman and Krueger, 1995). This type of relationship in environmental economics literature is known as Environmental Kuznets Curve (EKC). It assumes that environmental quality is a luxury commodity, affordable and of interest only to wealthy societies. This literature assumes that only after the society crosses a certain threshold of income, then public concerns, pressures by non-government organizations and state policies help in protecting the environment through investments in green technologies. This literature also recognizes that structural changes occurring in the economy also favours such kind of relationships.

Similar to EKC, the ecological modernisation theories also foresee an 'inverted U' shaped relationship between modernization and environmental impacts. The underlying rationale behind the ecological modernisation theories is that with modernisation the industry becomes more ecologically rational, i.e., with modernisation the industry takes steps to minimise environmental externalities (Mol, 1995; York et al, 2003a).

Governments are important actors in influencing the environment. With modernisation, the state environmentalism and public policies, can lead to a greening of production and consumption activities. Political and civil liberties are supposed to influence the environment negatively in the beginning and reversing the relationship later on, i.e., an 'inverted U' shaped relationship between political and civil liberties and environmental impacts.

Political economy perspectives see that the environmental changes are driven by the structure of the economies, the institutions of modernity and the commitment to growth inherent in production systems (York et al., 2003a). Its fundamental assumption is that economic production is in conflict with ecological limits. According to these theories, due to the influence of affluent section on the state, the state policies do not try to minimize the environmental impacts of the production and environmental externalities are generated at large scale and the technological developments and reform-oriented policies will not solve the problem of environmental degradation. The solution of environmental degradation problem rests in restructuring of societies away from economic expansion and toward ecological sustainability.

In the ecological science the debate on the relationships between ecosystem changes and its human induced drivers have taken place within the framework of the IPAT formulation (Harrison and Pearce, 2000; Stern et al., 1992, York et al., 2003b). This formulation specifies that ecosystem changes are the multiplicative product of population, affluence and technology. The affluence can be defined as the per capita production or consumption and technology measures the impact/intensity of per capita production or consumption. That is,

I=PAT

The IPAT emerged out of the discussion of the Ehrlich-Holdren Commoner in the early 1970²⁰ and it continued to be widely utilised as a framework for analysing the drivers of ecosystem changes (e.g., Harrison 1993, Dietz et al., 2007). It is used to disentangle the determinants of environmental impacts. It identifies precisely the relationship between driving forces and impacts and it recognizes that the driving forces are not impacting the environment independently on one another because of its multiplicative nature. To understand the relative importance of each of the determinants of change it is necessary to assess the rate and range of potential change in each of the determinants. York et al. (2002) introduced the concept of plasticity to measure the scale and rate of impact of each of the driver. Plasticity comprises two elements: (i) the potential range and variability of each driver; (ii) the rate at which each driver can change.

Waggoner and Ausubel (2002) reconceptualised the IPAT formulation and renamed it as ImPACT, by disaggregating T into consumption per unit of GDP (C) and impact per unit of consumption (T). The principle objective of reformulated model is to identify the factors that can be changed to reduce impacts and key factors that influence each other (York et al., 2003b). The underlying strength of these models is that they are rooted in ecological theories, but they are accounting equation and do not recognize the fact that human behaviour is stochastic and therefore do not allow hypotheses testing. Moreover, both the models assume proportionality in the functional relationship between the drivers a priori.

To overcome the problems of IPAT or ImPACT models, Dietz and Rosa introduced STRIPAT (stochastic impacts by regression on population, affluence and technology) which is capable of analysing the impacts of driving forces on a variety of ecosystem changes (Dietz and Rosa, 1997; Cramer, 1998; York et al., 2003a). The ST RIPAT model allows hypotheses testing.

20 The IPAT idea was proposed first by Ehrlich and Holdren (1970, 1972) and Commoner (1971) and Commoner et al. (1971) provided it for the first time an algebraic formulation and applied it into data analysis.

III. Indirect drivers

This section discusses the indirect drivers of ecosystem change such as demographic, economic, socio-political, cultural and religious, and scientific and technological factors. The basic pathway is from growing consumption driven by population to production processes that rely in part on ecosystem services to meet the consumption. The entire range of indirect drivers influences the ultimate effects on ecosystems of an additional person.²¹ The population-environment linkage is influenced by numerous factors other than population size and also determines the future pattern of consumption.

Demographic drivers

Population is considered a key indirect driver of ecosystem change. The population growth rate is declining below the replacement level in the European countries and in some 59 developing countries, whereas it is still high in sub-Saharan Africa, the Middle East and South Asia. The population growth in the next few decades is expected to be concentrated on the poor areas of sub-Saharan Africa, South Asia and Middle East as these are the areas with high fertility rate combined with young age structure. Table 1 gives an idea about the demographic details of the selected countries in South Asia (Bangladesh, Bhutan, India, Nepal and Pakistan) and their trend over the period 1980 to 2004.

The total fertility rate which has declined from as high as 5.78 (average for the five countries) in 1980 to 3.58 (average for the five countries), is still much higher than the replacement level (replacement level is a little higher than two). India has the largest share of population in the region (Figure 1) with the total fertility rate (births per woman) of 2.9. The life expectancy in the five countries taken individually has risen from 50.2 years in 1980 to 63.4 years in 2004 (average for the five countries). Therefore the South Asian region would experience high population growth in the next few decades and this would be an important indirect driver of ecosystem change and services in the region.

The fertility rate, mortality rate and migration determine the demographic transition of the region. Crude birth rate and death rates in South Asia have declined over last 25 years. There is not enough information on migration in the region to predict the future trend. Besides no single compelling theory of migration exists, projections are generally based on past trends and current policies, which may not be relevant in the future.²²

Table 1. Demographic details in South Asia 1980-2004

		Bangladesh	Bhutan	India	Nepal	Pakistan
1980	Crude birth rate (per 1000 people)	40	42	34	40	47
	Crude death rate (per 1000 people)	16	20	13	17	15
	Total fertility rate (births per woman)	5.4	5.9	5	5.6	7
	Under-five mortality rate	205	227	173	195	153
	Life expectancy at birth (years)	49	45	54	48	55
1990	Crude birth rate (per 1000 people)	35	38	30	38	41

²¹ MEA, Chapter 7, p. 181.

²² *ibid*, p.5

	Crude death rate (per 1000 people)	12	13	10	13	13
	Total fertility rate (births per woman)	4.3	5.6	3.8	5.1	5.8
	Under-five mortality rate	149	166	123	145	130
	Life expectancy at birth (years)	55	54	59	55	59
2004	Crude birth rate (per 1000 people)	27	30	24	29	27
	Crude death rate (per 1000 people)	8	8	8	8	7
	Total fertility rate (births per woman)	3	4.2	2.9	3.5	4.3
	Under-five mortality rate	77	80	85	76	101
	Life expectancy at birth (years)	63	64	63	62	65

Source:

1. <<http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=135>>
2. <http://earthtrends.wri.org/country_profiles/index.php?theme=4>

Current age structure is also a key determinant of population growth over the next few decades, because of the momentum inherent in young populations (Nelson, 2001). Table 2 provides the age structure of the five selected countries and their trend over the same period 1980-2004.

Table 2. Trends in age structure in South Asia: 1980-2004

(% of total)

	1980 Population			1990 Population			2004 Population		
	aged 0-14	aged 15-64	aged 65+	aged 0- 14	aged 15-64	aged 65+	aged 0-14	aged 15-64	aged 65+
Bangladesh	43	53	4	41	56	3	36	61	4
Bhutan	41	55	3	47	55	4	39	57	5
India	39	57	4	37	59	4	32	62	5
Nepal	42	55	3	42	55	3	39	57	4
Pakistan	43	54	3	44	53	3	39	57	4

Source:

1. <<http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=135>>
2. <http://earthtrends.wri.org/country_profiles/index.php?theme=4>

Figure 1 gives the trend in population in South Asia 1980-2004 along with the projected trend for 2025. The total population for the five countries has increased at a rapid rate from 867.81 in 1980 to 1398.48 millions in 2004 and it is projected to rise to 1855.95 millions in 2025.²³

The growth of population and its growth path, have important implications for ecosystem change and can be an important driver of ecosystem change in the coming decades.

23 (Source: <http://earthtrends.wri.org/country_profiles/index.php?theme=4>)

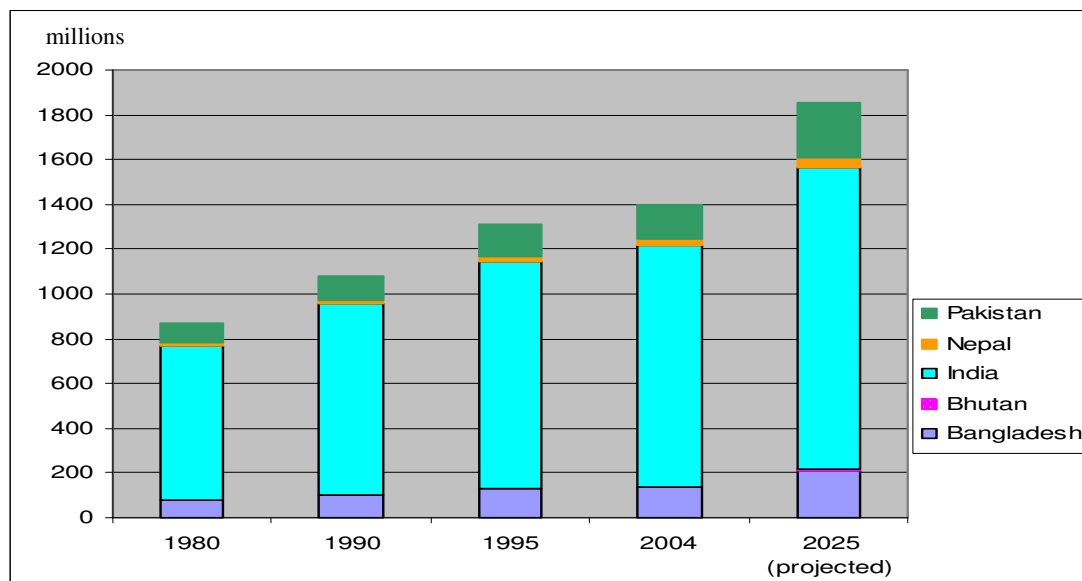


Figure 1. Total population in South Asia

Economic drivers: Consumption, production and globalisation

Economic activities are dependent upon natural resource endowments, ecosystem services. Economic activities also affect the natural resource base and quality of ecosystem services in the process of production and consumption. The output of commodities is the product of labour, man made capital and natural capital along with institutional set up. During the production process bad outputs such as atmospheric pollution are generated along with the production of desired goods and services. Thus, the production process of goods and services has significant bearing on the ecosystems.

The consumption pattern in economies change with rise in income. As indicated by Engel's law as income rises the share of income spent on food declines and as per Bennett's law there is a shift from primary starchy staples to more fat, protein, fruits and vegetables with rising income. As income rises there is more demand for non-agricultural goods and services and consequently the structure of the economy also changes. We see a change in consumption pattern in the South Asian region as suggested by above mentioned theories. In India there has been doubling of calories derived from fat over a 20-year period. Although Indian consumption of rice and wheat has been increasing, the percentage of all cereals in household expenditure has been declining. The major increases in food consumption in India are in milk, eggs, fruit, vegetables, and vegetable oils (Nelson, 2001). The meat consumption in all the South Asian countries has been showing a rising trend, although it's significantly less than the average per capita meat consumption in Asia excluding Middle East of 25kg and the world average of 38 kg.²⁴ Therefore with rising income the meat consumption in this region is expected to increase at a rapid rate, with consequent effect on natural resource base and ecosystem.

²⁴ meat consumption per person in 1998: Bangladesh-3kg, India-4kg, Nepal-10kg, Pakistan-14kg. source:

< http://earthtrends.wri.org/country_profiles/index.php?theme=6>

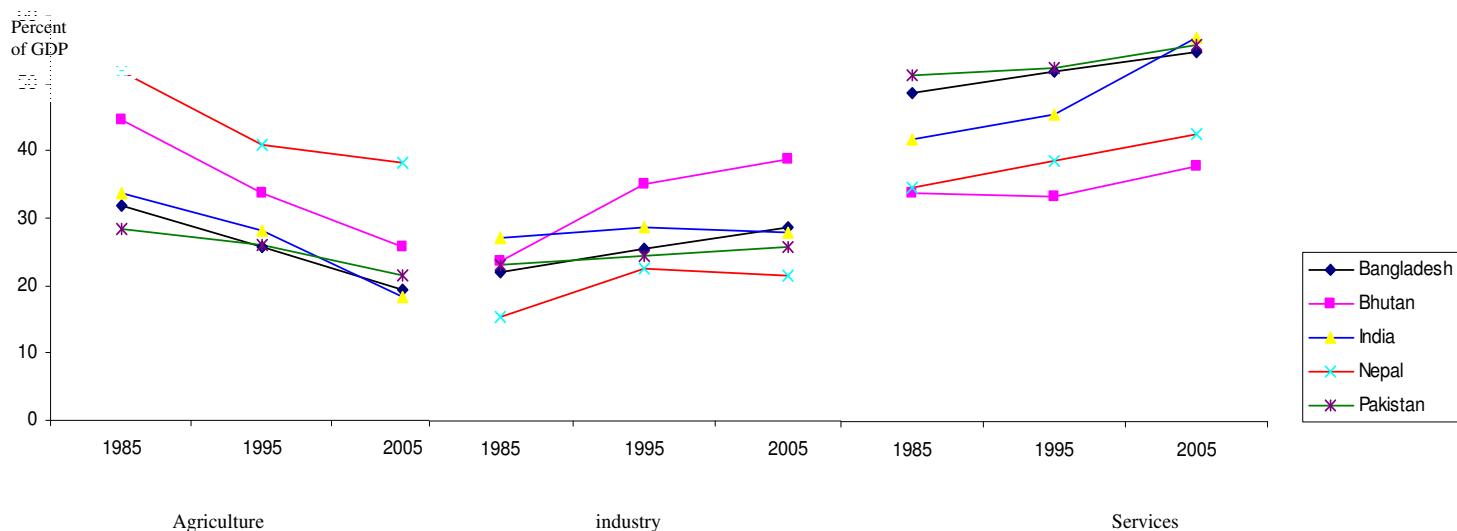


Figure 2. Changes in economic structure for selected countries 1985-2005
(Source of data: The World Bank Group)

The South Asian countries are also going through the structural change shifting from predominance of agricultural sector to a dominant non-agricultural sector. Figure 2 illustrates the structural changes in the selected South Asian countries through the period 1985-2005. The relative contribution of agriculture has been declining in the above countries through out the period and services have been showing a rising trend. However the effect of this structural change on ecosystems is ambiguous. In absolute terms there would be more production of agricultural products to cater to the increasing demand of a growing population with rising income. The other factors determining the effect of this particular indirect driver on ecosystem changes are the technological change substituting capital for labour and change in the pattern of demand because of urbanization. Proliferation of supermarkets has been always associated with increasing output of services even with agriculture-related activities. Supermarkets are also becoming an emerging force in South Asia, particularly in urban India since mid-1990s (Pingali, 2004).

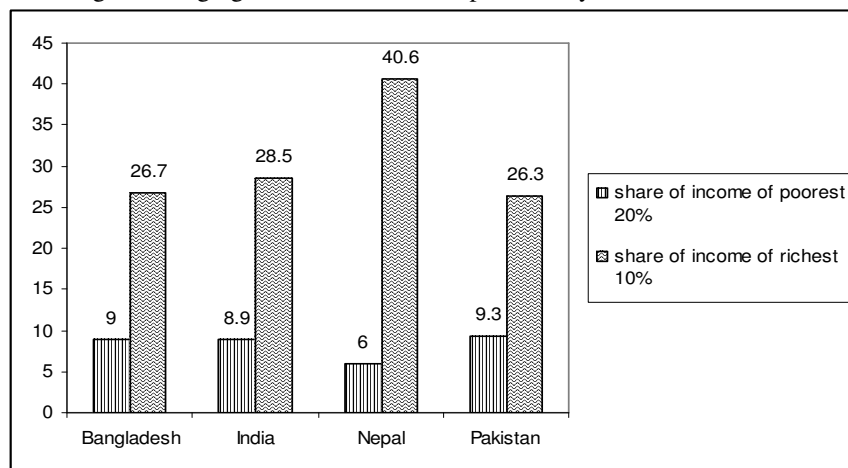


Figure 3. Share of income of richest 10% and poorest 20% of population

Table 3. Average annual growth rate (per cent)

	Bangladesh*	Bhutan	India	Nepal	Pakistan
GDP					

1985-95	4.2	5.7	5.5	5.0	5.2
1995-2005	5.4	6.9	6.0	3.9	3.7
2005	6.0	5.8	7.2	2.7	7.8
GDP per capita					
1985-95	1.8	3.0	3.4	2.5	2.6
1995-2005	3.4	3.9	4.3	1.6	1.2
2005	4.0	3.3	7.7	0.7	5.2

Source: < http://earthtrends.wri.org/country_profiles/index.php?theme=5>

*: the corresponding period of given data for Bangladesh are 1986-96, 1996-2006 and 2005.

Table 4. Economic drivers

		Bangladesh	Bhutan	India	Nepal	Pakistan
1990	GNI per capita, Atlas method (current US\$)	300.0	500.0	390.0	200.0	420.0
	GNI, Atlas method (current US\$) (billions)	31.0	0.3	330.6	3.9	45.5
	Gross capital formation (% of GDP)	17.1	32.5	24.1	18.4	18.9
	Trade (% of GDP)	19.7	57.6	15.7	31.6	38.9
1995	GNI per capita, Atlas method (current US\$)	340.0	500.0	380.0	200.0	490.0
	GNI, Atlas method (current US\$) (billions)	39.2	0.3	349.6	4.4	59.8
	Gross capital formation (% of GDP)	19.1	45.7	26.5	25.2	18.5
	Trade (% of GDP)	28.2	81.0	23.2	58.8	36.1
		Bangladesh	Bhutan	India	Nepal	Pakistan
2000	GNI per capita, Atlas method (current US\$)	390.0	720.0	450.0	220.0	480.0
	GNI, Atlas method (current US\$) (billions)	49.8	0.4	456.8	5.4	66.5
	Gross capital formation (% of GDP)	23.0	47.4	24.8	24.3	17.4
	Trade (% of GDP)	33.2	76.4	28.4	55.7	28.4
2005	GNI per capita, Atlas method (current US\$)	470.0	1250.0	730.0	270.0	690.0
	GNI, Atlas method (current US\$) (billions)	66.7	0.8	804.1	7.3	107.3
	Gross capital formation (% of GDP)	24.5	60.0	33.4	28.9	16.8
	Trade (% of GDP)	39.6	82.0	44.7	48.7	35.2

Source: < http://earthtrends.wri.org/country_profiles/index.php?theme=5>

(Source: World Development Indicators 2007, the World Bank Group)

The selected countries of South Asian except for Nepal are experiencing high growth rate of GDP. Existence of high level of poverty²⁵, and high-income disparity (Figure 3) in the selected countries has crucial implications on ecosystem change and services thereof in the region. Table.4 gives the summary of economic growth in the five countries of South Asia. India being a

25 % of population below national poverty line: Bangladesh (2000-06)-50%; India (1999-2005)-29%; Nepal (1999-2005)-31%; Pakistan (1999-2005) - 33%. Source: World Development Indicators 2007, the World Bank Group

country with large population and hence, high level of economic activity would always influence the growth of the region significantly.

International trade is considered a significant determinant of economic growth and Bangladesh, Bhutan, India and Nepal (only Pakistan shows a fluctuating movement) show a rising trend in share of total trade in GDP. There is a strong empirical evidence of a positive relationship between trade openness and productivity, industrialization, and economic growth. However, the countries experiencing the most rapid trade-driven economic growth were trading a large share of high-technology products (Nelson, 2001).

Some of the critical factors influencing growth of international trade are policies, institutions in the trading countries, international capital flows. Economic growth is propelled by development and adoption of new technology, hence, productivity growth, expansion of physical and institutional infrastructure. Expansion of physical infrastructure in terms of transportations, markets, settlements, public services, private sector activities are important drivers that affect ecosystem change.

Increasing demand for physical inputs and energy required in increasing economic activity always affect the ecosystem and the natural resource base. The materials and energy intensity of the South Asian region is low at present, as compared to developed countries (Table 5). However, the material and energy intensity and requirement in absolute terms is expected to rise with increasing economic activities.

Table 5. Energy consumption and CO₂ emissions in South Asia and high income countries

	CO ₂ emissions (metric tons per capita)		Electric power consumption (kWh per capita)		Energy use (kg of oil equivalent per capita)	
	2000	2003	2000	2004	2000	2004
Bangladesh	0.22	0.25	103.59	139.55	145.13	163.7
Bhutan	0.71	0.63
India	1.14	1.2	402.02	457.32	503.96	530.55
Nepal	0.13	0.11	57.63	68.82	334.21	340.53
Pakistan	0.77	0.77	373.54	425.03	463.15	489.09
High income countries		4.94		1434.88		2008.86

Source:

<<http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=135>>

Urbanization is another important factor that influences structure of production, consumption, demand for physical and institutional infrastructure, and affects the indirect drivers of ecosystem change and ecosystem services. Urban population in the South Asia region (Table 6) is projected to increase in the coming decades and have significant repercussion for the natural resource base and ecosystem. Urban areas would be more adversely affected because of change in ecosystem services, as water supply, infrastructure, drainage would be affected.

Table 6. Urban population (% of total population)

	1975	2004	2015
Bangladesh	9.9	24.7	29.9
Bhutan	4.6	10.8	14.8

India	21.3	28.5	32
Nepal	4.8	15.3	20.9
Pakistan	26.3	34.5	39.6

Source: WDI Indicators 2007, The World Bank

Socio-political drivers

Socio-political factors have always been important influence in change of environment. There are three major ways in which governance and policy changes (socio-political factors) have consequences for ecosystem services:

1. Introduction of new economic regimes possibly related to changes in political systems
2. Cooperation or competition among decision makers over resource management, particularly in open access or common property regimes,
3. Failed centrally planned projects for improving the living conditions for local communities and people.²⁶

Socio-political factors determine and affect how human interact with environment. Political freedom, press freedom, civil liberties in the countries influences public participation in environment assessments and related decision-making process. The five countries in the South Asian region do not enjoy absolutely free political rights, civil liberties or press freedom. India enjoys existence of comparatively free political and civil rights and Bhutan has comparatively less press freedom in the region (Table 7). The potential relation and interactions between environmental change and human security is one important element of socio-political drivers. Human security is understood as the survival and dignity of human beings through freedom from fear and freedom from want. The role of increased human security on environmental conservation and sustainability is potentially positive but as yet unresearched. Environmental-human security relationships can even be more direct compared to the environmental links to security more narrowly defined.

Table 7. Socio-political factors in South Asia

	Bangladesh	Bhutan	India	Nepal	Pakistan
Political rights (1=most free, 7=least free)	3	7	2	3	6
Civil liberties (1=most free, 7=least free)	4	6	3	4	5
Press freedom (1-30= free, 31-60= partly free, 61-100= not free)	63	72	42	60	57

Source: http://earthtrends.wri.org/country_profiles/index.php?theme=10

Other indirect drivers

Cultural values, norms, beliefs can influence people's perception and interaction with ecosystem and can act as drivers of ecosystem change. Culture refers to the characteristics of a group of people and one individual can assimilate the values and norms of a number of cultures. There has not been much research in this area in the past; however there has been emerging interest in studying role of culture in environmental change.

²⁶ MEA op cit, p. 148.

Scientific and technological progress can be and has been elements of important consequences for the ecosystem. Green revolution, genetically modified crops engineering are example of such scientific and technological changes which have affected the ecosystem.

IV. Conclusions

The drivers of ecosystem change, both direct and indirect act and interact with each other and affect the ecosystem in a synergistic way. Therefore, it is not possible to isolate the effect or impact of any particular driver. The study of individual drivers helps us in analyzing its behaviour and impact on ecosystem and its services. Each ecosystem is unique and idiosyncratic in its constitution and behaviour. Therefore, the need for a holistic study considering all possible drivers of ecosystem change cannot be overemphasised.

Although there has been scientific consensus on the primary drivers of ecosystem change, little progress has been made in determining the precise relationship between drivers and impacts. This gap constitutes a significant barrier to identifying the policies that have the most potential for reducing human impact on the environment, projecting future impacts, and estimating the level of effort needed to reduce adverse effects on the environment.

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Policy Responses to Ecosystem Conservation in Hindukush Region²⁷

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January 2008

²⁷ Paper written for Ecosystem Services and Poverty Alleviation in South Asia (ESPASSA)

I Introduction

Ecosystems in Hindukush region belonging to different climatic and geographical regions comprehensively represent all types of them found on earth. They are glacial and mountainous found respectively in higher reaches and middle and lower reaches of Himalayas and plains and deltaic in the basins of great rivers, Indus, Ganges and Bramaputra. Politically, they belong to a region identified as South Asia where a larger fraction of world's poor people live with the pre capita GDP as low as US\$ 2513 in the year 2005. Even with this very low per capita GDP, the distribution of income is more uneven in this region making the poor especially those living in rural areas are incapable of earning income by participating in the mainstream developmental activities. Therefore ecosystems have become sources of income and livelihood to the poor in terms of getting food, fodder, fuel and fiber.

Table 1 provides some information about the environmental/ecological outlook of South Asia. This region having the population of 1483 million demands primary energy equal to 7 percent of world demand and has 15 percent of land used for growing food crops in the world in the year 2005. It contributes to 7 percent of world greenhouse gas emissions and has the 37 percent bio-diversity loss due to agriculture. Bio fuels constitute 27 percent of

Table 1: Environmental Outlook for South Asia: Some Key Figures

				Rate of Change	
	1980	2005	2030	1980-2005	2005-2030
Population (unit: millions)	909	1,483	2,035	63%	37%
GDP per capita (USD)	1,088	2,513	6,421	131%	155%
Primary energy consumption					
Total (% of world total)	4%	7%	9%	170%	96%
<i>of which: coal (% of world total)</i>	3%	7%	11%	346%	163%
<i>Of which: traditional biofuels (% of world total)</i>	22%	27%	26%	61%	12%
Final energy use					
Total (% of world total)	5%	7%	9%	127%	80%
<i>of which: coal (% of world total)</i>	4%	8%	16%	134%	157%
Climate change					
GHG basket emissions (% of world total)	4%	7%	8%	149%	56%
Energy related CO ₂ emissions (billion kg C)	0.08	0.38	0.90	367%	136%
Energy related CO ₂ emissions per	0.09	0.26	0.46	190%	76%

capita (ton C)					
Nitrogen emission (% of world total)	3%	8%	17%	171%	89%
Sulphur emission (% of world total)	2%	8%	16%	246%	88%
Land use					
Food crops (% of world total)	15%	15%	15%	15%	28%
	1970	2000	2030	1970-2000	2000-2030
Biodiversity					
Remaining species abundance (% of potential)	49%	44%	33%	-5%	-11%
Species loss due to agriculture	36%	37%	50%	1%	13%
	1990	2005	2030	1990-2005	2005-2030
Population living in areas under severe water stress (% of population)	46%	49%	51%	39%	40%

Source: OECD Environmental Outlook, 2006

total primary energy demand in this region. Around 49 percent of population in the region is living in areas with severe water stress. Many economies of this region have been on very high growth path in recent times with the fast growing demand for ecosystems services from the developmental activities. The demand for ecosystem services from non-inclusive growth of income and continuing poverty has been exceeding the carrying capacity of ecosystems in South Asia especially the Hindikush region.

Historically, there have been policy responses for the sustainable use of ecosystems in this region starting with a low key during 70s of the last century and gradually picking up during later years. Many of the legislative responses are as old as 25-30 years and they form the foundations for the current new environmental policies in this region. The links between ecosystems and poor and well-being are better understood now and the ecosystem conservation is seen as one of the important strategies for reducing poverty. The new policy responses recognize the importance of the role of local communities and the civic society in the ecosystem conservation apart from the role of government. The national and international NGOs and funding agencies of governments of developed countries and the private sector are encouraged to undertake programmes of ecosystem conservation in this region.

The remaining paper is planned as follows. Section II describes legislative responses for the ecological conservation in Hindukush region. Section III attempts a review of some important actual policy responses for the conservation of forests, wetlands and bio-diversity from the countries in the region. Section VI deals with the policy responses to air and water pollution. Section V highlights policy responses to climatic change problems. Section VI provides case studies of actual policy interventions and international support for the conservation of ecosystems in the region and finally Section VII contains conclusions.

II: Legislative Responses

The feasible policy responses for the management of ecosystems in a country depend on its laws governing the environment. There is a spate of environmental laws in India, Pakistan, Bangladesh, Nepal and Bhutan starting from early 1970s. They are related to forest and bio-diversity conservation, wildlife protection and prevention of air and water pollution. These laws have formed the foundation of policies for the conservation of ecosystems in the respective countries. They provide for the use of wide range of policy instruments and institutions to deal with issues of efficiency and income distribution and poverty in the ecological conservation of this region. Government, local communities and civic society draw adequate powers from these legislations to appropriately ensure the sustainable livelihood for poor from the ecosystems.

India has a comprehensive set of environmental laws in this regions. They are the Wildlife Protection Act of 1972, the Water (Prevention and Control of Pollution) Act of 1974, the Water Cess Act of 1977, the Forest Conservation Act in 1980, the Air (Prevention and Control of Pollution) Act in 1981, the Environment (Protection) Act of 1986, the Public Liability Insurance Act of 1991 and the Bio-diversity Conservation Act, 2002. These laws constitute foundations of domestic environmental regulation. In the context of conservation of ecosystems of water resources and atmosphere, they provided for the setting up of Pollution Control Boards at the Central and the State levels, empowered to prevent, control and abate air and water pollution, and to advise governments on matters pertaining to such pollution. The Central Pollution Control Board is to co-ordinate the activities of the State Boards. The Acts also specify that industrial units have to provide on demand all information regarding their effluent and treatment methods. They also provide the rules to be followed by government for the conservation of forests, wild life, and coastal ecosystems. These laws with the necessary future amendments empower government and provide opportunities to local communities and civic society to participate in the conservation of ecological resources.

Pakistan has similar environmental legislations. The establishment of environmental policies and regulations began as early as 1975 leading ultimately to the promulgation of the landmark Pakistan Environmental Protection Ordinance of 1983. This ordinance providing a legal framework for national environmental management has resulted in the establishment of the national environmental quality standards that set limits for emissions and discharges. It has also called for the establishment of the Pakistan Environmental Protection Agency (Pak-EPA) and four provincial environmental protection agencies (provincial EPAs). The Ministry of Environment, Local Government, and Rural Development was formed in 1996 to ensure that environmental considerations and concerns of sustainable development are incorporated into national development plans and policies. The Pakistan Environmental Protection Act (PEPA), 1997 empowers Pak-EPA to handle pollution-related problems as well as hazardous and toxic waste.

The Himalayan countries of Nepal and Bhutan have major environmental legislations some of which originating in sixties of last century. The important environmental legislations in Bhutan are Forest Act, 1969, Forest and Natural Conservation Act, 1995, Environmental Assessment Act, 2000, Bhutan Water Act, 2002 and Bio-diversity Act, 2003. Nepal has National Park Act and Water Resource Act of 1973, Forest Act of 1993 and Environmental Protection Act of 1997.

Bangladesh has very comprehensive and impressive set of environmental laws in the Hindukush region. The earlier important legislations include Pesticide Ordinance, 1971, Bangladesh Wildlife

Preservation Order, 1973, Bangladesh Wild Life (Preservation) Order, 1973, Water Pollution Control Act, 1974, Maritime Zones Act, 1974, Motor Vehicles Ordinance, 1983, and the Marine Fisheries Ordinance, 1983. The Ministry of Environment and Forest was established in 1989. The government of Bangladesh came out with the national environment policy in 1992 and enacted the Bangladesh Environment Conservation Act, 1995. The most recent legislations are Environmental Court Act, 2000 and Open Space and Wetland Protection Act, 2001.

III Current Policy Responses

New Environment Policy and Poverty Alleviation

The new environmental policies of governments of countries in Hindikush region²⁸ explicitly recognize the link between ecosystems and poor and human well-being and consider it as the important reason for the ecological conservation. Addressing to this problem, the new environmental policy of Government of India sets some of its objectives as

(a) to protect and conserve critical ecological systems and resources, and invaluable natural and man-made heritage, which are essential for life support, livelihoods, economic growth, and a broad conception of human well-being,

(b) to ensure equitable access to environmental resources and quality for all sections of society, and in particular, to ensure that poor communities, which are most dependent on environmental resources for their livelihoods, are assured secure access to these resources and

© to ensure judicious use of environmental resources to meet the needs and aspirations of the present and future generations.

Similarly, the new environmental policy of Government of Pakistan aims to

(a) integrate environmental and poverty issues into economic policies and plans.

(b) increase allocations for targeted interventions aimed to address poverty-environment nexus, especially at the grass root level.

© enhance community level environment management by strengthening the capacity of union councils, tehsil municipal administration and district governments.

(d) improve access of poor to environmentally sound technologies that improve soil and water conservation and integrated pest management.

(e) regularize all the notified slum settlements and provide water supply and sanitation. and

(f) devise and implement national resettlement Policy

Similar policy statements could be found also for other countries in the region.

Forests, Wildlife and Bio-diversity

The National Forest Policy, 1988 and the Indian Forest Act, 1927 empower government to take measures for forest conservation. The legislative and institutional provisions of forest management are currently under review by the National Forest Commission set up by government in 2003. Some of the issues under consideration are giving legal recognition of the conventional rights of forest dependent communities and formulate innovative strategies to increase forest and tree cover to 33 percent by 2012. Granting legal rights to forest dependent communities reduce the conflicts between government and forest communities and provide incentives to the local community participation in forest conservation. The strategies to increase the forest cover should include (a) promotion of multi-stakeholder partnerships involving government, local communities, land owners, and investors (b) incentives to farmers to undertake social and farm forestry and (c) promotion of participatory practices such as Joint Forest Management and Van Panchayats.

As an important action for containing the degradation of forest ecosystems in India, government has set up the National Afforestation and Eco-Development Board (NAEB) in August 1992 for promoting afforestation, tree planting, ecological restoration and eco-development activities. The National Afforestation Programme is the most important scheme of NAEB, the most successful Joint Forest Programme being the output of this scheme.

²⁸ National Environmental Policy, 2006, Government of India, Ministry of Environment and Forests, 2006, National Environmental Policy, 2006, Government of Pakistan, Ministry of Environment and Forests, 2005.

The Forest Conservation Act and the Wildlife Protection Act together form a basis of the laws governing wildlife protection in India. A closer examination of these laws reveals that a top down or more centralized approach to wild life management currently practiced in India with the Government (Central) playing the major role. This approach to wild life management has several constraints:

- (a) It is more centralized and it does not take advantage of the federal and more decentralized form of Government in India. With the recent constitutional amendments, India has three levels of Government: Central, State, and local self governments (village panchayats).
- (b) The laws so far provide only for very limited involvement of important stakeholders of wild life and forests especially local people and communities and the general public.
- (c) In a more centralized management by the Government, the monitoring and enforcement costs of these laws are very high. Wild life having low priority in the development goals of any developing country like India, it is difficult to provide required budgetary support for it.
- (d) There are high risks of non-compliance to these laws because of questionable quality of Government.

These are some of the factors that have lead to the ineffectiveness of these laws as we are witnessing today in the form of vanishing of tigers in some well protected national parks and sanctuaries under the prestigious Project Tiger, poaching of Rhinos in Kajaranga national park, killings of hundreds of elephants every year by the ivory hungry bandits and scant concern for the dwindling biodiversity in the Himalayas and the rain forests of Western Ghats.

Laws for protecting forests and wildlife in India have to provide for a bottom up or more decentralized approach ensuring the involvement of all the stake holders of forests and wild life: local communities, general public, Non Governmental Organizations (NGOs) and the Government. The current laws provide for some involvement of local communities with the Government playing a pivotal role. A major amendment made to the Wildlife Protection Act in 1991 calls for the harmonization of the needs of tribals and other forest dwellers with the protection and conservation of wildlife. The provision for the creation of conservation and community reserves in the areas adjacent to national parks and sanctuaries for protecting the habitat of flora and fauna in the amendments made in 1993 and 2002 is a further step in right direction for the decentralized and participatory management of wild life in India. This is aimed to improve the socio economic conditions of people living in these areas as well as conservation of wildlife. The laws provide for the constitution of National Board and State Boards for wildlife, advisory committees for sanctuaries and the community reserve management committees involving the stakeholders. The Forest Conservation Act and its recent amendments provide for the involvement of village communities and voluntary agencies for the regeneration of forests. The currently existing provisions in the laws governing wildlife in India are not enough to ensure

- (a) the resolution of conflicts between the Government and the conservation lobby and the local communities,
- (b) appreciation of communities' immense knowledge of local biodiversity and historical experience of managing it,
- (c) understanding the links between livelihood of local people and biological resources,
- (d) recognition of rights of local communities and the need to increasing their ability to exercise those rights,
- (e) creation of rural assets that are complementary to the conservation of forests and wildlife
- (f) identification of benefits from wildlife and forest conservation and the instruments for appropriating them and
- (g) presence of institutions facilitating the sharing of benefits from the conservation of wildlife between the local communities and other stakeholders including Government.

The bottom up or more decentralized approach for the wildlife management in India could only ensure all these.

Lessons could be drawn from the success story of the Joint Forest Management (JFM) instituted in 1990 by the Government of India for the decentralized management of forest resources with the objective of attaining the resource use efficiency and sustainability. Some people have already suggested that an institution similar to JFM with the name Joint Protected Area Management (JPAM) could be there for the decentralized management of wild life.

'JPAM is the management of protected areas and their surrounds, with the objective of conserving natural ecosystems and their wildlife, as well of ensuring the livelihood security of local traditional communities, through legal and institutional mechanisms which ensure an equal partnership between these communities and government agencies' (Kothari, 1996)

The existing wild life and forest protection laws in India are silent on the benefits and costs of wild life protection. Conservation programmes of forests and wildlife involve costs and benefits to various stakeholders. In many of these programmes in India there are costs to Government and the local communities and benefits to rest of the society including international communities. The law has to provide for the appropriate instruments and institutions for appropriating the benefits so that gainers compensate the losers in the wildlife and forest management. People receive user benefits from the eco-tourism and non-user benefits in the form of bequest benefits and the personal satisfaction of knowing that the bio-diversity is protected. They would like to pay for these through appropriate institutions. Recent empirical studies in India show that the people would like to pay significant amounts for visiting national parks and sanctuaries and other wildlife areas. Wildlife enthusiasts in India and abroad may like to contribute voluntarily for the wildlife protection in the developing countries for the non-user benefits they receive. Appropriately designed user charges for the visitors to wild life areas, wildlife tax on the general public and the voluntary contributions from the international communities could become the instruments for the appropriation of benefits of wildlife protection and to create a sort of wildlife fund.

Biodiversity conservation and the conservation of forests and wildlife are complementary phenomenon. Biodiversity hotspots, sacred groves and landscapes are interwoven with forests, land and water resources. The National Biodiversity Strategy and Action Plan is aimed to strengthen the protection of biodiversity hotspots, pay attention to the trade off between biodiversity conservation and developmental projects, and the effective implementation of the Patents Act, 1970. It recognizes that the traditional knowledge possessed by the local communities is one of the basis for their livelihoods and means of knowing the value of genetic biodiversity. India is a signatory to the Convention on Biological Diversity (CBD) held in Rio de Janerio in 1992.

Similar approaches for the conservation of forests and bio-diversity could be found in other countries of Hindukush region. The national forest policy of Pakistan also highlights the participatory approach for forest management and aims for institutional reforms to achieve it. Some of its objectives are to promote social and farm forestry and irrigated plantations and to have a strategy for protection and rehabilitation of mangrove forests with the participation of local communities. It also aims to provide alternative sources of fuel to the local households for reducing the pressure on local forests and upland ecosystems for fuel wood. As it is the case of Indian government, the government of Pakistan also wants participatory approaches for the bio-diversity conservation and protected area management. The Biodiversity Action Plan of Pakistan aims to have more community involvement in the management of

national parks and protected areas for the conservation of bio-diversity through the provision of incentives and responsibilities.

Nepal provides a good example for highlighting the links between poverty and forest conservation. The forest policy in Nepal has gone through the phases of private forestry before fifties, nationalization or government forestry during 1960s and 1970s and community orientation or community forestry during the later periods. The Private Forest Nationalization Act, 1957 was the first forest legislation enacted by the government of Nepal. This Act intended for setting up an effective protection and management system for Nepal's forests has provided a base for the redistribution forests for the local community management in the later years. The Master Plan for forestry sector, which came in to force in 1988 aims to meet the basic needs of people for forestry products on sustainable basis and protecting and managing forests through people's participation. The Forest Act 1993 and Forest Rules 1995 have provided for having all three property rights regimes of community, government and private for the management of forests in Nepal. Therefore, people oriented forestry and the creation of protected areas or national parks for the bio-diversity conservation have been functioning side by side in Nepal as it is in India and other countries in the region.

In Bhutan people entirely depend on forests and water resources for their livelihoods. Over 80 percent of its population depends on mountain agriculture and livestock. Until recently, forests and water resources are under state ownership with little local community involvement resulting in having top down approach for the natural resource management. However, in the 8th Five year plan of Bhutan (1997), a decentralized approach for development planning is outlined with an objective of involving local people. In the year 2002, the mid term planning exercise has involved local communities in the development planning for the first time in Bhutan. The hydro- power, an important output from water resources in Bhutan contributes 11 percent GDP and 60 percent of government revenue. Exploitation of hydropower in Bhutan and exporting it to the neighboring countries has useful effects on ecological conservation in South Asia. The current strategy of Government of Bhutan to give highest priority for the development of hydropower is encouraging for substituting renewable energy to fossil fuels in the region. Many international development agencies including ADB and the agencies of India, Japan, Norway and Austria have been supporting this strategy and providing significant financial support for the power sector development in Bhutan.

Water Resources

Uses of water resources for human welfare have quantity and quality dimensions. Human activities affect both quantity and quality of water. Water pollution emanating from household, industrial and agricultural uses of water effects the quality of surface, ground and coastal waters. Greenhouse gas emissions bringing climatic changes affect precipitation and monsoon patterns. Excessive withdrawal of ground water for industrial and agricultural uses results in ground water depletion. Fortunately, for the living beings, water as an environmental resource is regenerative in the sense it could absorb pollution loads up to certain levels without affecting its quality and there could be a sustainable supply of water with an appropriate water conservation strategy. In fact there could be a problem of water pollution, only if the pollution loads exceed this natural regenerative capacity of a water resource. The control of water pollution is therefore to reduce the pollution loads from anthropogenic activities to the natural regenerative capacity of the resource. The benefits from the preservation of water resources are manifold. Not only can water pollution abatement provide marketable benefits such as reduced water borne diseases, savings in the cost of supplying water for household, industrial and agricultural uses, control of land degradation and fisheries development, it can also generate non-marketable benefits like improved environmental amenities, aquatic life and biodiversity.

Poor are affected relatively more from the depletion of quality and quantity of water than the rich. The incidence of health effects of water pollution is more on the poor because they are not afford to resort to defensive measures to avoid ill health from pollution.

The legislative responses and the new environmental policy described above provide for using the instruments and institutions for the environmentally sustainable use of water resources in Hindukush region. There have been a number of policy responses in this context in India, Pakistan and Bangladesh in recent times. For instance in India, the National River Conservation Plan (NRCP) and National Lake Conservation Plan (NLCP) provide assistance to state governments for improving the quality of rivers and lakes. The National River Conservation Directorate (NRCD) under the Ministry of Environment and Forests designs and implements various projects for cleaning the rivers and lakes. So far a total of 34 rivers have been covered under the programme. The first River Action Plan to be taken up under the NRCD was the Ganga Action Plan²⁹ followed by Yamuna Action Plan. Government of India under NLCP started a programme for conservation and management of polluted lakes in 2001. The objective of the scheme is to restore and conserve polluted and degraded lakes and other similar bodies. So far works on 37 lakes have been taken up including Dal lake in Jammu and Kashmir.

The new environmental policy of government of India provides an action plan for river conservation with the following elements: evaluate the impact of climate change on glaciers and river flows, mitigate the impacts on river and estuarine flora and fauna, promote integrated approaches for river basin management, and integrate conservation of wetlands into river basin management involving all relevant stakeholders, in particular local communities. Similar concerns could be found in the environmental policies of Pakistan and Bangladesh.

The governments of Hinudukush region have been undertaking programmes on conservation of wetlands in recent times. For instance, the Indian government has initiated in 1987 a programme with the objectives of assessment of wetland resources, identification of wetlands of national importance, promotion of R&D activities and formulation and implementation of management action plans of the identified wetlands. The National Wetland Committee was constituted with the representatives from states. The number of wetlands identified for inclusion in National Wetland Conservation Programme until recently are 71 in 21 states. The activities of Management Action Plans for identified wetlands include the survey and demarcation, catchment area treatment, desiltation, weed control, fisheries development, community participation, water management, public awareness and pollution abatement. The current environmental policies of all the countries in the region particularly emphasize the formulation of conservation strategies for each wetland ensuring the participation of local communities, and other relevant stakeholders. These policies also ask for the formulation and implementation of eco-tourism strategies for identified wetlands through multi-stakeholder partnerships involving public agencies, local communities, and investors.

Other Ecosystems

²⁹ See Section VI for details.

India, Bangladesh and Pakistan have been having programmes for the conservation of mangroves. For example, the Indian government has launched the Mangrove Conservation Programme in 1987. It also constituted the National Committee on Mangroves and Coral Reefs. Government has so far identified 38 mangrove areas for intensive conservation and management in the country. It gives full assistance under management action plans for undertaking activities like raising mangrove plantations, protection, catchments area treatment, siltation control, pollution abatement, biodiversity conservation, sustainable resource utilization, survey and demarcation, and education and awareness.

Mountain ecosystems provide forest cover, feed rivers, conserving bio diversity and resource base for livelihoods of poor. They are more susceptible to the anthropogenic activities and require policy interventions for their conservation. The new environmental policies in the region envisage appropriate land use planning and watershed management practices, regulation of tourist inflows, and the regulation of development activities in mountain areas.

IV: Policy Responses for Air and Water Pollution

Formal Regulation

The comprehensive environmental legislation and policy responses described above provide for the use of flexible set of policy instruments and institutions for the control of water and air pollution in Hindukush region. However, the countries in the region have not used these legislations so far for choosing a right mix of instruments for the environmental regulation. They still use command and control instruments. There are several empirical studies made recently especially in India exploring the possibility of using economic instruments and the institutions facilitating people's participation in the management of environmental resources³⁰. These studies argue for the use of economic instruments for the control of pollution by the industries, especially by the big factories, and the use of institutions facilitating collective action to control industrial pollution by the small-scale industries in an industrial estate, and the management of forest resources. Although it is widely known that command and control measures do not provide the necessary incentives to the polluters for the choice of least cost methods of pollution control, the governments of countries in the region have so far resorted only to such measures for controlling industrial pollution. On the other hand, fiscal instruments such as pollution taxes or marketable pollution permits though also coercive, provide incentives, to the factories for adopting the least cost pollution abatement technologies. Ironically, there are no serious attempts made in the region so far for using such instruments for industrial pollution abatement. Some of the recent research studies on the industrial pollution abatement in India³¹ give some information about the rate of tax to be levied on industries for making them comply with the prescribed water and air quality standards. One study carried out in the year 1989³² estimates the cost of treatment per a kiloliter of residual water at 1987-89 prices at Rs. 3.60 for Paper and Pulp industry, at Rs.2.61 for Oil Refineries, Rs. 2.21 for Chemicals and Rs.1.64 for Sugar. Another study³³ carried out in 1994 estimates the marginal cost of abatement for the reduction of 100 mg of Bio Oxygen Demand in the residual water for Paper and Pulp industry at Rs. 0.38 at 1991-92 prices. Yet another study published in 1999³⁴ has found that the pollution tax per 100 mg reduction of Chemical Oxygen Demand (COD) by the Indian Manufacturing Industry for realising the standard of 250 mg per litre of residual water is Rs. 0.32 at 1995-96 prices.

30 See Chopra et al., 1989; Mehta et al., 1996; Murty et al. 1999; World Bank, 1999; Murty and Surender Kumar, 2004.

31 See Gupta et al., 1989; Mehta et al., 1996; Murty et al., 1999; Pandey, 1999; Misra, 1999; World Bank, 1999; Murty and Kumar, 2004; Murty and Gulati, 2007..

32 Gupta, Murty and Pandey (1989.)

33 Mehta, Mundle and Shankar (1996).

34 James, Murty and Misra 1999

The taxes-standards method³⁵ is used here for designing water pollution taxes for the Indian industry. According to this method, if taxes are designed and levied such that the tax on each pollutant is equal to the marginal cost of abatement corresponding to the standard, the polluting firms will have incentives to comply with the standards. The designing of taxes for the water pollution abatement in India requires information about the standards for different water pollution parameters, and the estimates of water pollution abatement cost functions. Given this information, the pollution taxes required to make the factories to meet the standards can then be estimated.

The water polluting firms in the Indian industry are supposed to meet the standards set for the pollutants (35mg/l for BOD, 250mg/l for COD, and 100mg/l for SSP) by the Central Pollution Control Board. The thermal power generating plants have Stack Emission Standards of 115, 80 and 80 milligrams per Nm³ respectively for SPM, SO₂ and NO_x. Command and Control regulatory instruments are used to make the firms realize the standards. A survey³⁶ of sample of water polluting industries in India shows that most of the firms have effluent treatment plants and in addition some firms are using process changes in production and input choices to achieve the effluent standards. However, there is a large variation in the degree of compliance among the firms measured in terms of ratio of standard to effluent quality. The laxity of formal environmental regulation by the government and the use of command and control instruments could be regarded as factors responsible for large variations in the compliance to the pollution standards by the firms. Using this data Murty and Kumar provides the estimates of taxes on one tonne of BOD, COD, and SS as Rs. 20,157, Rs. 48,826, and Rs. 21,444 respectively. Similarly, a recent study³⁷ provides estimates of taxes on emissions of SPM, SO₂ and NO_x from thermal power generation in India as Rs. 2099, 20519 and 5554 per tonne respectively.

Informal Regulation and People's Participation

Economic instruments and the command and controls are known as instruments of formal regulation or regulation by the government. The designing and implementation of these instruments involve top down or a centralized approach. The success of these instruments in controlling pollution depends upon the quality of government and its ability to incur the high transaction costs. The governments of many developing countries could not meet these requirements resulting in the failure of regulation. A bottom up or decentralized regulation involving civic society and local communities and with a very limited role of government could save transaction cost and get rid of political and bureaucratic corruption. This approach draws theoretical support from the bargaining problem of Coase (1960) which says that given the initial property rights to any resource either to the generator of the externality or to the affected party, and if the cost of bargaining is zero, the bargaining between the two parties results in the optimal control of externality. The final outcome of bargaining is invariant to the initial property rights assignment. Even with the positive bargaining or transaction costs, the bargaining could result in the reduction of externality though not to the optimum level. Recent empirical experiences show that the bargaining between the local communities and polluters with the government protecting the property rights to the environmental resource to the people could control water and air pollution³⁸.

Take for example pollution abatement by small-scale enterprises located in industrial estates in India and other countries in Hindukush region. Use of command and control instruments by the government in an environment of non-availability of economically viable technological options for the pollution abatement has been causing considerable hardship to small-scale enterprises. The government-managed public sector has been the fountainhead of industrial development in this

35 Baumol and Oates, 1988

36 A Survey of Water Polluting Industries in India, 1996 and A Survey of Water and Air polluting Industries in India, 2000, Institute of Economic Growth, Delhi

37 Murty and Gulati, 2007.

38 Paragal and Wheeler, 1996; World Bank, 1999; Murty, et al. 1999

region during all these years. But the governments have not made any sincere efforts to promote economically viable pollution abatement technologies for the small-scale enterprises via R&D in the public sector. The presence of scale economies in pollution abatement, especially in the water pollution abatement, has compounded problems for the industrial estates. In such a situation, it is not economical for the small-scale enterprises to have their own individual effluent treatment plants to comply with the command and control regulation. Collective action involving all the relevant parties for the water pollution abatement (factories, affected parties and government) is now seen as an institutional alternative to deal with the problem of water pollution abatement in industrial estates especially in India³⁹. Collective action in industrial water pollution abatement is meant to bring about the necessary institutional changes that are compatible with the choice of cost saving technologies. For example, a Common Effluent Treatment Plant (CETP) can be adopted if necessary legislation is in place to define the property rights of the factories and the affected parties. A CETP for an industrial estate confers the benefits of saving in costs to the factories and the reduction in the damages to the affected parties. There are many incentives for polluters, affected parties and the government to promote collective action in the industrial water pollution abatement.

Recent studies⁴⁰ in the region about the historical developments leading to the adoption of CETP technologies by some industrial estates clearly provide evidence for the role of collective action involving affected people from pollution, the factories, NGOs and Government. There are three processes involved in the collective action for control of water pollution in an industrial estate. These are (a) collective action of affected parties; (b) collective action of factories and (c) the bargaining between a coalition of affected people and a coalition of factories. The collective action of affected people is possible, if the damages from pollution are substantive enough to justify the transaction costs of coalition and bargaining. The factories in an industrial estate have to take recourse to pollution abatement methods taking into account of possible collective action by the affected people. The available pollution abatement technologies may provide the small factories a broad spectrum of technological choices out of which the common effluent treatment plant may be the least cost technology. Therefore, the collective action by the factories can be technology driven. Finally, the bargaining between a coalition of affected people and a coalition of factories produces the end result of collective action, that is the realization of prescribed environmental standards.

The management of environmental resources can no longer be taken as the responsibility of a single institution like market or government. The now well-known limitations on either market or government in managing the environment have paved the way for having a mixture of institutions. The experiences from both developed and developing countries show the emergence of informal regulations in the pollution control. The World Bank Policy Research Report (World Bank, 1999) and Murty, James and Misra (1999) have discussed some of the aspects of this new approach.

The market agents, consumers, producers and stockholders have incentives for pollution control. Consumers regulate the market for pollution intensive commodities by expressing preference for green products or commodities produced using cleaner technologies. Investors have also incentives to invest in the industries using cleaner technologies. Higher levels of observed pollution in a firm is an indication to the investors that the firm uses inefficient technology resulting in the loss of profits. The profit losses may occur because of reduced demand for its products by green consumers, increased cost due to higher penalties imposed by the government for non-compliance with the pollution standards, and the settlement of compensation to the victims. In this case there

39 Murty, et al. 1999

40See Murty and Prasad, 1999 in Murty, et al. 1999.

may be a downward revaluation of the firm's stocks in the capital market. On the other hand, a good environmental performance by the firm may result in upward evaluation of its stocks⁴¹.

In developed countries, contesting environmental regulations by local communities and industries is now becoming an important component of enforcement of environmental laws. Some recent studies have reported that US Environmental Protection Agency (USEPA) encourages private litigants to bring suits against polluters. Private litigation now constitutes a major component in the enforcement of US Clean Air Act. The European Commission in its 1993 Green paper has clearly signalled its intent to keep up the rights of individuals to pursue polluters for compensation for environmental damages. It has reported that the lawmakers in Canada are committed to empowering private agents in virtually every aspect of the pollution control process, from the drafting of regulations to undertaking enforcement.

Some recent studies have shown that the stock markets in both developed and developing countries react to the environmental performance of the firms. Studies about stock markets in US and Canada show that the gains from good news or bad news about environmental performance are in the range of 1 to 2 percent (World Bank, 1999). Also studies about the firms' behaviour with respect to environment performance related changes in stock prices show that the firms react to such changes by reducing the pollution loads. The recent World Bank sponsored studies about this phenomenon in some developing countries like Argentina, Chile, Mexico, and Philippines show that the stock prices are even more volatile to the news about environmental performance of firms. The average of gains in stock prices due to good news about environmental performance is found to be 20 percent in these countries.

There are now evidences also about a number of industries in the developing countries complying with the environmental standards even in the absence of formal regulation by the government. One interesting example is the success story of PT Indah Kiat Pulp and Paper (IKPP) in Indonesia described in World Bank (1999). IKPP is the largest and the cleanest paper producing company in Indonesia. Clean up began in some of its mills in 1990s with pressures from local communities. Local villagers claimed damages from the mills with help of local NGOs. Indonesia's national pollution control agency, BAPEDAL, has mediated an agreement in which IKPP acceded to the villagers' demands. Furthermore, need for going to Western bond market for financing the expansion of IKPP to meet the growing export demand, has made the company to go for cleaner technologies. The good performance of the company in pollution management has resulted in the increase of its stock value in comparison to the Jakarta's composite stock index.

Murty, James and Misra (1999) have reported the results of a survey of a number of industrial estates and an All India survey of large scale water polluting factories in India providing evidences of local community pressure resulting in the industries complying with the standards. A number of agencies such as local communities, elected representatives (members of Parliament, State Assemblies, Municipal Committees), industries, NGOs and government are found to be involved in the processes leading to the establishment of common effluent treatment plants in the industrial estates. There are also several examples of physical threats, and public litigation cases against the factories for claiming the damages from pollution by the local people resulting in the big factories complying with the standards. Take for example, the Pattancheru industrial estate in Andhra Pradesh state of India. Local opposition to the pollution started in 1986 when about 3000 villagers marched to the Chief Minister's office after suffering large-scale crop losses and health damages due to contamination of ground water and the pollution of near by river. In 1989, about 5000 people held a demonstration before the state assembly, demanding an end to industrial pollution. In the same years farmers blocked the highway running through Patancheru for two days. Not

41 Cormier et al. 1993; Cohen et al. 1995; Hamilton, 1995; Hart and Ahuja, 1996; Khanna et al. 1998; Dasgupta et al. 2001; Gupta and Goldar, 2005.

withstanding these threats, the villagers had also filed court cases by jointly sharing the cost with the contribution of Rs. 200 per household. This legal action through the collective efforts of people has ultimately forced the factories in the industrial estate to have a common effluent treatment plant for complying with the water pollution standards. Similar experiences are reported from many other industrial estates in the region.

Informal regulation by local communities is resulting in the factories complying with standards as explained by the examples given above. The amount of influence the local communities exert on the factories to undertake pollution depends, among other factors, upon their affluence, the degree of political organisation, education and environmental awareness. Pargal and Wheeler (1996) have found a negative relationship between BOD load in a factory effluent and per capita income and educational levels of local communities in a sample of 243 factories in Indonesia. Similarly, Murty and Prasad (1999)⁴² have found a negative relationship between BOD effluent-influent ratio and a relative index of development of local community, and the political activity of local community measured in terms of percentage of votes polled in the recent election to the Indian Parliament.

The introduction of roles of communities and markets in the pollution control gives raise to a more robust model explaining the firms' behaviour in response to environmental regulation. Even with out formal regulation by the government, the pressure applied through these channels can increase the expected implicit penalties on the firms for the non-compliance with the pollution standards. The firms react by reducing pollution in this situation as in the case of government regulators enforcing the standards.

In this new model, the government regulators have still a role to play. But their role is not creating and enforcing the environmental standards. It is merely a catalytic role of providing information about the environmental programs designed and the available cleaner technologies and providing some financial incentives to local communities. Therefore, this new model constitutes a regulatory triangle consisting of local community, market and government.

V: Policy Responses to Climatic Change and International Co-operation

The countries of Hindukush region have to play an important role in the international efforts for the conservation of global ecosystems comprising atmosphere and marine ecosystems. They have to deal with the global externalities problems of greenhouse gas emissions, ozone depletion and bio-diversity conservation along with other countries of the world. Some of the governments in this region have been a party to most of the multilateral environmental agreements such as the Convention on Wetlands for International Importance, Vienna Convention for the Protection of the Ozone Layer, Montreal Protocol on Substances that Deplete Ozone Layer, Conventions on Biological Diversity, UN Framework Convention on Climate Change, Kyoto Protocol, the Basel Convention on Tranboundary Movement of Hazardous Substances, Convention to Combat Desertification and Stockholm Convention on Persistent Organic Pollutants.

Climate is a global public good affected by greenhouse gas emissions needing international action to avoid drastic changes in it. Some recent studies show that the poor living South Asia are more affected by the climatic change induced problems of water scarcity, floods, sea water ingression and cyclones. The IPCC Fourth Assessment Report, 2007⁴³ provides evidence with

⁴² See Murty et al. 1999.

⁴³ Climate Change 2007: Impacts, Adaptation and Vulnerability, Working Group II Contribution to the Intergovernmental Panel on Climate Change, Fourth Assessment Report, 2007.

the increased confidence for the relationship between the observed climatic change and the recent changes in the natural and human environment. It makes predictions about the climate change impacts on fresh water resources, ecosystems, crop productivity, coastal systems, industry and settlements and health. By 2050, annual average water supply is projected to increase by 10-40 per cent at high latitudes and in some tropical wetlands and decrease by 10-30 percent in dry regions at mid-latitudes and in some dry tropics. The resilience of many ecosystems is likely to be exceeded in 21st century by a combination of climate change and other drivers of environmental changes. Approximately 20-30 percent of plant and animal species known so far face the increased risk of extinction with the increase of global temperatures by 1.5-2.5^o C. Crop productivity is projected to increase at mid to high latitudes for local temperature increases up 3^o C and decrease at lower latitudes even for the rise in temperature is up to 1^o C. Many million people living in coastal regions have increased risk of being flooded every year due to sea level rise by 2080s.

A recent review of various climatic change models (Stern, 2007) shows that the future impacts and risks of climate change associated with the emissions of business as usual (BAU) scenario are equivalent to the average 5 percent reduction of global per capita consumption now and forever. This cost will increase further even up to 11 percent if one takes into account non-market impacts on environment and human health. Reduction of greenhouse gas emissions could be obtained by (a) reducing demand for emission-intensive goods and services, (b) increased efficiency in reducing cost and emissions, (c) reduction of non-energy emissions by avoiding deforestation etc. and (d) switching to lower carbon technologies for power heat and transport. The cost of mitigation to the world economy for stabilizing greenhouse gas emissions at levels of 500-550ppm CO₂e is one percent of global GDP by 2050. The cost of mitigation depends on the international co-operation and the policy instruments used for reducing emissions. Significant reductions in mitigation costs could be obtained by using economic instruments of carbon taxes or auctioned permits for obtaining the greenhouse gas target reductions. The studies reviewed by IPCC 2007 estimate the mitigation cost for stabilizing emissions between 450-710 ppm in 2030 in the range of 3 - 0.1 percent of global GDP. The reviewed studies differ with respect to instruments considered from a broad range of policies consisting of integrating climate policies in broader development policies, regulations standards, taxes and charges, tradable permits, voluntary agreements and financial incentives.

It is important to attempt model simulations for comparing projections of environmental changes under alternative policy options with the baseline projections of BAU scenario. Two important policy options for climatic change problem are (a) using economic instruments, price or quantity instruments (carbon pricing or tradable carbon permits) and (b) technology policy. Green house gas emissions could be reduced with lower cost by making the emitters to pay a carbon price. A uniform carbon price to be paid by the polluters world over could be established if the world countries agree to have either the international carbon tax or a regime of tradable carbon permits. The price quantity regimes for reducing emissions instill competition among the polluters to choose low cost abatement technologies and invest in innovation. Lack of information could a barrier to use carbon prices and to have international co-operation. Information policies including fixing of safe environmental standards, spreading the knowledge of dangers of pollution and climatic change and removing the barriers to access the technologies could result in the efficient functioning of a regime of carbon pricing.

Some studies predict changes in temperatures across seasons and regions in the Indian subcontinent. IPCC (1996) projected that the temperature increases by 0.10^o C to 0.30^o C in summer and 0.30^o C to 0.70^o C in winter in India. Mean rainfall is not likely to change by 2010

but may increase by 10 percent during the winter by the year 2050. Climate change affects agricultural production in two ways: directly through changes in temperature and precipitation and indirectly through changes in soil and distribution and frequency of crop diseases. Model simulations show that the climatic change effects are positive for rice amounting to rising yields of 5-20 percent and uncertain for wheat with yield changes in the range of 25 percent to – 30 percent.

Hindukush region could benefit from the international co-operation even in the context of domestic environmental regulation. The developed countries have already got rich experience of using economic instruments of emission taxes and marketable permits to deal with the problems of air and water pollution in selected sectors. Environmental regulation has helped to develop cost minimizing pollution abatement technologies in these countries. The developing countries could have incentives to use economic instruments if they have access to the newly developed pollution abatement technologies in the developed countries. The ethical and social concerns of developed countries about the environmental safety of people living in poor countries could make them to use trade policy instruments of import taxes and environmental quality standards on the exports from India and other developing countries. However, it is known that the trade policy instruments used by either exporting developing country or importing developed country are inefficient instruments to deal with the domestic environmental problems. The economic instruments are appropriate to deal with the domestic environmental problems and the developed countries could help countries in Hindukush region by sharing the knowledge of pollution abatement technologies and the environmental regulation.

VI: Policy Responses: Some Examples from Indian Subcontinent

Fragile and degrading ecosystems in Hindukush region have been a cause of concern for the international communities because they are rich in bio-diversity, sources of living for millions of poor people living in the region and the potential means for containing the global climatic changes. Apart from the governments of countries in the region, many governmental and non-governmental international agencies have been spending money in the programmes of conservation of ecosystems and strengthening the adaptation of poor for the ecological changes. The agencies involved in these programmes include World Bank, Asian Development Bank, Bank of Japan, UNDP, UNEP, American Aid, DFID, Canadian, Swedish and other development agencies. It could be useful to provide some examples of these programmes in this region.

A Major Policy Response for River Ecosystem Conservation ⁴⁴: Ganga Action Plan

Ganges river and its tributaries flow through four countries of Hindukush region: India, Nepal, Bhutan and Bangladesh. Ganga Action Plan (GAP), a project for the conservation of river ecosystem in the region is a major investment project of Indian government with some financial support of international agencies. Cleaning of the international river, Ganges provides multiple benefits. There are benefits accruing to people who stay near the river or visit the river for pilgrimages or tourism. These will be in the form of recreation and health benefits and are called user benefits. The other type of benefits are called non-user benefits accruing to the people who are not staying near the river but gain welfare from knowing the river is clean. This category of people can be both Indians and foreigners. The non-user benefits of the Ganges arise out of motives people have to bequeath the bio-diversity the river supports to the future generations (bequest motive), for getting reassured about the conservation of Ganges with the knowledge that the river is kept clean and the aquatic life is protected (existence motive), and to protect the people living in the river basin from water borne diseases (altruistic motive). Other beneficiaries include fishermen, farmers and those for whom employment is created as a result of the project.

⁴⁴ This discussion is drawn mainly from Markandya and Murty, 2000.

Fishermen get benefits of improved fish production while farmers get irrigation benefits. The investment projects for cleaning Ganges provide employment to unemployed or underemployed unskilled labor in India. Also, the cleaning Ganges contributes benefits in the form of cost savings to water supply undertakings along the river. Hence the beneficiaries from cleaning Ganges can be classified as users, non-users, health beneficiaries, farmers, unskilled labor, and fishermen. Therefore, the Ganga Action Plan (GAP) in India, the investment project for cleaning Ganges provides most of the benefits described above.

The Ganges supports 25,000 or more of species of bio-diversity ranging from microorganisms to mammals. There are a number of international species comprising of mammals, reptiles and birds supported by the Ganges ecosystem. The Ganges dolphin, Irrawaddy dolphin, finless porpoise, and a variety of otters are some of the important mammals found in the river. In the case of bird life, osprey, ring tailed fishing eagle, and Indian skimmer are important species. A variety of crocodiles including Gharial, marsh crocodile or Maggar, and salt-water crocodile and a number of turtles unique to the Ganges are the reptiles supported by the Ganges. The GAP has helped in preserving these species in four ways. First, there are some for which there have been *in situ* conservation and captive breeding programmes. Second the GAP has raised awareness and encouraged conservation efforts through information dissemination etc. Third, the GAP has facilitated the collection of information on species and their habitat, something that will contribute in an important way to their conservation. Finally, the general improvement of the quality of water of Ganges has helped most of the above species. The international significance of many of these species can result in placing substantial non-use values on the Ganges by the international communities. Therefore, the international communities can potentially contribute money for cleaning the Ganges if India desires such a support. The resource constraints and the very high opportunity cost in terms of foregone development benefits from the conservation programs of Ganges may make this option attractive to India for the river cleaning programs in future.

User and Non-user Benefits

The user and non-user benefits of cleaning Ganges are estimated using the contingent valuation methods of survey of households⁴⁵. There are 2000 households surveyed in 10 cities in India for estimating non-user benefits. For measuring user benefits, especially amenity benefits from Ganges; the sample is limited to residents, tourists, and pilgrims in the cities along the river. Each household was asked to place a value on the three scenarios of river quality: (a) quality before the river cleanup, (b) the current quality, and (c) bathing quality. The willingness to pay function relating these values to socio-economic characteristics of households and the river quality was then estimated⁴⁶. Table 2 provides estimates of mean willingness to pay for users and non-users based on the estimated willingness to pay functions. Table 3 provides the estimates of benefits to the entire beneficiary population in India.

Table 2: Mean Willingness to Pay for Non-users and Users
(Rupees per household per annum at 1995-6 prices)

Levels of Water quality	Bathing quality	1995 quality with GAP	1985 quality
Non-users	557.94	192.81	101.48
Users	581.59	167.23	93.28

⁴⁵See Freeman III, 1993 and Mitchell and Carson, 1993 for a detailed description of contingent valuation methods.

⁴⁶See Markandya and Murty, 2000; 2004 for details about the estimated willingness to pay equations.

Source: Markandya and Murty (2000)

**Table 3: Aggregate Willingness to Pay for Changes in Ganges Water Quality
(Rs. million at 1995-96 prices)**

Change in water Quality level	Non-user Benefits	User Benefits
1985 to bathing quality	4021.1	32
1985 to 1995 quality	797.7	5

Source: Markandya and Murty (2000)

Health Benefits

The estimates of health benefits from the reduction in Ganges pollution are obtained using the cost of illness approach. A study conducted by the All India Institute of Hygiene and Public Health (AIIPH&PH, 1997), Calcutta has obtained these estimates. Data was collected about the health of a sample of population living along the Ganges in the two scenarios of with and without river cleaning. Since cross section data are used in estimating the health benefits, the data about the health of the population in the control region are used for the scenario without river cleaning. The health benefits are estimated as the improvement in user income due to reduction in working days lost due to illness from water borne diseases. The recreational benefits to the literate households living along the Ganges are estimated using the contingent valuation method.

Fisheries Benefits

GAP could contribute to the increased supply of fish and reduce the risk of fish infection or contamination. For estimating the benefits from the improved fish supply from Ganges, the data are needed about fish species caught and catch volume, catch effort, fish prices, and the significant non-Gap changes and GAP changes that could affect fish catch. Unfortunately, the reliable data on these various items are not available so that the fisheries benefits from the GAP could not be estimated. Given that the incremental fisheries benefits mainly accrue to fishermen in the Gangetic basin belonging to a very low-income group in the Indian economy, these benefits assume importance from the point of view of income distributional effects of GAP in the estimation of social benefits.

Cost of GAP

River cleaning involves cost to government, households and the industry and the employment benefits to the unskilled labor. The total actual investment under GAP Phase I is Rs.6397.25 million at 1995-96 prices. These expenditures cover a large number of water pollution abatement projects contributing to clean up Ganges. The annual expenditure of on the operation and maintenance cost of these projects is Rs. 355.703 million. These expenditures made by government have created employment for a large number of surplus unskilled laborers and there by increasing their incomes in the Gangetic basin.

The international experience of river cleaning programs including that of Ganges in India shows that a combination of instruments and institutions have to be used to achieve the river cleaning objectives. The environmental regulation requires the polluters to comply with safe environmental standards. The compliance to the environmental standards requires both private and public investments. In the case of cleaning Ganges, there is public investment through the project GAP and there is private investment by industries in the Gangetic basin. It is mandatory for the industries to make investments in pollution control to meet the national standards for the

water quality. There are 68 heavily polluting industries in Gangetic basin generating 2.6 million kilolitres of effluent every day. The data about the pollution abatement cost collected for a sample of 18 water-polluting industries in the river basin that are meeting the effluent standards provides an estimate of Rs. 0.39 per kilolitre of water treated at 1993-94 prices (Murty et al. 1999). The daily cost of treating 2.6 million kilolitre of effluent is Rs. 1.014 million. The annual cost of effluent treatment for the water polluting industries in the river basin is estimated as Rs.370.11 million.

Estimates of Social Benefits and Costs of GAP

For estimating the social benefits of GAP using the methods of social cost benefit analysis of investment projects (Dasgupta, Marglin and Sen, 1972; Little and Mirrlees, 1974) one requires the estimates of social rate of discount and the shadow prices of investment and unskilled labor for the Indian economy. The social cost of investment in GAP could be greater than the cost at market prices or the financial cost because of scarcity of capital. The social cost of employing unskilled labor on the project could be lower than the wage bill paid at market wage because there is surplus unskilled labor in the Indian economy. Similarly, the social rate of discount could be lower than the market rate of interest because of the presence of economic externalities in the accumulation of capital; the society will have lower time preference rate for savings than the rate individuals have in the free market⁴⁷.

The criteria of net present social value, internal rate of return and the benefit-cost ratio could be used to estimate the social benefits of GAP. Considering the estimates of benefit and cost flows of GAP during the period 1985-2020, Table 4 provides estimates of present value of benefits and costs to various agents in the Indian economy from cleaning Ganges at 10 percent rate of discount. The net present value of GAP at 10 percent rate of discount is estimated as Rs. 4147.51 million. The internal rate of return on investments on GAP is as high as 15.4 percent. The benefit cost ratio is estimated as 1.68.

Table 4: Present Value of Benefits of GAP to Different Beneficiaries at 10 Percent Rate of Discount (Rs. million at 1995-96 prices)

At shadow prices	
1. Users	29.11
2. Non-users	6871.03
3. Farmers	574.93
4. Health beneficiaries	826.93
5. Fishermen	NA
6. Unskilled labour	1919.42
7. Industrial units	-1504.59
8. Government	-4569.32
9. Net present value	4147.51
10. Benefit cost ratio	1.68

Source: Markandya and Murty. 2000.

Note: Rate of discount is taken as 10 percent. The cost to the government is the present value of costs incurred up to the year 1996-97.

⁴⁷ See Markandya and Murty (2002) for the details about the values taken for these national parameters in India. For the most recent estimates of national parameters for the investment project appraisal in India see Murty and Goldar, 2007.

Policy Responses for Urban Ecosystem Conservation: Changing Fuel and Mode in Road Transport

Road transport contributes to the maximum amount of air pollution in all major urban areas in the Indian subcontinent. The pollution from the transport sector could be reduced through inter fuel and inter modal substitution. Substitution of compressed natural gas (CNG) to petrol and diesel and switching mode of transport from road to Metro rail could significantly reduce air pollution. The CNG as a fuel is being substituted to petrol and diesel in many cities of Indian sub-continent including Delhi and Dhaka. There is a diversion of traffic from road to metro rail in the urban areas of Delhi, Kolkata and other cities. Physical accounts of air pollution for the road transport could be prepared given the emission coefficients and the number of vehicles on road for different types of vehicles. For example, given the estimates of emission coefficients with and without CNG introduction for different vehicles, estimates of emission reduction with CNG could be obtained. Monetary accounts of emission reduction could be obtained given the estimates of annual cost per vehicles for using CNG. The incremental annual cost of using CNG by all the vehicles in the transport sector could be taken as an estimate of air pollution abatement cost of road transport sector.

Changing mode of transport from road to metro rail in an urban area could be the cost effective alternative for reducing air pollution. For example, Metro rail substitutes road transport for passengers. Fewer vehicles and the decongestion for the residual traffic on roads due to Metro could lead to reduced air pollution. In India, Metro rail is being developed as an alternative to road transport in many major urban areas and is certainly going to be true for the other countries in the region in the near future. For example, the Delhi metro project is currently undertaken in India with the initial financial support of Bank of Japan. A recent study⁴⁸ has estimated the cost savings in reducing air pollution in Delhi due to Metro. This study estimates the annual benefits from air pollution reduction due to Phase I and Phase II of Delhi metro as Rs. 6883 million at 2005 prices.

Responses to Natural Disasters: Some Examples from Pakistan, Bangladesh and India

In Bangladesh, UK and UNDP have been jointly funding the Comprehensive Disaster Management Programme to improve the capacity of Bangladesh to cope up with the natural disasters like floods and cyclones. UK has been contributing £120 million through DFID in support of Bangladesh development programmes. DFID is spending £50 million during 2004 and 2011 for increasing the livelihood security for 6.5 million poor living in the riverine areas of Northern Bangladesh. Another programme funded by DFID 'Challenging the Frontiers of Poverty Reduction in Bangladesh' is designed to help poor women and their households. DFID has already contributed £16 million for the first phase of this project and has committed £75 million for the second phase of seven years.

Floods and river erosion have been the recovering disasters in India affecting around 7.6 million hectares of land and resulting in the damages amounting to US\$ 400 million annually during recent years. India has flood prone area of 46 million hectares mostly in the less developed regions. The National Common Minimum Programme of 2004 has given priority to protection and development of these regions. In the framework of revised National Water Policy of 2002, 16 million hectares of riverine land has been protected. To complement these efforts of Indian government, the North Eastern Integrated Flood and Riverbank Erosion Management Project funded partly by the Government of UK and managed by Asian Development Bank (ADB) aims to reduce flood and river bank erosion damage in Assam state of India. The total cost of the project is US\$ 1.1 billion. As per the statistics available, 36 percent of 36 million people in

⁴⁸ See Murty et al. (2006) for details.

Assam live with below poverty line incomes and 80 percent of them live in rural areas. Around 40 percent of geographical area of Assam is flood prone. It is estimated that on the average, US\$ 47 million worth of annual crop is lost affecting some 3 million people. River bank erosion has resulted in the annual loss of 8000 hectares of land and the displacement of 10000 families. Therefore, project while providing the conservation of riverine ecosystems in Assam will provide sustainable livelihood for the poor.

Similarly in Pakistan, the World Health Organization's Disease Early Warning System (DEWS) with the support of DFID and the European Commission has saved many lives following earthquake in 2005. The DEWS has helped 3.5 million people affected by the earthquake. DFID funding has ensured the continuance of operation of this system eventually merging in to district health systems of Pakistan. Now it is planned to ensure that DEWS covers the entire country, helps Pakistan to detect and quickly respond to outbreaks and epidemics wherever they occur.

Responses to Increased Water Stress: Examples from Nepal

In Nepal, the Community Support Programme funded by DFID has supported over 3,000 projects targeting poor and excluded communities for providing safe drinking water among other things. This project operates in over half of Nepal's districts, with a budget of £15 million between 2004 and 2008. For example, this project has made a huge difference to the lives of 73 households in the village of Lawasta Guptipur. These households are from the poorest sections of Nepalese society. This village got a grant of £1,500 from this programme and the villagers voluntarily making some more contribution to it were able to build a shelter over their fresh water spring to keep the water clean and unpolluted.

Agriculture is the most important source of livelihood of the rural poor in Nepal providing employment to 80 percent of active workforce. Micro irrigation including drip and micro sprinkler has emerged as an irrigation technology helping small and marginal farmers. These farmers have achieved significant income gains with this technology. Drip and sprinkler irrigation has been found to be environmentally sound with the improved water use efficiency and soil fertility. A recent project, Economic and Social Inclusion of the Disadvantaged Poor through Livelihood Enhancement with Micro-irrigation in Nepal funded mainly by ADB is planned to help 2500 households for growing high value vegetables with micro-irrigation.

VII: Conclusion

The countries in Hindukush region have been going through several legislative responses for the conservation of ecosystems during last many decades leading ultimately to a very comprehensive set of legislations to deal with the development induced ecological changes. However, they are far behind the effective implementation of these laws. Many of these countries are now on high growth path of development with a striking trade off between the development and ecological conservation. The transaction cost or monitoring and enforcement cost of environmental regulation is very high. There are resource constraints for meeting these costs with the conservation having a low priority among the developmental goals of governments. Given that most of these legislations are government centric making the government responsible for the enforcement of environmental laws, the quality of governments in this region also forms an important constraint.

The new environmental policies recognize the role of different stakeholders in the ecological conservation and the links between poor and ecosystems. They recognize the limitations on the government centric approach for the conservation and advocate more decentralized approaches providing incentives for the effective stakeholder participation. The strategies for the conservation of forests and bio-diversity include the institutions of community forestry, joint forest management and joint protected area management. These institutions recognize the

rights of local communities to ecosystems and provide incentives for their participation in conservation through sharing of benefits from ecological services.

Air and water pollution is the main cause of degradation of urban ecosystems and surface and ground water ecosystems. Environmental legislations in this region provide for the use of flexible set of instruments and institutions for the control of air and water pollution. However, the countries in the region have not used these legislations so far for choosing a right mix of instruments for the environmental regulation. They still use command and control instruments. There are several empirical studies done recently especially in India exploring the possibility of using economic instruments and the institutions facilitating people's participation in the management of environmental resources. These studies argue for the use of economic instruments for the control of pollution by the industries, especially by the big factories, and the use of institutions facilitating collective action to control industrial pollution by the small-scale industries in an industrial estate, and the management of forest resources.

It is observed empirically in this region that a bottom up or decentralized regulation involving civic society and local communities and with a very limited role of government has been in place for controlling industrial pollution. This approach could save transaction cost and get rid of political and bureaucratic corruption. This approach draws theoretical support from the bargaining problem of Ronald Coase. Empirical experiences show that the bargaining between the local communities and polluters with the government protecting the property rights to the environmental resource to the people could control water and air pollution. Empirical studies also show that the incidence of damages from industrial pollution is more on poor. Poor suffer more from the health damages of air and water pollution. Ground water pollution from industries in the subcontinent has affected poor local communities in terms of health losses and loss of land productivity and cattle.

The countries of Hindukush region have to play an important role in the international efforts for the conservation of global ecosystems comprising atmosphere and marine ecosystems. They have to deal with the global externalities problems of greenhouse gas emissions, ozone depletion and bio-diversity conservation along with other countries of the world. Some of the governments in this region have been a party to most of the multilateral environmental agreements. Again, empirical studies show that the poor in the region are more affected from climatic changes and the resulting effects on ecosystems.

Fragile and degrading ecosystems in Hindukush region have been a cause of concern for the international communities because they are rich in bio-diversity, sources of living for millions of poor people living in the region and the potential means for containing the global climatic changes. Apart from the governments of countries in the region, many governmental and non-governmental international agencies have been spending money in the programmes of conservation of ecosystems and strengthening the adaptation of poor for the ecological changes.

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Changing Eco-system Social System Links Affecting Rural Livelihood in Fragile Environments*

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Introduction

Ecosystem services and their contributions to livelihoods of the people exhibit significant diversities. Attention to this aspect, generally ignored by mainstream aggregative discourse on ecological services and associated policy processes call for higher priority and its closer integration with the mainstream thrust of the discourse. Because of the very nature of methods and tools of investigations as well as availability of data (which are more macro-focused), the diversity and micro-dimensions of the debated components generally get low coverage. But once one looks at the role of ecosystem services in enhancing livelihood options and reducing poverty, the above disregard of diversities may discount the very purpose of operationally oriented discourse.

The present paper addresses the above mentioned aspects with particular focus on social dimensions (or community approaches) relating to usage and management of environmental resources and how the same have been affected by largely generalized aggregative policy-programme interventions. This is attempted with reference to the field situations in two fragile ecosystems represented by Himalayan middle mountains (covering parts of India, Nepal, Pakistan) and seven tropical arid and semi-arid states in India. Besides, their relative high degree of fragility (and some other broadly shared features to be mentioned later) exposes them to interlinked environmental and social vulnerabilities (Allan et. al 1988).

Besides describing fragility in terms of vulnerability to irreversible damage by higher use intensity, (DESFIL 1988) one can describe it in terms of: low input absorption capacity of the resource; limited scope for resource manipulation; and required high level of biochemical subsidization of the natural resource to achieve a level of output comparable to that from better land resources. The phenomenon can also be expressed in terms of input-output ratios, where the fragile lands have higher than average input-output ratios. Described this way areas with low potential for crop farming including Himalayan middle mountain land scapes with steep slopes and shallow soils (except in some valleys), tropical dry areas with low productivity soils as well as low and undependable moisture availability, fall under this category of fragile landscapes. Despite apparent differences of the two landscapes, for operational purposes fragility and associated attributes impart a degree of similarity, if not exact homogeneity, to these areas. This paper summarizes the relevant findings from the same. This imparts significant advantage in understanding the role of changing ecosystem services in reducing or enhancing rural poverty. The latter happens because the changing bio-physical and socio-economic processes in these areas tend to disrupt the flow of ecological services (or dependent livelihood options) more rapidly (Chambers 1987). Another factor guiding this choice is the author's close links with the

above regions through research and advisory work exceeding more than a decade in each of the indicated regions, largely while working with ICAR and ICRISAT for dry areas and ICIMOD for mountain areas. The focus of the above work had been largely on micro-level (community level) situations covering diversified farming systems and natural resource management. This paper largely summarizes understanding and inferences from the above personal involvement. More details including quantified details are scattered in the authors' works cited as references.

After a brief descriptions of livelihood affecting features of mountains and dry tropical areas under discussion, first we look at the traditional arrangements manifesting the ecosystem social system links, which facilitated combined focus on production and conservation of natural resources, specially under the context of low population and local autonomy reflected through locally evolved arrangements to regulate resource use systems. This is followed by discussion on the disruptions of the above arrangements following the enhanced external interventions and links leading to marginalization of local resource management systems and inappropriate resource use intensification, contributing to emergence of indicators of unsustainability. The paper makes use of evidence and observations from the areas mentioned above. Most of the information based on research conducted or read by the author is presented in the form of matrix tables to save the space.

The Fragile Ecosystems: Mountains and Dry Tropics

The above two ecosystems greatly differ from each other, but they do share some common features with significant relevance to the present discussion. Compared to the prime lands (agricultural landscapes or agro-ecosystems) both the above regions are faced with ecological and social vulnerabilities due to: fragility of land resources obstructing resource use intensification; limited accessibility (though more in mountains), marginality (both bio-physical and socio-economic marginality) offering only low pay off opportunities and promoting their neglect by the mainstream policy makers/planners; significant degree of diversity and niche resources (acting as source of diverse ecological services and potentially high pay off production systems, though their harnessing is obstructed by marginality, inaccessibility etc.); and unique human adaptation mechanisms and coping strategies to address the above specificities.

Range of implications and imperatives of the aforementioned specific features of fragile areas under question are elaborated elsewhere (Jodha 1991, 1995). Here we focus on poverty related implication of these features. Accordingly, as summarized under Table 1, one can juxtapose the implications of biophysical and social features of fragile regions with the process and factors universally associated with or contributing to enhanced production and prosperity, as historically observed in the developed regions (see Table 1, columns). We relate these issues to agriculture in fragile areas on which most of the poor directly depend. The key message of Table 1 is that intensification and exchange driven processes in fragile resource zones are obstructed by their bio-physical and social characteristics such as fragility, marginality, inaccessibility etc. (Jodha 1991). Even the high potential opportunities due to different types of niche resources in the two landscapes are not locally harnessed due to the above mentioned constraining resource specificities. The external interventions (while over exploiting the niche) are usually not sensitive to the situations indicated by Table 1, beyond extracting the resources for mainstream benefits with limited local gains. Thus unless the circumstances promoting and sustaining poverty prospects in fragile areas are positively addressed their bio-physical endowments are not conducive to converting poverty into prosperity.

Table 1: The Indicative Factors/Conditions Potentially Ensuring Gainful Production and Exchange Options and their Status in Fragile Areas

(A) Resource/area Specificities (objective circumstances) in fragile areas – mountains & dry tropics	(B) Indicative conditions/processes promoted by and conducive to gains from production and exchange					
	Relating to production processes			Relating to post production processes		
	High producti-vity involving resource use intensificatio n, high input availability and absorption capacity	Specialis-ation and economie s of scale	Trad-able surplus generati on/invest ment potential	Infrastruc-ture, processin g facilities-access	Equitabl e effective market and external links	Human capacities, response to changes, replicability of external successes
Limited Accessibility: distance, semi-closedness, high cost of mobility and operational logistics, low dependability of external support, or supplies	(-)	(-)	(-)	(-)	(-)	(-)
Fragility: vulnerability to degradation with intensity of use, limited low productivity/ pay-offs, risky options	(-) ^a	(-)	(-)	(-)	(-)	(-)
Marginality: limited, low pay-off options; resource scarcities and uncertainties, cut off from the 'mainstream', social vulnerability	(-)	(-)	(-)	(-)	(-)	(-)
Diversity: high location specificity, potential for temporally and spatially inter-linked diversified products/activities	(+) ^a	(-)	(+)	(-)	(-)	(-)
Niche: potential for numerous, unique products/activities requiring capacities to harness them	(+)	(+)	(+)	(-)	(-)	(-)
Human adaptation mechanisms: traditional resource management practices-folk agronomy, diversification, recycling, demand rationing, etc.	(+)	(+)	(-)	(-)	(-)	(-)

Source: Table adapted from Jodha (2001, chapter 3)

Note: a (-) and (+) respectively indicate "extremely limited" and "relatively higher" degrees of convergence between imperatives of biophysical features and the conditions associated with potential gains from production and exchange systems. The situation may differ between more accessible (commercialised) and poorly accessible areas. Besides, the socio-economic vulnerabilities may further affect the above degrees of convergence. To enhance the gainful/high pay off opportunities as adaptation options against the impediments, the degree of convergence between (A) and (B) indicated by (+) has to be increased. This would involve (i) enhanced accessibility, (ii) upgrading and development of fragile/marginal lands or evolve high pay off activities suited to them; (iii) demarginalisation and empowerment of mountain communities; (iv) harnessing of niche and high pay off diversified activities with equitable local gains and (v) build upon indigenous knowledge combined with R&D based scientific measures to evolve resource management/usage systems with high returns. All this needs greater understanding of fragile area situation and act accordingly.

Livelihood Strategies Two-way Adaptation Systems

Despite natural circumstances – determined constraints (including those obstructing harnessing of niche opportunities), the communities in the above fragile regions have not only survived but developed in several social and cultural terms. Over the generations this has happened through communities adapting to the ecological circumstances. Human adaptations in fact manifest the traditional arrangements characterized by a two-way adaptation systems. In here based on local knowledge and local control of resources, people have evolved the arrangements and practices (folk agronomy/engineering, locally evolved and enforced regulatory norms etc.) to adapt their demands to what ever nature has offered; and adapt/amend the resource base wherever possible, to suit the human needs. The latter is illustrated by terracing, community irrigation systems, agro-forestry etc. in mountains and agro-silvi-pastoral practices and water harvesting in dry areas). In fact diversified land use and mixed farming, mix cropping and crop rotations etc. prevailed in both ecosystems under review. The traditional arrangements and practices summarized under Table 2 (col.1) for mountain areas and dry tropical areas illustrate the situation. Accordingly, rather than expanding the supplies through over-extraction of generally fragile, marginal and low productivity land resources, the communities evolved methods to control and regulate pressure of demand on fragile resources. Accordingly, the management of demands on fragile ecological resources, under (i) largely subsistence and low populations contexts, (ii) supported by locally evolved and enforced institutional arrangements externally undisturbed due to relative isolation, (resulting from limited accessibility and external interventions), had been the important features of the traditional systems.

However, the above (sort of a low levels equilibrium) situation represented by traditional systems of resource use, changed with the enhanced (but on unequal terms) administrative and economic integration of these areas with the mainstream, prime land, dominant economic areas in different countries. This not only marginalized or disrupted the traditional systems but added to the pressure on fragile resources through increased external and internal demands resulting from market and population growth. Thus despite several gains from the above integration, the latter also induced inappropriate resource use intensification bypassing the ecological imperatives.

The Change Process and its Drivers

The highlights of externally induced measures, processes and consequences are summarized under Table 2 and 3. Under Table 2 we present measures and practices against constraining features of fragile areas directly affecting agriculture or farming systems, the key source of

livelihood for the communities. The measures evolved and traditionally used by the communities are put along with the ones promoted by public agencies in the recent decades. The Table 2 lists the key features of the traditional measures and public interventions directed to address the problems due to fragility, marginality, increased demand pressure, unequal external linkages and wider market systems. The table also lists the measures (options) directed to harnessing of diversity and niche opportunities of fragile areas. It also indicates the limitations and indicative potential of the above measures for enhancing sustainability of fragile land agriculture and related activities.

The details presented in Table 2 are fairly self explanatory to need elaboration. However, it will be useful to put the inferences from the Table, in a wider context of factors and processes associated with the community approaches and usage of natural resources (or ecosystem services) in fragile zones under (a) the traditional and (b) the present day systems. The relevant aspects in this context are summarized under Table 3.

Table 3 first describes the basic objective circumstances characterizing the above (a) and (b) systems. These circumstances under (a) helped promote high collective concern for the health and productivity of natural resource base (NRB) or ecosystems, as source of community's sustenance. The changed objective circumstance under (b) led to reduced collective concern for local NRB and rise of individual interest-driven resource extractive strategies.

Next, the Table 3 lists the key driving forces shaping the resource management systems under (a) traditional and (b) present day situations. Under (a), these drivers led to evolution of collective stake in ecological systems supported by local autonomy and functional knowledge of resource capacities and limitations. Under (b) the changed or new driving forces (including external interventions, economic and socio-political differentiation within the community), led to loss of collective stake and local control of community resources and "reactive" mode of user-responses to the change (Jodha 1998, 2001).

Table 2: Measures against constraints to sustainable resource use (agriculture) in fragile resource zones under traditional systems/development interventions

Measures Adopted Under	
Traditional Resource Usage Systems	Conventional Development Interventions
(A) Enhancement of Use Intensity/Input Absorption Capacity of Land	
(a) Measures	
Resource amendments by ethno-engineering measures: terracing/trenching/ridging, moisture conservation/drainage management/shelterbelts/ agro-forestry, etc.	Selective resource upgrading through irrigation/ other infrastructure, biophysical changes (e.g. new introduction; R and D activity/pilot projects for range lands, watersheds, etc.)
Attributes of (a) Conducive to Sustainability	
Local resource centred, community oriented and supported, small scale, diverse, adapted to local situation; linked to other activities	Science and technology input, strong logistic/ resource support, advantage of scale
Limitation of (a)	
Reduced feasibility with rising pressure on land and weakening of local level collective arrangements, lack of new high productivity components	Side effects of massive interference with fragile resources (water logging, salinity, landslides); inequities between transformed (e.g. irrigated) and leftover areas; insensitivity of R and D based initiatives to local resource

	diversity and user perspective/knowledge
(B) Usage and Management of Low Use-Capability Lands	
(b) Measures	
Folk agronomy involving activities with low land intensity and low (local and affordable) input regimes; integration of low intensity-high intensity land uses (based on annual-perennial plants, crop-fallow rotations, indigenous agro-forestry, common property resources; social sanctions, resource use regulation; migration/transhumance	Sectorally separated production programmes; high intensity uses through new technology inputs/ incentives/subsidies; focused conservation oriented initiatives (forests/pastures/watersheds) in largely projects mode.
Attributes of (b) Conducive to Sustainability	
Diversified, interlinked activities with different levels of intensity, community participation, control on local demand	New technological input, resource support and legal sanctions
Limitations	
Reduced feasibility and effectiveness due to population growth, decline of collective arrangements, and side effects of dominant; technological and institutional interventions	General indifference to resource limitations, user perspective; 'Technique' and 'project mode' dominated

Cont'd...

(C) Options to Harness Diversity and Niches	
Measures	
Folk agronomy – diversified cropping, focus on multiple-use species; complementarity of cropping-livestock—forestry/horticulture; emphasis on biomass in choice of land use and cropping patterns; complementarity of spatially/temporally differentiated land-based activities; stability oriented, location specific choices, harnessing niches for small tradable surplus	Sectorally segregated programmes and their support systems (R and D, input supplies, crop marketing); focus on selected species and selected attributes (e.g. monoculture, high grain-stalk ratio); extension of generalized development experience of other habitats with high subsidy support
Attributes Conducive to Sustainability	
Diversity, linkages as dictated by resource characteristics, locally renewable resource focused	Initiatives with strong technological and logistic components, high potential for generating new options

Traditional Resource Usage Systems	Conventional Development Interventions
Limitations	
Low productivity, land extensive measures incompatible with high man land ratio, and changed institutional environment	Indifferent to the totality of farming system and diverse resource potentialities; high subsidisation
(D) Resilience of the System and Mechanisms to Handle High Pressure of Demand	
Measures	
Diversification and linkages of landbased activities; flexibility in scale, operations input use; locally renewable resource focus, recycling of inputs/products, self provisioning; crisis period -collective sharing arrangements, common property resources, social regulations	Public relief and support during crisis/scarcities; public interventions replacing traditional self-help strategies and informal regulatory measures; highly individual (not community) focused interventions (e.g. privatization of common property resources;

for rationed use and protection of fragile resources; release of periodic/seasonal pressure by migration, transhumance, remittance economy	crisis period cushion promoted by increased private-resource productivity of HYVs, etc.; occasional linking of relief measure with productivity measures
Attributes Conducive to Sustainability	
Range of options to match specific constraints of the habitats; emphasis on community centred and regulated activities; informal rationing of demand on fragile resources.	Resource transfer from better off areas to scarcity prone areas; possibility of linking relief initiatives with resource conservation/production programmes
Limitations	
Infeasibility and reduced efficacy of collective self-help measures and folk agronomic devices, due to changed demographic, institutional, and technological environment	Dependency for sustenance on external resources; encouragement for perpetual growth of pressure on fragile resources; indifference to local self-help initiative
(E) Linkages with Other Systems (including Wider Market Systems) Measures	
General state of relative inaccessibility (particularly for mountains) and isolation from mainstream market; limited market linkages through tradable surplus; crisis period external dependence through periodic migration and remittance economy	Improved physical and market linkages; integration of fragile resource economy with other systems; focus on special area development programmes, transformation of limited area and their demonstration effect
Attributes Conducive to Sustainability	
A few positive side effects of isolation, local demand centred, socially controlled extraction of fragile resources, better links between the ecological resources and the resources users	Improved opportunities for relaxing internal constraints through technology, resource transfer, interactions with other systems; inducement for fuller use of niches through external demand; closer integration with mainstream economy
Limitations	
Persistent neglect and marginal status of fragile resource areas; slow pace of transformation of agriculture; unfavourable terms of exchange for marginal areas and products	Unless guarded against; high chances of extending irrelevant external experiences (including technologies); external demand induced heavy extraction of niche; unfavorable terms of exchange; distortion in local demand patterns and resource use patterns

Source: Table adapted from Jodha (1991, 1995b), based on studies of resource use and farming systems carried out by the author while working at ICRISAT and ICIMOD. Also see Jodha (2001) for details on different aspects.

Table 3: Factors and processes associated with the community approaches and usage of natural resources in fragile areas under the traditional and the present day systems

Situation under traditional systems	Situation under the present day systems
<p>A. Basic objective circumstances:</p> <ul style="list-style-type: none"> (i) Poor accessibility, isolation, semi-closeness; low extent and undependable external linkages and support; subsistence oriented small populations; (ii) Almost total or critical dependence on local, fragile, diverse natural resource base (NRB). <p>Bottom line: High collective concern for health and productivity of NRB as a source of sustenance</p> <p>B. Key driving forces/factors generated by (A):</p> <ul style="list-style-type: none"> (i) Sustenance strategies totally focused on local resource; (ii) Sustenance-driven collective stake in protection and regeneration of NRB; (iii) Close proximity and access-based functional knowledge/understanding of limitation and usability of NRB; (iv) Local control of local resources/decisions; little gap between decision makers and resource users. <p>Bottom line: Collective stake in NRB supported by local control and functional knowledge of NRB.</p> <p>C. Social responses to (B):</p> <ul style="list-style-type: none"> (i) Evolution, adoption of resource use systems and folk technologies promoting diversification, resource protection, regeneration, recycling, etc.; (ii) Resource use/demand rationing measures; (iii) Formal/informal institutional mechanisms/group action to enforce the above. <p>Bottom line: Effective social adaptation to NRB</p> <p>D. Consequences:</p>	<ul style="list-style-type: none"> (i) Enhanced physical, administrative and market integration of traditionally isolated, marginal, areas/ communities with the dominant mainstream systems at the latter's terms; increased population; (ii) Reduced critical dependence on local NRB; diversification of sources of sustenance. <p>Bottom line: Reduced collective concern for local NRB; rise of individual (extractive) strategies.</p> <ul style="list-style-type: none"> (i) External linkage-based diversification of sources of sustenance (welfare, relief, trade, etc.); (ii) Disintegration of collective stake in NRB; (iii) Marginalisation of traditional knowledge, and imposition of generalized solutions from above; (iv) Legal, administrative, fiscal measures displacing local controls/decisions; wider gap between decision makers and local resource users. <p>Bottom line: Loss of collective stake and local control over NRB; resource users respond in a 'reactive' mode.</p> <ul style="list-style-type: none"> (i) Extension of externally evolved, generalized technological/institutional interventions; disregarding local concerns/experiences and traditional arrangements; (ii) Emphasis on supply side issues ignoring management of demand pressure; (iii) Formal, rarely enforced measures. <p>Bottom line: NR over-extracted as open access resources</p>

<ul style="list-style-type: none"> (i) Nature-friendly management systems; (ii) Evolved and enforced by local communities; (iii) Facilitated by close functional knowledge and community control over local resources and local affairs <p>Bottom line: “Resource-protective/regenerative” social system – ecosystem links.</p>	<ul style="list-style-type: none"> (i) Over-extractive resource use systems, driven by uncontrolled demands; (ii) Externally conceived, ineffective and un-enforceable interventions for protection of NRB; (iii) Limited investment and technology input in NRB. <p>Bottom line: Rapid degradation of fragile NRB; “nature pleads not guilty”.</p>
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Source: Table adapted from Jodha (2001, Chapter 10)

All the above factors, finally contributed to effective human adaptation to ecological circumstances under (a); while under (b) they led to over-extraction of NRB as open access resources. As a final inference, the situation under (a) promoted “resource protective/regenerative” social system-ecosystem links; the situation under (b) induced rapid degradation of ecological system and reduced livelihood opportunities for the people, where “nature pleads not guilty” (Jodha 1998, 2001).

Without discounting the positive contributions of a number external interventions in fragile areas, it is not difficult to infer from Tables 2 and 3 that as far as the ecological systems and their services to the communities are concerned, there has been many negative consequences, specially for the poor due to their greater dependence of the former. There has been visible negative trends. We call them the emerging indicators of unsustainability of present patterns of natural resource use. Some of them were captured through field investigations in the two fragile regions focused by this paper.

Emerging Indicators of Unsustainability

Through participatory investigations under different studies covering over thirty villages in each mountain areas and dry tropical areas, involving recall focused discussions with relatively older people, complemented by scattered village records, some evidence and observations on the changes over 30 to 40 years were collected. Based on the same, some indicators of decline natural resources and their contributions to livelihoods of the people in the fragile areas were identified (Jodha 1991; 1995a). The details are summarized under Table 3A and 3B separately for mountain and dry tropical areas. Since the thrust of the investigations was on sustainable agriculture, we called them “indicators of emerging unsustainability”. Both the interviewed groups of villagers and available revenue and development records suggested close links between emergence of negative trend on the one hand and the public plus market interventions and demographic changes in the areas on the other. Put in the context and the language the ESPASSA Project, above indicators represent the declining ecological services adversely affecting the poor; and they are largely rooted in the external interventions.

Table 4A: Negative changes as indicators of the unsustainability of agriculture (Mountain Areas)

Visibility of Change	Changes Related to a)		
	Resource Base	Production Flows	Resource Use/Management Practices
Directly visible changes	Increased land slides and other forms of land degradation; abandoned terraces; per capita reduced availability and fragmentation of land; changed botanical composition of pasture/forest (e.g. spread of <i>Lantana in forest</i>) .	Prolonged negative trend in yields of crop, livestock, etc. increased input need per unit production; increased time and distance involved in food, fodder, fuel gathering; reduced capacity and period of grinding/saw mills operated on water flow; lower per capita availability of agricultural products; etc.	Reduced extent of: fallowing, crop rotation, intercropping, diversified resource management practices; extension of plough to sub-marginal lands; replacement of social sanctions for resource use by legal measures; unbalanced and high intensity of input use, etc.
Changes concealed by responses to changes b)	Reduced water-flows for irrigation, domestic uses, and grinding mills.	Increased seasonal migration; introduction of externally supported public distribution system (food, inputs) intensive cash cropping on limited areas.	Shifts in cropping pattern and composition of livestock; reduced diversity, increased specialization in monocropping; promotion of policies/programmes with successful record outside, without evaluation
Development initiatives, etc. potentially negative changes c)	Substitutions of: cattle by sheep/goat; deep rooted crops by shallow rooted ones; shift to non-local inputs Substitution of water flow by fossil fuel for grinding mills; manure by chemical fertilizers New systems without linkages to other diversified activities; generating excessive dependence on outside resource (seed, fertilizer/pesticide based technologies) ignoring traditional adaptation experiences.	Agricultural measures directed to short term quick results; primarily product—(as against resource) centred approaches to agricultural development, etc.	Indifference of programme and policies to mountain specificities, focus on short term gains, high centralisation, excessive, crucial dependence on external advice ignoring traditional knowledge systems.

Source: Table adapted from Jodha 1991

Note:

- a. Most of the changes are interrelated and they could fit into more than one block.
- b. Since a number of changes could be for reasons other than unsustainability, a fuller understanding of the underlying circumstances of a change will be necessary.
- c. Changes under this category differ from the ones under the above two categories, in the sense that they are yet to take place, and their potential emergence could be understood by examining the involved resource use practices in relation to specific resource characteristics.

Table 4B: Negative changes as indicators of the unsustainability of agriculture (Dry Tropical Areas)

Visibility of Change	Changes Related to a)		
	Resource Base	Production Flows	Resource Use/Management Practices
Directly visible changes	Various forms of resource degradation: Emergence of salinity, coverage of fertile soil by shifting sands, vanishing top soils due to water/wind erosion; deepening of water tables, ground water salinisation; emerging plantlessness, reduced perennials, increased inferior annuals and thorny bushes; reduced per capita availability of productive resources.	Reduced total and per capita biomass availability; reduced average productivity of different crops, increased cropping on sub-marginal lands; reduced resource, product recycling; higher dependence on inferior options, (e.g. premature harvesting/ lopping trees), rising severity of successive drought-impacts; increased dependence on public relief, increased migration.	Changes in land use pattern; cropping on sub-marginal lands; decline of common property resources; reduced diversity of agriculture (e.g. number of crops and their inter-linkages); reduced feasibility and effectiveness of traditional adaptation strategies (e.g. rotations, inter-cropping, biomass strategies).
Changes concealed by responses to (negative) changes	Increased emphasis on mechanization of cultivation and water lifting; substitution of draft animals by tractors; reduced fallowing of land; large scale 'reclamation' of wastelands; shift from local to external inputs (e.g. from manure to chemical fertilizers, wooden tyre to rubber tyres for bullock carts).	Higher coverage by public distribution system (food, inputs) and other anti-poverty programmes; reduced reliance on self-provisioning system and greater dependence on external market sources; changes in land use pattern favouring grain over biomass production.	Discarding of minor crops, shift towards monocropping with standardization inputs/practices; increased land use intensity; shift from two-oxen to one—ox plough; tractorisation; practices; replacement of self-help systems by public support systems.
Development initiatives, etc. potentially negative changes c)	R & D focus on: crop rather than resource; technique rather than user—perspective (e.g. method/species/inputs rather than group action for watershed/range development); resource upgrading ignoring its limitations (e.g. irrigation in impeded drainage areas); inducing high use intensity	Highly subsidized, narrowly focused production programmes; focus on crops ignoring other land based activities; grain yield ignoring biomass; monocropping ignoring	Sectoral focus of R and D and other support systems ignoring flexibility and diversification needs; privatization of common property resources; extension of generalized external approaches to specific areas; disregard of folk knowledge informal interventions;

	of erodable soils, and other resource extractive measures (e.g. tractorisation).	diversification; relief operations focused on people and livestock ignoring resource base, thus promoting high pressure on poor resource base.	replacing local informal arrangements by rigid legal/administrative measures.
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Source: Table adapted from Jodha (1991)

- Note:
- a. Most of the changes are interrelated and they could fit into more than one block.
 - b. Since a number of changes could be for reasons other than unsustainability, a fuller understanding of the underlying circumstances of a change will be necessary.
 - c. Changes under this category differ from the ones under the above two categories, in the sense that they are yet to take place, and their potential emergence could be understood by examining the involved resource use practices in relation to specific resource characteristics.

The negative changes as indicators of unsustainability of agriculture (covering diversified and interlinked land based activities such as cropping, livestock rearing, agro-forestry etc.) are grouped according to: (a) their visibility, i.e. directly visible changes; negative changes concealed by inappropriate (or appropriate) responses; and development initiatives with potentially negative consequences; and (b) the context of the changes, i.e. negative changes relating to production resource base; production flows; and resource use/management practices.

Thus there are $(3 \times 3) = 9$ groups for each of the two eco-systems, under which indicators of unsustainability of fragile land agriculture are presented under Table 4A and 4B. To illustrate, for mountain areas directly visible change relating to resource base includes cases like abandoned degraded terraces; or reduced water flow inspiring. Relating to production flows examples include prolonged negative trend in yield of crops, increased time and distance required for collection of fodder, fuel etc. by women and illustrations of negative changes relating to management practices include reduced extent of fallow or rotation of crops.

Similarly under “visibility” category represented by the changes concealed by responses to negative changes include substitution of shallow rooted crops for deep rooted crops (due to erosion of top soils) substitution of sheep and goat for cattle (due to reduced forage availability) etc. both in mountains and dry lands.

Also increased seasonal migration and greater dependence on public distribution system for food and inputs in both the areas fall in the same ‘visibility’ category but relate to production flows. The same way shift in cropping patterns and composition of livestock (part of management systems) represent the change in response to negative change or specific constraints faced by the farmers.

The visibility category: development initiatives with potentially negative change, considered by the farmer groups, as emerging source of unsustainability included promotion of crops with no links with other farm enterprises; product rather than resource centred agricultural technologies both in mountains and dry areas. The relative inappropriateness of newly promoted agronomic practices fell in to management systems with potential negative impacts.

Table 4A and 4B are fairly detailed and self explanatory to need further elaboration. However, this should be noted that several of the items placed under each of the (9) groups can be easily shifted from one group to another. Secondly, since a number of changes put under different categories of negative change, may have other guiding factors, the farmers’ views reported in the tables may be considered indicative only. This applies strongly to “development initiatives etc.” as a group of indicators. However, despite such qualifications, the details under Table 4A, 4B, do suggest people’s perspectives and concerns of shrinking ecosystem services for them. This may also be added that concerned with the negative, trends in many areas, people through collective or individual efforts have effectively tried to restore the health and productivity of natural resources; as revealed by the revisited villages (Jodha 2008).

Other Components of Eco-systems

To complement the discussion on agricultural resource base of the poor and policy-programme interventions ignoring the socio-ecological perspective at micro-levels, we may comment on a few other inter-linked components of micro-ecosystems (landscapes) which greatly helped in sustaining livelihoods of the poor in fragile areas. They include (a) "waste lands (WL)" (b) Common Property Resources (CPRs).

Wastelands

Waste lands (WL) as a category in the land revenue records in India has its roots in the British systems of land classification, where any land not contributing to government revenue through crop cultivation was designated as waste land (*Shiva 1986*). Governed by their goal of streamlining land revenue collection system, such lands, despite their biophysical supplies as well as the environmental and economic support to croplands and to the farmer's livelihoods, were treated as waste lands, with little government attention to them. An important side effect of the government's indifference to non-cultivated lands amounted to leaving them to the defacto custody of village communities. For the latter, the non-crop contributions of waste lands proved a major source of sustenance. To enhance and stabilise these contributions, the communities evolved their own methods of managing WL as a part of village commons (CPRs). In most areas this helped in the undisturbed continuation, of the traditional management systems for CPRs, except when some CPRs (e.g. forests) being more productive were acquired by the colonial rulers. Thus, the colonial government, by default encouraged the management of WL involving their protection, conservation, development and usage by the communities.

In the post-independence period (specially since early 1950s) the state adopted a relatively pro-active approach to address the problems of WL, primarily by exerting its own authority over WL, and evolving various technical as well as administrative measures for development and management of WL. Though in some sense they did continue the colonial approach to resource conservation, which considered rural people completely 'ignorant' of conservation needs and methods. This perspective was used for justifying the nationalisation of resources, over-reliance on both the public sector and the wisdom of bureaucracy in managing natural resources (*Gadgil and Guha, 1995* *Blaikie 1985*). The dominant aspects of state interventions in WL included dismantling of the traditional community management system and replacing them by formal, legal, administrative and fiscal arrangements; top down, largely technology dominated approaches, with little or limited participation of local communities. These measures (listed under Table 5) are identified as: (i) legal categorisation of uncultivated/uncultivable lands as waste land by the colonial government and the latter's indifference to WL; (ii) the post-independence government's proactive but often poorly enforced policies towards waste lands, by pronouncing its authority on these lands and discarding their traditional management systems; (iii) undeclared policy of privatisation of CPRs including WL (since the introduction of land reforms in early 1950s); (iv) technology centred approaches for development and conservation WL (1950s - 1960s); (v) special area/sector/group focussed programmes such as DPAP, social forestry, equity-promoting afforestation programmes including tree patta scheme, rehabilitation of degraded forest land through rural poor (1970s-1980s) etc.; (vi) integrated watershed development programmes; (vii) massive fiscal support based effort in terms of establishment of National Waste land Development Board; and (viii) participatory/NGO supported programmes such as JFM; integrated watershed development project, pasture rehabilitation etc. Table 5, summarises the major WL management initiatives with their key attributes described as motives and myths, (i.e. premises and goals guiding public interventions), mechanism and measures (i.e. approaches and steps to implement the policies); and finally the gaps and consequences associated with the above initiatives. Table 5 is quite simple and explicit to need further elaboration.

Table 5: Management/development of the “wastelands” in India during different phases

Myths & Motives	Models & Mechanisms	Gaps & Consequences
<p>PRE-INDEPENDENCE PERIOD Generating crop-revenue is the only indicator of productivity of land</p> <p>POST-INDEPENDENCE PHASES KNOWLEDGE</p> <p>(a) State’s authority/power to control land means knowledge/capacity; to protect, conserve, manage WL; at local level control WL (since 1950s) village communities are ignorant of conservation needs</p> <p>(b) Conservation technology is only solution to WL problems and creation of technical research centres is answer to the former. (1950s-1960s)</p> <p>(c) Special area/sectoral/group focused approaches can help development of WL. (1970s-1980s); WL treated as piece of land separated from totality of rural economy</p> <p>(d) A generalised/uniform watershed development approach can enhance and harness contributions of WL in all regions (1980s-1990s)</p> <p>(e) A massive resource allocation can rehabilitate WL (1980s-1990s)</p> <p>(f) Formal legal arrangements and subsidisation can ensure effective community participatory for WL development (1980s-1990s)</p>	<ul style="list-style-type: none"> • Separation of uncultivated lands as WL (through land revenue classification) and their neglect by the state • Undeclared policy of privatising WL as part of CPRs; dismantling of traditional CPR management systems through formal legal, administrative, fiscal arrangements • Creation of research centres for: Soil Conservation in for ravines; desert areas/acid lands, grass lands, areas with salinity and water logging, forestry etc. supported by public sector resources. • Often externally funded special programmes for the rural poor including the ones with focus on development of waste lands e.g. DPAP, social forestry, pasture development, watershed development (in some areas). • Largely foreign aided initiatives on watershed development in different agro-ecological regions; increased space for NGOs. • Establishment of National Waste Land Development Board, with large financial 	<ul style="list-style-type: none"> • Disregard of economic and ecological contributions WL; management of WL (as CPRs) by communities without state help. • Alienation of local communities from local resources; decline in area, productivity (biomass) and services of WL/CPRs; spread of ‘PWD’ (civil works) system to WL works. • Top down, technique dominated approach without people’s involvement; creation of vast scientific information with limited applicability application. • Top down, subsidy driven activities without local participation as well as concern for local needs and indigenous knowledge in choice of activities, species and methods. • Persistence of sectoral approach with domination of forestry component; disregard of both ecological and social diversity of involved components; limited local participation and domination of official decisions and spending targets. • Operations constrained by multiple concerns; increased financial resource-induced complexities (e.g.. inter-ministry tug of war within GOI); focus on ‘spending-targets’ etc. • Gradual emergence of clearer direction and approaches in

	<p>resources;</p> <ul style="list-style-type: none"> • It incorporating various models/methods tried earlier; multiple goals to deal with multiple dimensions of WL (ranging from research, pilot schemes to advocacy and awareness promotion). • Multi agency involvement (e.g. NGO-run initiatives) • Support to user group initiatives especially in community forestry, pasture development etc. • Increased of involvement of NGOs • Joint forest management initiatives; decentralisation through Panchayats etc. 	<p>different contexts e.g.. User participation; local ownership of WL development initiatives etc.</p> <ul style="list-style-type: none"> • Limited and scattered area specific specially NGO-supported success stories. • Continued disregard of understanding of key factors that make successful group action e.g. diversity of communities and WL features and local knowledge.
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Table: Adapted from Jodha (2000)

Rural Common Property Resources (CPRs)

Rural common property resources are another source of supplies specially for the poor in the fragile areas). Table 6 based on seasonally, physical verification of situations in study villages indicates the type of supplies and services by individual categories of CPRs. both in mountains and dry areas. In particular, a four year study of CPRs covering over 80 villages in 21 districts of 7 arid and semi-arid states of India, indicated that CPRs contribute 14 to 23% of income of the poor households. For others (specially large and medium farm households the corresponding figure was 2-3%. The per household/employment provided by CPRs to the rural poor ranged between 137 to 196 per year (Jodha 1992). A fairly reduced scale of field work covering lesser number of villages in mountain areas indicated higher dependence of poor compared to others in mountain areas as well. However, despite these gains, CPRs have declined both in area and productivity in all the studied areas.

The decline of CPR area has been largely attributed to governments' policies to distribute these lands in the name of helping the poor, who received very insignificant share of privatized CPRs. Transfer of part of CPRs (waste lands which formed part of CPRs) to protected areas and bio-diversity parks also reduced the CPR area. In dry areas of India CPR area declined by 31 to 55 percent during 1950-52 to 1982-84. Consequently, pressure on CPRs in different districts increased from 14 to 101 per 10 ha. of CPR area in early 1950s to 47 to 286 during early 1980s. Increased population and land hunger accentuated the above pressure. Consequently, physical decline of CPRs in terms of plant species and productivity also declined affecting the rural poor the most. (Jodha 1992, 2007). The main inference of the above account is the loss of community's natural assets affecting the rural poor most.

However, revisits to some of the above areas indicated that group of people in the villages have revived selected CPRs (Jodha 2008).

Table 6: Contributions of Common Property Resources to Village Economy in Dry Regions of India^{a)}

Contributions	CPRs Types ^{b)}					
	A	B	C	D	E	F
Physical Products:						
Food/fibre items (NTFP)	●		●	●		●
Fodder/fuel/timber, etc.	●	●	●		●	●
Water (surface/ground water)			●	●	●	
Manure/silt/space	●	●	●			●
Income/employment Gains						
Off-season activities	●				●	●
Drought period sustenance	●	●				●
Additional crop activities			●	●		●
Additional animals	●	●				●
NTFP based petty trading/handicrafts	●					●
Larger Social, Ecological Gains						
Resource conservation	●	●			●	
Drainage/recharge of groundwater			●	●		●
Sustenance of poor			●	●	●	
Sustainability of farming systems	●	●	●		●	●
Renewable resource supply	●	●	●	●		
Better micro-climate/environment	●	●		●	●	

- a) Table adapted from Jodha (1992)
- b) CPRs: A – community forest, B – Pasture/waste land, C – Pond/tank, D – River/rivulet,
E – Watershed
drainage, F – river/rivulet banks and beds

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