ECOSYSTEM SERVICES AND POVERTY ALLEVIATION STUDY IN SOUTH ASIA (ESPASSA):

A SITUATION ANALYSIS FOR INDIA AND THE HINDU KUSH HIMALAYAN REGION

Regional Analysis

A Project Report Prepared for NERC, DFID, and ESRC by the ESPASSA Consortium
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Executive summary

Since the early 1990s, countries in the South Asian region have been on high economic growth trajectories, but the expected improvements in human development levels have largely been non-commensurate in a number of well-being dimensions. Further, the environmental costs of such high and non-inclusive growth patterns continue to be largely unaccounted for in conventional development planning and resource allocation. The degradation of ecosystems is likely to be a significant barrier to the achievement of the Millennium Development Goals (MDGs) related to reduction of poverty, hunger and disease in the region.

The present report is structured around the multiple and varied links that characterize the relationship between human well-being and ecosystem services. Understanding of these links is still constrained both by difficulties in conceptualising the underlying notions and large gaps in the scientific evidence base. This Situation Analysis feels that 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.

The analysis of poverty statistics for the region reveals that there are huge variations among countries in achieving poverty alleviation. Despite the declining trends, the magnitude of poverty remains large in all countries. Further, within countries there exist marked differences in the incidence of poverty by geographical regions. Studies from Bangladesh and Nepal indicate that the vulnerability of the poor is significantly increased by the loss of ecosystem regulating services. This Situation Analysis strongly emphasizes the need for updating and improving (better quantification) existing poverty maps in the South Asia region and aligning them with spatial information on the landscape domains of the poor. This may need to be done in a geographically selective manner but equally exhaustively with respect to ecosystems. Without these basic underpinning data sets, strategic policy development cannot be undertaken and will be piecemeal at best.

Knowledge gaps persist in the identification of the whole range of ecosystem services and in valuing the impacts of even known services. A major research need for advancing the ESPA programme is improving the methodology to quantify the various contextual dimensions of poverty and access to ecosystem services. Livelihood indicators are required to capture the wider (non-income) dimensions of poverty and more directly link *livelihoods* through to *ecosystem services* derived from the landscape. This needs to be done for the region as a whole, recognising that the indicators will differ depending on the dominant landscape features (ecosystems) on whose services the poor depend.

The drivers of ecosystem change, both direct and indirect, and interact with each other and affect the ecosystem in a synergistic way. The influences of macro- economic factors like trade, investment, fiscal and monetary reforms on local services like aquaculture, timber extraction and soil erosion is yet to be fully explored and require an interdisciplinary approach amongst social and bio-physical scientists. Among the direct drivers, climate change has important implications for human well-being in South Asia but there are key areas in which priority research needs have been found to exist. These are:

- Currently global and regional climate models provide regional monsoonal prediction with high uncertainty. There is a need to improve prediction of features (onset, duration

breaks) of monsoonal rainfall on time scales relevant to the livelihoods of the poor (intra- and inter-seasonal and decadal). Simultaneously, there is a need to examine existing coping strategies of the poor to the consequences of monsoonal variation to aid in the design of future adaptation and mitigation strategies.

- Continued glacial retreat and increased variation in the pattern of monsoonal rainfall as a result of climate change will result in major alterations to regional hydrology. The scale and magnitude of the impacts of these changes on regulating and sustaining services of ecosystems (for example erosion and flood control and cropping regions) requires investigation in context of poverty distribution.
- At the river basin and catchment scale, there is a need to evaluate different and competing sectoral demands for water and develop frameworks that aid decision making to protect and improve ecosystems services for poverty alleviation.
- Given the high concentration of poverty in agro-ecosystems, continued research focussing in particular on the provisioning and sustaining services underpinning natural resource management and crop diversification is essential. The seasonal patterns of dependence of the poor and their existing coping strategies require in depth evaluation in the whole region.
- Empirical research on forest vegetation characteristics and plant functional types, plant physiological parameters is required to improve model prediction of changes in forest extent, type and distribution in response to climate change scenarios.

Changes in the flow of ecosystem services affect the well-being of the poor, directly or indirectly, through multiple pathways. Very few studies identify the complete 'impact pathways' from drivers to responses in dynamic settings. Case studies from the region reveal an asymmetry in the distribution of benefits (damages) from ecological conservation (degradation) between the rich and the poor. The rich benefit more than poor from ecological conservation while the poor suffer more damages than the rich from degradation.

Emerging policy responses in the South Asia region recognize the importance of stakeholder involvement, market-based incentives, and participatory monitoring. Building on such initiatives requires capacity building in (a): developing and applying the tools for economic valuation of ecosystem services, (b) designing the right institutions and monitoring systems, and (c) understanding stakeholder roles and interactions.

Contents*

* This report is accompanied by Annexure 1

Abbreviations

BRAC	Bangladesh Rural Advancement Committee
CBD	Convention on Biological Diversity
DFID	Department for International Development
DPAP	Drought Prone Areas Programme
EMU	European Monetary Union
ESPA	Ecosystem Services for Poverty Alleviation
ESPASSA	Ecosystem Services and Poverty Alleviation Study in South Asia: A Situation Analysis for India and the Hindu Kush Himalayan Region
ESRC	Economic and Social Research Council
FUGs	Forest User Groups
GDP	Gross Domestic Product
GIS	Geographical Information System
GNI	Gross National Income
HDI	Human Development Index
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Inter-governmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
MA	Millennium Ecosystem Assessment
MDG	Millennium Development Goal
NERC	Natural Environment Research Council
NTFPs	Non Timber Forest Products
OECD	Organization for Economic Cooperation and Development
PES	Payment for Ecosystem Services
PPP	Purchasing Power Parity
SAARC	South Asian Association for Regional Cooperation
SDPI	Sustainable Development Policy Institute
SEZ	Special Economic Zone
SWIMMER	Institute for Sustainable Water Integrated Management and Ecosystem Research
TERI	The Energy and Resources Institute

1. Introduction to the ESPASSA project

Humans are dependent on the functioning of the natural environment and the ecosystem services that result, including clean air, fresh water and food. In the developed world this dependency is often obscured by societal and technological structures; conversely, in developing countries like those of South Asia, the inherent dependence of human well-being on the natural environment is more evident, especially amongst the poor (MA, 2003).

The global agenda that was defined through the international adoption of eight Millennium Development Goals (MDGs) placed the primary emphasis on the eradication of extreme poverty and hunger (MDG No. 1) (UN, 2006). Realisation of the MDGs requires the establishment of baselines through identification, quantification and evaluation of the *status quo*, assessment of spatial and temporal trends affecting these baselines and the development of information-backed strategic initiatives, tailored to the need of regional stakeholders, to instigate change, as well as to assist in measuring the impact.

Three UK agencies (NERC, DFID and ESRC) have developed an Ecosystem Services for Poverty Alleviation (ESPA) programme to facilitate research-based progress towards achieving MDG No. 1, focussing on global poverty hotspots with vulnerable ecosystems. This report presents the 'Situation Analysis' undertaken for '**India and the Hindu Kush Himalayan Region**' by the ESPASSA consortium. Specifically, it addresses the region within the combined geographic boundaries of Bangladesh, Bhutan, India, Nepal and Pakistan (Figure 1.1).

The specific objectives of this Situation Analysis are to:

- Collect and analyse evidence on
  - ecosystem services most important to wellbeing of the poor
  - challenges to ecosystems that provide these services
  - key ecosystem management functions for maximising poverty alleviation
- Identify how challenges can be addressed through research to provide poverty alleviation outcomes
- Conduct information & knowledge needs assessment with policy-makers and other stakeholders
- Assess need for skills and knowledge exchanges to strengthen capacity of regional research providers and research output users
- Present the analysis to a regional peer group and develop findings based on feedback and collective reflection

These specific objectives are addressed by answering key questions, which, in combination, provide a holistic understanding of current knowledge on poverty and ecosystem services within the region. The principal lessons learnt are identified and prioritised research agenda recommendations are made.

The Situation Analysis will be used in the development of the wider ESPA research agenda as well as providing a vehicle for communication of proposed regional priorities to decision makers at all tiers (from community to central government) within South Asia.

Figure 1.1 – South Asia

Source: http://www.un.org/Depts/Cartographic/map/profile/seasia.pdf

2. Characteristics of the study region

South Asia[13] is home to around a quarter of the world's population on a surface area that is only 4 percent that of the latter and is the most densely populated region with 307 people per sq. km (World Bank, 2007). The five countries covered under the present SA – Bangladesh, Bhutan, India, Nepal and Pakistan – together account for 97 percent of the South Asian population and 86 percent of the region's surface area. Among the five countries, population density in Bangladesh (1090) and Pakistan (796) is well above the regional average while Nepal (147) and Bhutan (14) have below-average estimates.

Going by the World Bank's (2007) estimates, the South Asian economies – in terms of gross domestic product – grew at an average annual rate of 5.6 percent during 1990-2000 and the pace has only accelerated thereafter (6.5 percent per annum during 2000-05). The growth rate of the region is second only to that of the East Asia & Pacific group of countries. India's performance since 2000 has been particularly impressive with an average annual growth rate of 7 percent. A common feature of economic growth among the five countries under study is the declining contribution of agriculture to national incomes and the growth of the service sector. Economic policymaking in all countries has also moved commonly in favour of greater liberalization and integration with the global economy.

Along with rapid economic growth, the countries in South Asia have been experiencing significant social transitions. Urbanization has been a significant phenomenon in the region with the urban population growing at an average annual rate of 2.8 percent during 1990-2005, which is markedly higher than the region's average population growth rate of 1.9 percent per year for the corresponding period (World Bank, 2007). Migration from rural areas, largely induced by livelihood-related 'push' and 'pull' factors, has emerged as a key pressure on urban infrastructure in all countries of the region.

Though the region has some success in reducing infant mortality and increasing school enrolment, challenges remain in the areas such as child malnutrition, 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.

While recent political developments in Nepal and Bhutan have widened the democratic base of political governance in the region, strong decentralization initiatives in India have served to deepen its foundations. Decentralization has led to the emergence of local-level institutions with community participation for resource management, particularly in the case of forests and water, in India, Nepal and Bangladesh.

It has been suggested that much of the growth that occurred during 1970-2000 in the Indian sub-continent was either unsustainable or barely sustainable when the productive base[14] of the countries is taken into account (Dasgupta, 2007). It is also pointed out that the on-going growth and consumption pattern in South Asia is likely to impoverish local ecosystems and diminish the important services they provide[15] (Imhoff et al, 2004). To date, South Asian

[13] Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka
[14] Productive base of a country is its stock of capital assets and institutions (Dasgupta, 2007).
[15] Imhoff et al (2004) show that South Central Asia consumes more than 80 percent of its regional NPP (net primary production) – the net amount of solar energy converted to plant organic matter through photosynthesis – which represents the primary food energy source for the world's ecosystems. Human appropriation of NPP, apart from leaving less for other species to use, alters the

development process has been environment-intensive and environment-depleting (Alauddin, 2004) and the demand for ecosystem services is projected to increase significantly in the future from the currently high but non-inclusive growth trajectories of many countries in the region (Table-2.1). The degradation of ecosystems is likely to be a significant barrier to the achievement of the Millennium Development Goals (MDGs) related to reduction of poverty, hunger and disease in the region.

Table 2.1: Environmental outlook for South Asia: some key figures

Indicators	Year			Rate of change (%)	
	1980	**2005**	**2030**	**1980-2005**	**2005-2030**
Population (unit: millions)	909	1483	2035	63	37
GDP per capita (USD)	1088	2513	6421	131	155
Energy					
Total primary energy consumption (% of world total)	4	7	9	170	96
of which: coal (% of world total)	3	7	11	346	163
traditional biofuels (% of world total)	22	27	26	61	12
Total final energy use (% of world total)	5	7	9	127	80
of which: coal (% of world total)	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 capita (ton C)	0.09	0.26	0.46	190	76
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, 2006

composition of the atmosphere, levels of biodiversity, energy flow within food webs and the provision of important ecosystem services.

3. Poverty and ecosystem services

Poverty

Following the conceptualization of poverty as "the pronounced deprivation of wellbeing" (World Bank, 2001), national strategies for poverty alleviation in many parts of the developing world have sought to bring about changes that improve wellbeing in its different dimensions. The MA (2005) identifies five interlinked dimensions of well-being – the basic material needs of a good life, experience of freedom, personal security and good social relations – with the observation that the expression or experience of well-being is context and situation dependent, reflecting local physical, social, and personal factors such as geography, environment, age, gender, and culture. Moreover, the concepts of well-being and poverty are complex and value laden (Narayan et al, 1999).

There are various approaches – such as the UNDP's Human Development Index (HDI), Moser's (1998) 'asset vulnerability framework'[16] – that have been used to identify and quantify the dimensions of poverty more explicitly. The measures of poverty thus obtained are aggregates and, as a result, tend to mask small-scale variations that may have significant implications for certain social groups, with consequent implications for policy formulation (Lipton, 1991). The processes of impoverishment need to be disaggregated to show specific differences as well as those linked to particular ecological conditions or diminished access to key ecosystem services (Forsyth and Leach, 1998).

Subjective assessments of well-being have also been used to highlight the significance of key environmental endowments and entitlements which conventional definitions of poverty tend to overlook. The concept of vulnerability is of central importance in case of environmental resources that provide livelihood security to the poor. 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).

Recent research considers poverty as a process rather than as a state and considers entitlement as a tool for reducing poverty and the role of institutions in shaping outcomes (Forsyth and Leach, 1998). Much work on food security, following Sen (1981), has focused attention on formal legal institutions and the role of the market in shaping well-being. In contrast, others have emphasised the importance of informal institutions such as kinship networks in guaranteeing well-being (e.g. Swift 1989). Entitlements-based approaches have also figured with reference to notions of vulnerability other than that of food insecurity, and the experiences of particular social groups (e.g. Kabeer, 1994).

Given the variety of approaches to defining, quantifying and analysing poverty in its multi-dimensional context, this Situation Analysis has been developed taking a very broad view of poverty. It recognises poverty 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

[16] The HDI is based on a bundle of indicators referring to general standards of health, education, and wealth, which may be used to indicate general levels of development. Moser uses an alternative grouping for the various dimension of poverty, which includes labour, 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).

asset endowments,[17] and draws on the concepts of material minimum, health, vulnerability, social relations and freedom from the MA (MA, 2005).

Ecosystems

In this analysis, the term *ecosystem* encompassed a broad definition following the MA[18] both in workshops and throughout the development of the Situation Analysis. For many authors the term remains a conceptualization as opposed to a factual entity (e.g. Maltby, 1999) as the definition does not lend itself easily to usage, for instance either in the physical mapping of ecosystems (Mace et al, 2005) or to measures and indicators of their function and value (Carpenter et al, 2006). Moreover decisions about what constitutes ecosystem 'goods and services' are not solely determined by the way in which ecological structures and functions are considered to link up but also by what features of the system particular stakeholders think are significant (Haines-Young et al, 2006).

There is a need to recognise that people interact with and are dependent on a number of what may conventionally be termed ecosystems. For example, taking a sustainable livelihoods approach (DFID, 1999), predominantly sedentary, rural poor communities may depend upon goods and services provided simultaneously from several biotic communities within the landscape (e.g. 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.

In this Situation Analysis the term *landscape* provides an operational definition of a land (including coastal and/or freshwaters) surface delivering ecosystem services. It may be either natural or derived and maintained by anthropogenic processes (e.g. agricultural landscapes) and may comprise multiple/numerous habitats. However, although the focus of this Situation Analysis is actually landscapes, these are invariably discussed in terms of their dominant 'ecosystem' type to facilitate interpretation by the reader.

Ecosystem goods and services

The biogeochemical functioning of ecosystems delivers a range of ecosystem services such as food, building materials, clean air, fresh water, detoxification and decomposition of waste, renewal of soil fertility, regulation of climate, drought and flood mitigation, pest control, pollination. However, a commonly agreed definition of ecosystem services is lacking (e.g. MA, 2003; Ekins, 2003; Daily, 1997; Costanza et al, 1997) and the term is a source of ongoing debate. Such terms as ecosystem/ecological and goods/services are sometimes used as synonyms in combination (e.g. Daily, 1997; Costanza et al, 1997; de Groot 1992). The difficulty in defining and valuing ecosystem goods and services (Boyd and Banzhaf, 2006; Hartje et al, 2003) is not only compounded by what constitutes an ecosystem in terms of ecological structures and functions but also by what features of the system stakeholder

[17] Generally the productivity of the assets owned by the poor people is low due to the factors such as market failures, institutional gaps, public goods deficits and unfavorable public policies (Dasgupta, 1998).

[18] The Millennium Ecosystem Assessment (MA, 2003) adopted the definition "a dynamic complex of plant, animal and micro-organism communities and their nonliving environment interacting as a functional unit" following the UN Convention on Biological Diversity, 1992.

groups (scientists, managers, policy makers, public bodies, interest groups) consider to be relevant. However, as Haines-Young and Potschin (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 potential benefits of ecosystem management.

The term 'ecosystem goods and services' is in part a re-naming of an old concept, as Brauman et al (2007) have discussed. This concept, that there are free 'goods and services' provided by nature that are over-exploited by population growth exacerbating poverty, is often articulated in terms of environmental degradation. In the context of poverty alleviation however, focus on loss of goods and services places emphasis on the resources available to the poor and the provision and delivery of them across a range of spatial scales. Whilst recognising the importance to policy makers of the need for agglomerative measures of 'ecosystem health' (Meyerson et al, 2005) and the need to value particular 'goods and services' for comparative purposes by stakeholders, this analysis retains the MA taxonomy of Provisioning, Regulating, Cultural, and Supporting services (MA, 2005), recognising that supporting services constitute intermediate, and not end, products.

Methodology for undertaking the Situation Analysis

Operationalising previous frameworks, such as the MA framework, from the public policy perspective and generating new policy relevant research requires some key questions to be answered (Cork et al, 2001; Daily, 1999; PCAST, 1998) including: What ecosystems provide which services?; Who benefits and over what scales of time and space?; What are the impacts of humans upon the supply of services?; How is the supply of services related to the condition of ecosystems?; How much damage has been done already?; What is needed to repair damaged ecosystems?; Where are the problems geographically?; How interdependent are ecosystem services?; How reliant are the services on biological diversity?; How much can technology substitute for ecosystem services?; and Given likely future technology, what area of natural ecosystems will be needed to support human life into the future?

This Situation Analysis progressed as far as possible towards addressing some of these questions within the resources available by drawing on both documented information and stakeholder opinion from within the region. The information was synthesised and analysed as follows:

1. Poverty statistics were collated for the region and, where available, mapping of various poverty indicators was utilised to determine the distribution and extent of poverty within the region (Chapter 4).
2. An assessment was undertaken of the status of dominant ecosystems and ecosystem services in the South Asian context. (Chapter 5).
3. The direct and indirect drivers of ecosystem change within South Asia were identified (Chapter 6).
4. Case study analysis was undertaken for poverty hotspots within the dominant ecosystems of the region in order to analyse in detail the impact of ecosystem degradation, via the delivery of ecosystem services, on the poor in these locations (Chapter 7).

5. Formal and informal policy responses that have been used within the region to tackle ecosystem degradation were evaluated and the effectiveness of these responses was assessed (Chapter 8).
6. Drawing on information from the case studies and analysis of policy responses within the region, the key ingredients for successful policy responses were identified and the areas requiring further research in order to develop region-relevant policy responses were identified (Chapter 9).
7. A comprehensive programme of stakeholder engagement activities was undertaken throughout the development of the Situation Analysis to ensure that the research-based analysis was stakeholder driven and that the analysis was directly linked to policy development strategies within the region, thereby ensuring that the outcomes of this and future research initiatives have maximum potential to be translated into beneficial activity within the region in order to achieve poverty alleviation outcomes. Stakeholder needs were assessed and evidence obtained (through direct engagement) as to how addressing these needs would contribute to poverty alleviation in the region (Chapter 10).
8. Drawing on the lessons learnt through development of the Situation Analysis, on the knowledge gaps identified within the analysis and on the specific needs identified by regional stakeholders, crucial areas of future research were identified for the region and prioritised based on their perceived regional importance by stakeholders and their potential to maximise poverty alleviation outcomes (Chapter 11).

4. Poverty in South Asia

4.1 Income/consumption poverty

South Asia, with GNI per capita (PPP) at $3,142[19], was home to an estimated 32 percent of the world's 986 million poor living on less than $1 a day[20] in 2004 (World Bank, 2007). The region has made significant progress in poverty reduction since 1981, by reducing the share of people living on less than a $1-a-day from 52 percent in 1981 to 43 percent in 1990 and further down to 32 percent in 2004 (Table-4.1). Since 1990 the region has experienced significant GDP growth, between 5 to 6 percent per year, which has helped reduce the incidence of income/consumption poverty substantially.

Table 4.1: Poverty in South Asia as per international poverty lines

Country	Survey year	Population below $1-a-day (%)	Poverty gap at $1-a-day (%)	Population below $2-a-day (%)	Poverty gap at $2-a-day (%)
Bangladesh	2000	41.3	10.3	84.0	38.3
Bhutan	2001	36.3	..	..	..
India	2004-05	33.5	7.6	80.0	34.6
Nepal	2003-04	24.1	5.4	68.5	26.8
Pakistan	2002	17.0	3.1	73.6	26.1

Source: World Bank, 2007 for all countries except Bhutan; figures for Bhutan are from SAARC, 2006

Within South Asia there are huge variations among countries in achieving poverty alleviation. Among the five countries under consideration, except for Pakistan, the others have experienced a declining trend in the incidence of poverty – in terms of national poverty lines – since the mid-1990s (Table 4.2). In Pakistan, the proportion of population below the national poverty line increased at an annual rate of 2.54 percent during the period 1990-01, though more recently poverty decreased remarkably to 23.9 percent in 2005[21] (SAARC, 2006).

Table 4.2: Poverty trends in South Asia

Country	Population below national poverty lines							
	Survey year	Rural (%)	Urban (%)	**National (%)**	Survey year	Rural (%)	Urban (%)	**National (%)**
Bangladesh	1995-96	55.2	29.4	**51.0**	2000	53.0	36.6	**49.8**
Bhutan	2000	41.0	6.4	**36.3**	2004	38.3	4.2	**31.7**
India	1993-94	37.3	32.4	**36.0**	1999-00	30.2	24.7	**28.6**
Nepal	1995-96	43.3	21.6	**41.8**	2003-04	34.6	9.6	**30.9**
Pakistan	1993	33.4	17.2	**28.6**	1998-99	35.9	24.2	**32.6**

Source: World Bank, 2007 for all countries except Bhutan; figures for Bhutan are from SAARC, 2006

Despite the declining trends, the magnitude of poverty remains large in all countries. A growing challenge for national governments in South Asia is worsening income inequality in the region that includes a growing rural-urban divide. Among the SAARC countries, the inequality of income is highest in Nepal – the poorest 10 percent have only 2.6 percent share

[19] Corresponding estimates for Sub-Saharan Africa and Europe EMU are, respectively, $2,004 and $28,915.
[20] In $2-a-day terms, the incidence of poverty in the region increases to 78 percent.
[21] The official claim does not square with other independent analysis.

of the country's national income, whereas the richest 10 percent have a 40.6 percent share (Table 4.3).

Table 4.3: Income/expenditure inequality in South Asia

Country	Survey year	Share (%) of income or expenditure - **MDG**				Inequality measures		
		Poorest 10%	Poorest 20%	Richest 20%	Richest 10%	Richest 10% to Poorest 10%	Richest 20% to Poorest 20%	Gini index
Bangladesh	2000	3.7	8.6	42.7	27.9	7.5	4.9	33.4
Bhutan	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
India	2004/05	3.6	8.1	45.3	31.1	8.6	5.6	36.8
Nepal	2003/04	2.6	6.0	54.6	40.6	15.8	9.1	47.2
Pakistan	2002	4.0	9.3	40.3	26.3	6.5	4.3	30.6

Source: UNDP, 2007

Within countries there exist marked differences in the incidence of poverty by geographical regions. In Bangladesh it is the north-west part of the country that has the highest incidence of poverty, Bhutan's eastern part has more pronounced poverty and in Nepal the mountain region has the highest concentration of the poor followed by the Terai and the hills (SAARC, 2006). The coastal areas of Bangladesh are not only the most populated but also reported to have a relatively high incidence of poverty compared to the rest of the country[22]. In India, state-wise, nearly 72 percent of India's poor and half of her population are located in the following six states: Uttar Pradesh (including Uttaranchal), Bihar (including Jharkhand), Madhya Pradesh (including Chhatisgarh), Maharashtra, West Bengal and Orissa. Further, within these states, there are regions with a high incidence of the 'very poor'[23] – South Western Madhya Pradesh, Southern Uttar Pradesh, Southern Orissa, Inland Central Maharashtra, Southern Bihar, Northern Bihar, and Central Uttar Pradesh (Datta and Sharma, 2000).

As per the 1997 UNDP Human Development Report, poverty is usually worse in drier zones than it is in wetter zones. For instance, India's dryland regions include 125 districts spread over 12 states that are officially identified as drought prone areas or DPAP districts and 32 of these have a high or very high incidence of poverty (NIRD, 2000). The non-income dimensions of poverty are very much evident in the drought-prone regions: livelihood security is low on account of high instability in crop production and there are significant social costs on account of large-scale inter-state migration (Mehta and Shah, 2006).

Poverty in South Asia is primarily a rural phenomenon with the majority of its population living in rural areas[24] and primarily dependent on agriculture for income and employment[25]. The ability of the rural poor to sustain their livelihoods is generally constrained due to adverse environmental conditions – high ecological vulnerability and low resource productivity – and limited access to land and other natural resources (World Bank, 2002). For the rural poor,

[22] In 2001, it was reported that 35.1 million people live in coastal areas of which 25 percent are poor and 24 percent extremely poor (Islam, 2004).
[23] Defined as those with incomes three-fourths of the national poverty line or less.
[24] Among the five countries under consideration, Nepal has the largest share of rural population (84.2 percent) and Pakistan the least (65.1 percent). India and Bangladesh have, respectively, 71.3 and 74.9 percent of their population living in rural areas (World Bank, 2007).
[25] The share of agricultural employment in case of Nepal, for instance, is as high as 80 percent (World Bank, 2007).

access to a variety of natural resources is critical for sustaining livelihood because they provide them with diversification options as environmental conditions change (Koziell and Saunders, 2001). Poverty in the forested regions of India has been linked to widespread entitlement failure (Mehta and Shah, 2006). The rural poor are also hampered by their lack of access to markets, dependence on rains and threatened food security. Chronic rural poverty[26] in the semi-arid region of India has been attributed to the negligible/inferior resource endowments of the poor that restrict their ability to augment income (Singh and Binswanger, 1993). Among the different occupational categories of the country's rural population it is accepted that chronic or extended duration poverty is highest in case of the asset-poor 'casual agricultural labourers' (Bhalla, 2000).

4.2 Basic capabilities

Social progress in SAARC countries has generally lagged behind economic growth, the exceptions being Sri Lanka and the Maldives. In terms of the UNDP's Human Development Index (HDI), which measures a country's progress in basic human capabilities linked to health, education and standard of living, the average for the South Asia region as a whole was 0.63 in 2003 – much lower compared to the world average (0.74) and that of high-income OECD countries (0.91) Within the region, compared to Sri Lanka's HDI of 0.74, the five countries under study have HDI values ranging from 0.51 (Nepal) to 0.62 (India) (UNDP, 2007). Of more concern is the downward slippage internationally in the rankings of SAARC countries between 1990 and 2000, though thereafter there has been a reversal for most of the countries (Table-4.4). Even then, the five countries under study continue to remain in the bottom quartile in international rankings. Table-4.4 also presents the GDI values that reflect the gender disparity in basic capabilities within countries.

The challenges facing countries in South Asia for ensuring faster social progress is more starkly brought out when we consider the relevant MDG indicators. According to the latest report card for the region, the SAARC countries are 'off-track' for most of the indicators that have a bearing on human capabilities and well-being. Particularly worrying is the case of Pakistan, which appears to have regressed on a couple of indicators linked to the goal of eradicating extreme poverty and hunger.

[26] The defining characteristic of the chronically poor is 'not so much low per capita income/expenditure in any year as low variation in it (in absolute terms) over time' (Gaiha, 1989).

Table 4.4: Human development indices for SAARC countries

Country/Region	HDI		HPI-1	GDI
	1990	2005	2005	2005
Bangladesh	0.422 (135)	0.547 (140)	40.5 (93)	0.539 (121)
Bhutan	..	0.579 (133)	38.9 (86)	..
India	0.521 (121)	0.619 (128)	31.3 (62)	0.600 (113)
Nepal	0.427 (140)	0.534 (142)	38.1 (84)	0.520 (128)
Pakistan	0.467 (120)	0.551 (136)	36.2 (77)	0.525 (125)
Sri Lanka	0.702 (76)	0.743 (99)	17.8 (44)	0.735 (89)

Source: UNDP, 2007

Note: Figures in brackets are country ranks

4.3 Vulnerability and insecurity

A key dimension of poverty is vulnerability, which "reflects a household's resilience in the face of shocks and the likelihood that a shock will lead to a decline in well-being" (World Bank, 2007; p. 73). Poor households are vulnerable to sudden and pronounced fluctuations in income that may arise out of ill-health, thin markets as well as market fluctuations, and natural calamities. Since the rural poor in South Asia are primarily dependent on the agriculture sector for livelihood, they automatically become the most vulnerable to climate-change induced risks of crop failure and livestock losses (Box-4.1).

Vulnerability to natural disasters is possibly the greatest in Bangladesh. As a flood-prone country, approximately 34 percent of land in Bangladesh stays submerged under water for 5 to 7 months of the year and affects approximately 60 percent of its households (Rahman and Hassan, 2006)[27]. During floods women and children become particularly vulnerable to health impacts and wage labourers suffer from sharp falls in employment. For many rural households in Bangladesh, riverbank erosion is a more constant threat to well-being. It has been estimated that 2,000 to 3,000 kms of riverbank experience erosion in Bangladesh annually (Hutton and Haque, 2004) and 31 percent of households in Bangladesh are vulnerable to riverbank erosion (Rahman and Hassan, 2006). The impact is severest among the landless and the marginal farmers. Hutton and Haque's (2004) study suggests that the displaced, particularly women, suffer mental stress because of social fragmentation and difficulties in adjusting to urban areas to where they migrate.

[27] During the 1998 flood – considered to be the worst in the 20th century in terms of extent and duration – approximately 50 percent of the country was submerged for 67 days (Hofer and Messerli, 2006), 30 million people were affected and there were up to 400,000 cases of diarrhea of which 500 ended in death (Hutton and Haque, 2004), and an estimated 24 percent of the anticipated agricultural production was lost which contributed to significant food insecurity among the flood-exposed households (Ninno et al, 2001).

Box4.1: Climate change and the future projections for South Asia

Climate change is predicted to result in a significant aggravation of the environmental pressures in many developing countries of Asia, especially in South and East, and interrupt sustainable development of the region. The projected surface warming and shifts in rainfall in most countries of the continent is expected to cause up to 30 percent decline in agricultural crop productivity in Central and South Asia by the mid-21st century. Given the rapid population growth and urbanization in many parts of these regions, the risk of hunger is projected to remain very high. Endemic morbidity and mortality due to diarrhoeal diseases primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle associated with global warming. Freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease due to climate change which again coupled with rise in population and increase in demand due to higher standards of living could adversely affect more than a billion people by 2050. Changes in seasonal runoff due to rapid melting of glaciers and in some areas an increase in winter precipitation could have significant effects on hydropower generation and on crop and livestock production. Predicted sea-level rise could result in many additional millions of people being flooded each year. Sea water intrusion could increase the habitat of brackish water fisheries but can hamper the aquaculture industry. Increases in coastal water temperature would intensify the abundance and/or toxicity of cholera in South Asia. It is predicted with a high confidence that climate change together with the current population explosion could be threatening to the biodiversity resulting from land use changes. A threat to the ecological stability of wetlands, mangroves and coral reefs is also predicted.

IPCC, 2007

The unique geo-climatic conditions have made Nepal most vulnerable to a variety of natural and manmade disasters. The frequency and severity of natural disasters have increased in recent years. The majority of the rural poor live in marginal, ecologically fragile areas (such as steep hillsides, floodplains), with high exposure to environmental hazards such as floods, landslides, and earthquakes (SIDA, 2004). It is pointed out that of the 75 districts in the country, 49 are prone to floods/landslides, 23 are prone to fire (forest/bush) and one is prone to windstorm disasters[28]. In the years 2000 to 2005 more than 1314 people, mostly the poor, died of floods and landslides across the country (CBS, 2006). Hill people are highly reliant on subsistence agriculture, which is directly affected by extreme climate conditions leading to food insecurity. Lohani (2007) reports that in 2005-06 farmers from mid and far-western hills and mountains experienced dry winter, which affected their subsistence winter crops. Rainfall during the summer monsoon of 2006/07 was about 16 percent below normal, which reduced the cultivation area of paddies in the country.

Unanticipated environmental consequences of development projects have often been a great source of misery for local communities. Constructions of upstream projects often create

[28] http://www.environmentnepal.com.np/disaster_m.asp

downstream environmental hazards leading to significant loss of livelihood. Thus, for instance, constructing embankments in the Ganga-Brahmaputra river basin to moderate flood impacts has put large areas in the basin region in a semi-permanent waterlogged state, seriously affecting human health and agriculture (Bandyopadhya, 2002).

4.4 Poverty mapping

In 1998, Henninger argued that there was a need for a critical examination of both *where* and *why* poverty occurs and that geo-referencing at the household level together with economic and non-economic measures of poverty was essential to improving population alleviation. As argued above, there is a conceptual link between household and communal poverty and the landscape from which livelihood resources are drawn and the concomitant goods and services provided by ecosystems.

Maps of the location of poverty are available at the country level for all five countries but there is considerable variation in the mapping resolution and the indices of poverty used (examples are shown in Figures 4.1 – 4.5). No poverty maps based on economic indices were available to the reviewers for Bhutan; the map in Figure 4.2 showing vulnerability to food insecurity.

Economic poverty maps are available for the other four countries with coarse resolution mapping for India (Figure4.5) and Pakistan (Figure 4.4) and more detailed maps for Bangladesh (Figure 4.1) and Nepal (Figure 4.3).

Sub-national (district) spatial poverty data have been published for India (Erenstein et al, 2007 – Figure-4.6; Jayaraman and Srivastava, 2003) and Bangladesh (Bangladesh Rural Poverty Mapping Project, 2004) covering a number of poverty indicators including land tenancy, livestock ownership and adult educational attainment and also based on the sustainable livelihoods approach (Erenstein et al, 2007). Such approaches have demonstrated the ability to identify poverty pockets such as regions in NW Bangadesh that experience *monga* (Box-4.2) and to detect broad causal links between poverty and ecosystem services such as access to irrigation water. Shah and Sah (2004) have also pointed to the multidimensional causes of poverty in India and the different dependencies of arid zone and forest dwellers and Jayaraman and Srivastava (2003) have summarised some of the processes and issues associated with the development of poverty maps (Box-4.3).

Box-4.2: Monga

"Monga" is the local name for seasonal hunger, unemployment, and acute deprivation that affects 40% of the population of NW Bangladesh. Of the 2.5 million households reported in the region in 2005, 28% were considered functionally landless with less than 0.5 acre of land, 39% were marginal farmers with up to 1.5 acres, 18% were small farmers with 1.5 to 3 acres and only 15% were large farmers with 3 to 7 acres. Despite their numbers, landless and marginal farmers operated only 22% of the cultivated land. A multi-agency study in 2004 identified areas of the country that were most food-insecure. The study used a daily per capita consumption of <1600 Kcal to define a food insecure household. Nationally, 30 % of households in this category were landless or cultivated no more than 1.5 acres of land. The study revealed that poverty was concentrated in specific regions of the country. The great majority of the ultra-poor (82%) felt that lack of year round gainful employment was the main cause of food insecurity and hunger followed by low income and landlessness (73 and 70% respectively). Lack of employment between September and late November is a major cause of monga when poor families survive without regular income or proper meals. In this period landless and marginal farm households struggle to buy food from the market even though rice is available. They are therefore compelled to take money by forward selling labour as harvest contracts to land-owners (mostly small farmers) but at wages at least 40% lower than the daily rates at harvest (Anon 2005 a, b).

IPCC, 2007

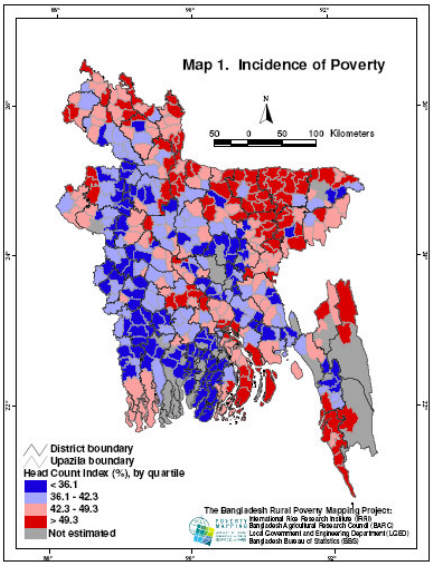

Figure-4.1: Incidence of poverty in Bangladesh (Bangladesh Rural Poverty Mapping Project, 2004)

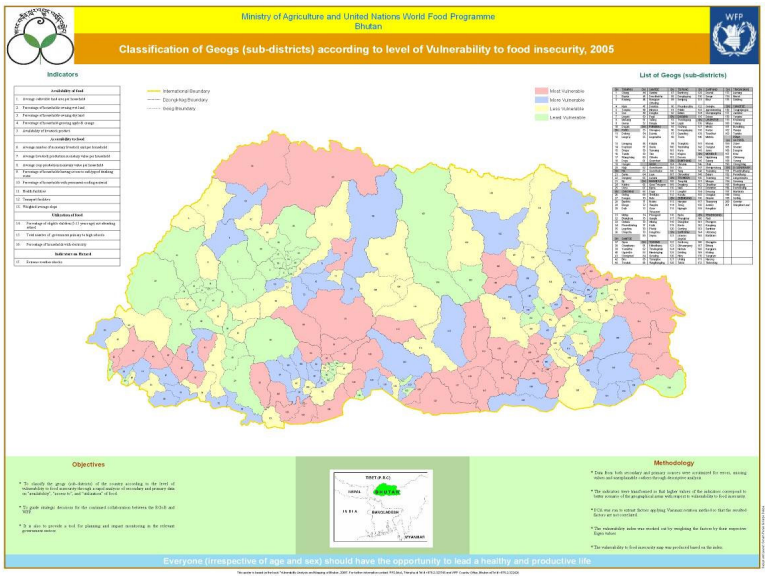

Figure-4.2: Vulnerability to food insecurity in Bhutan (World Food Programme, 2005)

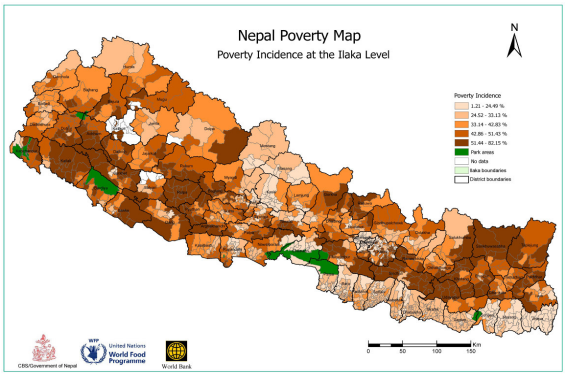

Figure-4.3: Incidence of poverty in Nepal (World Food Programme, 2006)

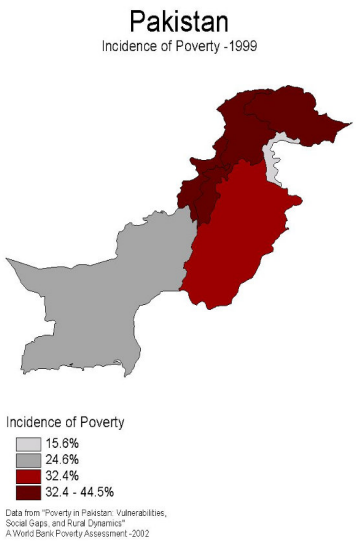

Figure-4.4: Incidence of poverty (%) in Pakistan (World Bank, 2002)

Box-4.1: Recommendations for poverty mapping in India

1. Poverty maps are critical for targeted interventions and to reduce the leakage in the poverty alleviation programmes.
2. Producing poverty maps with all the typical attributes, as per their contextual needs, calls for a multi-institutional and multi-stakeholder approach. Appropriate institutional mechanisms must be in place to address this.
3. There are several operational constraints related to producing poverty maps. It requires the synthesis of large secondary data sets from the different sources having incompatible formats, standards, scales etc. The gaps in data/information have always been the constraining factor to produce the poverty maps.
4. Another challenge is the scale or resolution of spatially disaggregated maps to capture the expected heterogeneity addressing the dynamics of poverty and associated attributes at desired level. A fine resolution or a scale too large increases the cost of compiling, managing, and analyzing the data, while small scale maps do not capture the heterogeneity.
5. Technically, it is the use of remote sensing & GIS that has driven the operationalization of poverty mapping, enabled them to establish their operational reliance and expanding their outreach in the diverse areas related to targeting the poor, their physical and natural *IPCC, 2007*

Jayaraman and Srivastava, 2003

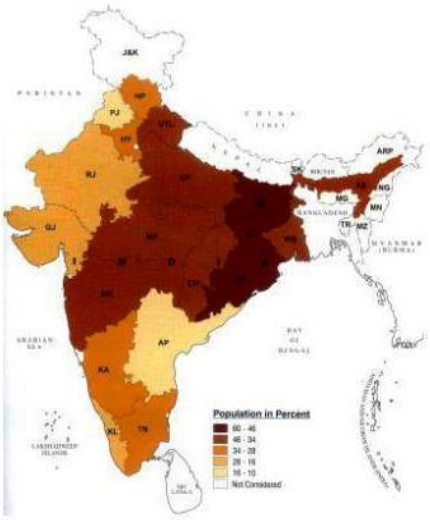

Figure-4.5: Population (%) below the poverty line in India (Jayaraman & Srivastava et al., 2003)

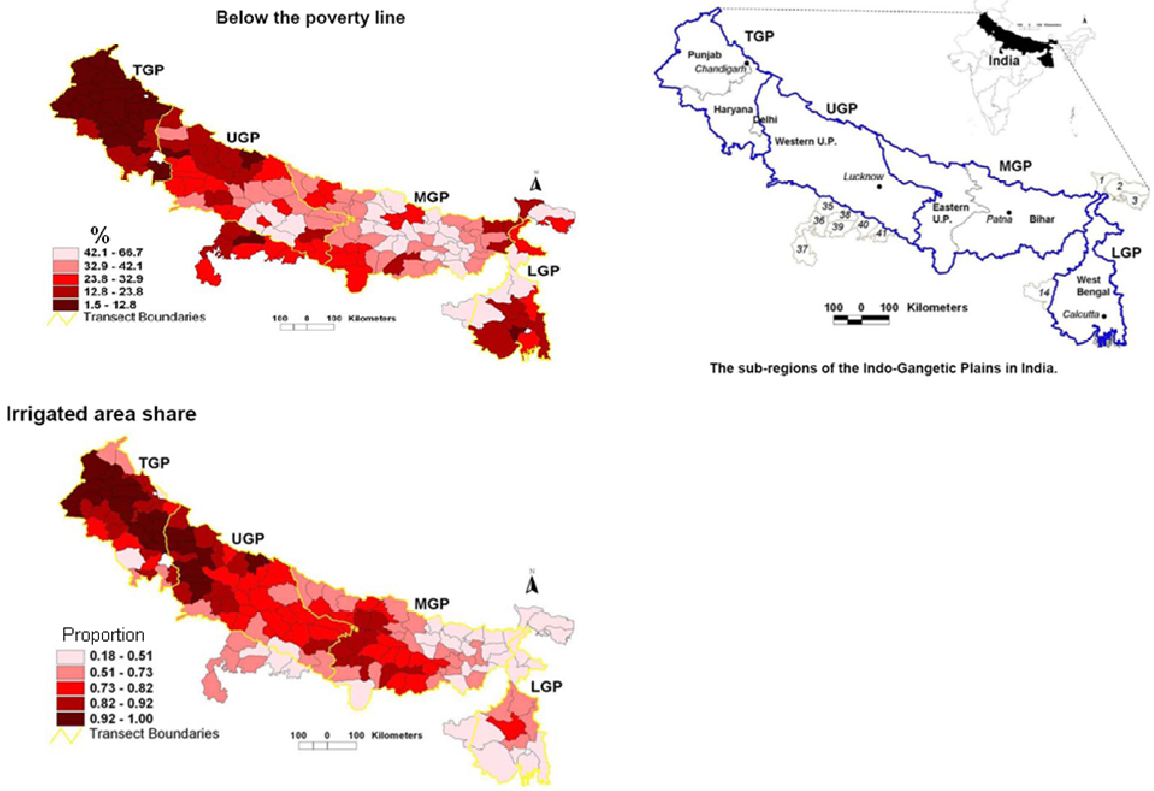

Figure-4.6: The spatial analysis of poverty in the IGP. From Erenstein et al, 2007.

5. Major ecosystems and their services in South Asia

The South Asia region covers extremes in both topography and climate, from the Himalayan mountains to the lowland plains, and this diversity has resulted in a variety of ecosystems (Table 5.1).

Table 5.1: Landscape characteristics and dimensions of the situation analysis

Characteristic	Year	Bangladesh	Bhutan	India	Nepal	Pakistan
Total land area (thousand hectares)[1]	2003	14400	4700	328726	14718	79610
Length of coastline (kilometres)[2]	2000	3306.4	0	17181.3	0	2599.1
Total forest area (thousand hectares)[3]	2005	871	3195	67701	3636	1902
Non-tropical forest (thousand hectares)[4]	1990-1999	0	1129.3	9260.3	2660.5	2083
Tropical forest (thousand hectares)[4]	1990-1999	862.5	966.3	44449.9	1162.2	806.5
Natural forest (thousand hectares)[3]	2005	592	3193	64475	3583	1584
Forest plantations area (thousand hectares)[3]	2005	279	2	3226	53	318
Mangrove forest area (square kilometres)[5]	1997	5767		6700		1683
Mixed forest area (square kilometres)[6]	1992-1993	6948	4407	97509	16408	268
Closed shrubland area (square kilometres)[6]	1992-1993	1742	89	27243	9215	10741
Open shrubland area (square kilometres)[6]	1992-1993	1350	2758	257947	15765	289652
Grassland area (square kilometres)[6]	1992-1993	608	3994	26203	11111	18899
Barren or sparsely vegetated area (square kilometres)[6]	1992-1993	336	916	100560	5929	275792
Savannas area (square kilometres)[6]	1992-1993	0	0	1040	1	81
Cropland area (square kilometres)[6]	1992-1993	93841	840	1742140	38905	237801
Arable and permanent cropland (thousand hectares)[1]	2003	8419	128	169739	2490	20130
Permanent pasture (thousand hectares)[1]	2003	600	415	11065	1735	5000
Irrigated land area (thousand hectares)[1]	2003	4725	40	55808	1170	18230
Waterbodies (square kilometres)[6]	1992-1993	11951	5	42425	522	9017
Permanent wetlands (square kilometres)[6]	1992-1993	3476	0	1471	1	914
Snow and ice covered areas (square kilometres)[6]	1992-1993	0	874	14633	3159	20807
Urban and built-up areas area (thousand hectares)[7]	2000	72.5	0	2129.1	15.3	383.4

[1]Food and Agriculture Organization of the United Nations (FAO). 2006. FAOSTAT Online Statistical Service. Rome: FAO. Available online at: http://faostat.fao.org.
[2]World Vector Shoreline, United States Defense Mapping Agency, 1989. Figures were calculated by L. Pruett and J. Cimino, unpublished data, Global Maritime Boundaries Database (GMBD), Veridian - MRJ Technology Solutions, (Fairfax, Virginia, January, 2000).
[3]Food and Agriculture Organization of the United Nations (FAO). 2005. Global Forest Resources Assessment 2005: Progress towards sustainable forest management. [4]FAO Forestry Paper 147. Rome: FAO. Available online at: http://www.fao.org/forestry/foris/webview/forestry2/index.jsp?siteId=101&langId=1.
[4]Iremonger, S., C. Ravilious, T. Quinton, "A statistical analysis of global forest conservation." In: S. Iremonger, C. Ravilious, and T. Quinton (Eds). "A Global Overview of Forest Conservation CD-ROM" (World Conservation Monitoring Centre (WCMC) and Centre for International Forestry Research, Cambridge, U.K., 1997).
[5]Spalding, M., F. Blasco, and C. Field (Eds.). "World Mangrove Atlas", The International Society for Mangrove Ecosystems (ISME), Okinawa, Japan, 1997.

[6]Loveland, T.R., Reed, B.C., J.F., Brown, J.F., Ohlen, D.O., Zhu, Z., Yang, L. Merchant. J. 2000. Global Land Cover Characteristics Database (GLCCD) Version 2.0. Available online at: http://edcdaac.usgs.gov/glcc/globdoc2_0.html.
[7]Global Land Cover 2000 database. European Commission, Joint Research Centre, 2003. Available online at: http://www-gvm.jrc.it/glc2000/.

These deliver a broad range of ecosystem services and by way of example, Table 5.2 provides an overview of the major ecosystems of Pakistan.

Table 5.2: The major ecosystems of Pakistan and examples of ecosystem services

Ecosystem	Characteristics	Significance	Ecosystem services
Indus delta and coastal wetlands	Extensive mangroves and mudflats	Rich avian and marine fauna	Marine fish spawning grounds
	Inadequate protected area coverage	Diverse mangrove habitat	Fuel
		Marine turtle habitat	Flood control
Indus river and wetlands	Extensive wetlands	Migratory flyway of global importance	Flood control
		Habitat of Indus river dolphin	
Chagai desert	A desert of great antiquity	Many endemic and unique species	Biodiversity refuge
Balochistan Juniper forest	Huge and ancient Junipers	Largest remaining Juniper forest in the world	Fuel, fibre and fodder
		Unique flora and fauna	
Chilghoza forest (Sulaiman Range)	Rock outcrops with shallow mountain soils	Important wildlife habitat for several species at risk	Fuel, fibre and fodder
Balochistan sub-tropical forests	Mid-altitude forests with sparse canopy but rich associated flora	Very few areas now remain	Fuel, fibre and fodder
		Important wildlife habitat	
Balochistan rivers	Not connected with the Indus river system	Unique aquatic fauna and flora with high levels of endemism	Biodiversity refuge
			Food
Tropical deciduous forests (Himalayan foothills)	Extend from the Margalla Hills National Park east to Azad Kashmir	Perhaps the most floristically rich ecosystem of Pakistan	Fuel, fibre and fodder
			Cultural services, tourism
			Climate regulation
			Carbon sequestration
Moist and dry temperate Himalayan forests	Important forests tracts now becoming increasingly fragmented	Global hotspot for avian diversity; important wildlife habitat	Fuel, fibre and fodder
			Cultural services, tourism
			Climate regulation
			Carbon sequestration
Trans-Himalayan alps and plateaux	Spectacular mountain scenery	Unique flora and fauna; centre of endemism	Cultural services, tourism
			Climate regulation
			Carbon sequestration

Adapted from BAP, 2000

Forests

Forest ecosystems provide critical, important regulating services (such as soil protection, recharging groundwater, flood control/regulation, carbon sequestration, and nutrient cycling) but these are less well documented compared to their provisioning services. Forest catchments are the main sources of water used for hydroelectric power, irrigation and drinking water, particularly in Nepal. The Himalayan forests and those of the Western Ghats are a very significant depository of biodiversity of global importance (Fisher and Treg, 2007; Myers et al, 2000) and Table-5.3 illustrates the roles of particular dominant tree species. Tourism, based on forest ecosystems, is one of the major sources of external income for countries like Nepal and Bhutan.

The rural communities of South Asia are typically dependent on forests as their source of energy, supplementary nutrition, animal fodder, medicine, farm implements and household assets. Forest foods in general do not contribute the major component of the forest dwellers diet but are significant in maintaining nutrition. Hassan et al (1985) concluded that the nutritional status of young children in villages near forests (with up to 30% of their diet derived from forests) was superior to those in distant villages.

The importance of agro-forestry at the household level in India has been highlighted by Alavalapati et al (1995) and Altieri (1999) has pointed out that salient feature of traditional farming systems is their degree of plant diversity in the form of polycultures and/or agroforestry patterns. Complex agro-forestry systems, as an alternative to slash and burn systems practiced in India and Nepal, have been estimated to sequester up to 70 t ha^{-1} of carbon (ASB, 1998).

The quantification of the value of other component services of forest ecosystems remains outstanding (Puri and Nair, 2004) and particularly with respect to poverty alleviation.

Table-5.3. A summary of ecosystem attributes and services of major forest species in the central Himalaya and of *Lantana camara* dominated bushland that establishes after deforestation (from Singh et al, 2007)

Species	Attributes	Ecosystem services
Baj Oak (*Quercus leucotrichophora*)	• High biomass (~400-500 t/ha) • Fine roots and carbon deposition up to 1.50 m or more • High investment of photosynthate in ectomycorrhizae • Massive yearly nutrient return to soil through litter fall	• Deep soil formation • High soil fertility • Effective carbon sequestration (especially in deep soil) • Considerable nutrient and water retention
Chir pine (*Pinus roxburghii*)	• Low biomass (~200 t/ha) • High productivity (~ 20 t/ha/yr) • High nutrient use efficiency, ability to tolerate stress • Effective coloniser	• Erosion control on steep slopes with little soil • Retention of nutrients on steep and rocky slopes, leading to associated nitrogen fixation.
Alder (*Alnus nepalensis*)	• Low biomass (~100 t/ha) • Very high productivity (20-30 t / ha / yr) • Primary coloniser, high rate of N-fixation (up to 200 kg/ha/yr)	• Coloniser • Facilitation in succession • Nitrogen fixation
Bushland (*Lantana camara*)	• Fast growing, low biomass • Low biodiversity • Flammable by cool fire	• Facilitation of annual species • Nutrient release through slash and burn

Rangeland - grassland, pastures and shrubland

The importance of the ecosystem services of grasslands for carbon sequestration, methane absorption and reduction of NO_2 emissions is well documented (Sala and Paruelo, 1997; Mosier et al. 1991) together with biomass for grazing. According to the available data (Table 5.1), in the last decade, the area under permanent pasture in the region has suffered decline in India and Nepal, increased in Bhutan at the expense of forests and is in stasis in Bangladesh and Pakistan. Concomitantly, heads of livestock have increased in all counties, with the exception of cattle in India (Table 5.4).

Grasslands provide grazing and pasture services for domestic as well as wild herbivores. Most of the original grasslands in India's Gangetic plains have disappeared owing to population pressure, except in isolated pockets in the *terai*. In Punjab, Haryana and western Uttar Pradesh, improved irrigation facilities have led to the grasslands being replaced by arable agriculture, predominantly the rice-wheat system. Moreover, Geevan et al (2005) report that in the Kutch district of Gujarat in India, grazing and the invasion of the exotic mesquite *Prosopis juliflora* has severely degraded grasslands. Whilst there is clear evidence that overgrazing has resulted in significant environmental degradation and increase in wastelands (Jayaraman and Srivastava, 2003), the detailed role of biodiversity in the maintenance of sustainability of grasslands in India under grazing is yet to be fully understood (Sankaran and McNaughton, 1999).

Box 5.1: Migratory herding in Bhutan

Migratory herding was central to Bhutan's traditional pastoral economy and is still an important livelihood activity for many Bhutanese. Migratory herding embodies considerable knowledge about ecology, climate and topography among the herdsmen. The seasonal migration of yak herders from higher elevations to lower elevation during winter (and vice-versa during summer) is a strategy adopted by herders to overcome extreme winter conditions (which translates to a shortage of feed and fodder resources) in higher altitudes, and exploit economic opportunities at lower elevations.

Wangchuk et al, 2006

The livelihoods of a significantly large population of pastoral and agro-pastoral communities in the arid/semi-arid regions of Bhutan, India, Nepal and Pakistan depend on the pasturelands and free grazing livestock (Box 5.1). Ram et al (1989) have pointed to the long term stability of alpine and sub-alpine grasslands in the central Himalayan alpine region which have been grazed using traditional transhumance practices for decades, and in which biomass exchange was at equilibrium in the annual cycle.

Table 5.4: Country statistics on pasture and major herd stocks

Country	Permanent pasture (in sq. km.)		Cattle stocks (1000 head)		Goat stocks (1000 head)	
	1993	2003	1993	2003	1993	2003
Bangladesh	6,000	6,000	23,569	24,500	25,967	36,900
Bhutan	3,500	4,150	338	372	20	30
India	113,010	110,650	203,634	185,180	116,300	124,358
Nepal	17,570	17,350	6,237	6,954	5,452	6,792
Pakistan	50,000	50,000	17,779	23,303	40,225	52,763

Desert

Pakistan is predominantly an arid country and in three-quarters of its land area plants lose more moisture through evapo-transpiration than are compensated for by rainfall. In fact, roughly half of this arid zone is best described as desert-like; particularly its western and south-eastern parts, which have as little as 25 mm of average annual rainfall and temperatures that rise frequently above 40 ºC in May and June.

In India, the arid and semi arid zones are spread over eight states but 90 percent of the hot desert is located in the north-western part of the country. Of this, 62 percent is located in the state of Rajasthan. The Great Indian Desert, or the *thar* extends about 2.3 million sq. km and is the most populated one in the world with a density of 75 persons per sq. km. Marginal land cultivation in the *thar* has increased from 32 percent in 1960s to 52 percent in 1990s leading to further desertification (Singh, 1998).

A number of authors (e.g. Chauhan, 2003; Khan, 1997; Sinha, 1996) have highlighted the extent and use of biodiversity in these zones in relation to afforestation and revegetation. For example the construction of the Indira Gandhi Canal in 1952 converted the desert ecosystem in the command area of the canal into an evergreen forest ecosystem (Sinha et al, 1997) illustrating the potential for provision of services underpinning poverty alleviation. However there has been little quantification of the value of biodiversity with respect to provisioning services of the poor other than species inventories.

Wetlands

Freshwater wetlands

Inland South Asia has many different types of freshwater wetlands that range from areas of permanently flowing rivers to areas of seasonal streams, lowland oxbow lakes, high altitude glacial lakes, swamps and marshes, paddy fields, reservoirs and ponds. The provisioning service of wetlands are particularly important for Bangladesh: they cover 35 percent of the country's land area and it has been estimated that 80 percent of people in rural Bangladesh depend on wetlands areas for fish and other aquatic resources (USAID, 2007).

Despite their importance, wetlands in the South Asian region are under threat from encroachment, unsustainable harvesting, industrial pollution, agricultural runoff, and the introduction of exotic and invasive species. While the rivers and streams suffer from pollution impacts and obstruction to flow, the most important pressure on lentic bodies like ponds, lakes, floodplain marshes, etc is in the form of encroachment and reclamation. Many wetlands are drying out, converted into agricultural lands, or otherwise subjected to unsustainable use. Poor property rights[29] and development infrastructure[30] are among the chief contributors to the degradation of wetland ecosystems.

[29] In the case of the *haor*s in Bangladesh, for instance, the government typically provides short-term leases, which encourages maximum exploitation while excluding poor people from using the resources (Islam et al, 2000).

[30] For instance, in Bangladesh, polders built to prevent sea water during storms and floods from entering agricultural fields adjacent to wetland bodies called *beel*s have served to block the tidal flow of rivers and created siltation and waterlogging, which eventually do not allow sea water to be drained (Choudhury et al, 2004).

Coastal wetlands

Bangladesh, India and Pakistan have extensive coastlines that contain wetlands such as estuaries, lagoons, mangroves, backwaters, and salt marshes. Typically the coastal areas are the most densely populated. In Bangladesh, for instance, it is reported that 35.1 million people lived in coastal areas in 2001 and that the extent of poverty in these areas is relatively high compared to the rest of the country (Islam, 2004).

Coastal wetlands such as Rann of Kutch (Gujarat) and the Chilika Lagoon in India are unique coastal ecosystems that provide rural livelihoods based on fishing. In the Rann, the influx of tidal and rainwater during monsoon results in the formation of huge but shallow lakes, forming a hybrid environment of inland and coastal wetlands persisting for 3-4 months. The Chilika lagoon in contrast is permanent (see Box 5.2).

Box 5.2: The Chilika Lagoon

Chilika Lagoon (a Ramsar site) is the largest brackish water lagoon on India's eastern coast, covering an average area of 760 km^2 with high biodiversity and a fishery for over 200,000 people. Records indicate that fishing strategies, using different methods in relation to ecological zonation within the lagoon, have historically proved sustainable, given the maintenance of salinity as the dominant factor determining the lagoon's ecology and aquatic biodiversity.

However loss of ecosystems services resulting from deforestation that previously protected the lagoon from siltation and ensured oceanic access, together with eutrophication through agricultural intensification and loss of surrounding wetlands had led, by the 1990s, to a 30% reduction in salinity. A consequential proliferation of freshwater aquatic plants resulted in changes in fish and crustacean community structure, greater fishing intensity, declines in biodiversity in particular the avian fauna which affected revenue streams for local livelihoods through tourism.

Re-establishment of ecosystem services by re-connection to the ocean, surrounding micro-watershed management, avian habitat protection and prevention of over-fishing has returned fishing to previous levels and protected rural livelihoods.

Ghosh and Pattnaik, 2005

Mangroves

Mangroves deliver a wide variety of ecosystem services including: shoreline stabilisation; storm protection (Das, 2008); water quality; micro-climate stabilisation; groundwater recharge and discharge; flood and flow control; sediment and nutrient retention; habitat protection; biodiversity; biomass productivity and resilience; gene bank; recreation, tourism and culture; hunting and fishing; and forestry products. Figure 5.1 shows the percentage use of some of these mangrove-derived ecosystem services in Coringa Wildife Sanctuary area (Zone 1) and the non-sanctuary area (Zone 2) of the Godavari mangrove region. Fuel wood is seen to be the dominant use of the mangroves in both zones.

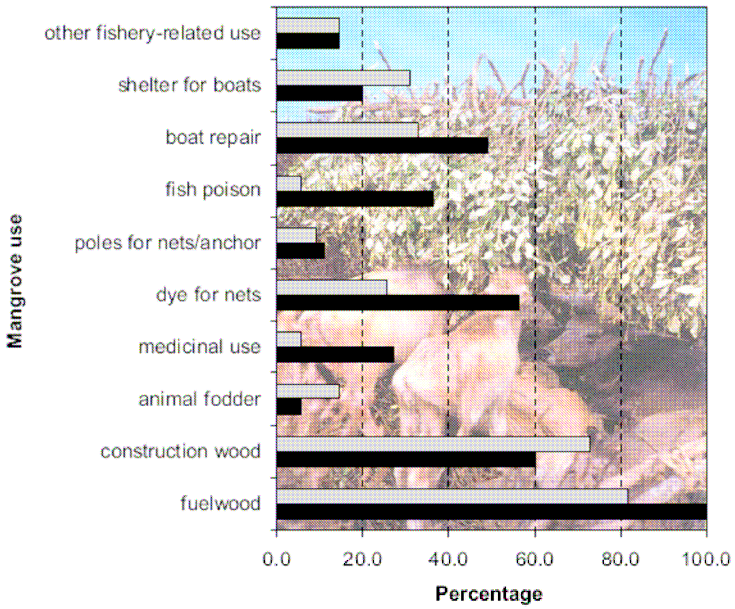

Figure-5.1. Percentage use of different mangrove use classes in Zone 1 (black) and Zone 2 (grey) amongst the 100 interviewed households (n zone1 = 55; n zone2 = 45). The background photograph shows *Avicennia* branches used as fodder for feral water buffaloes. (from Dahdouh-Guebas et al, 2006).

Mangroves also attract tourism, providing an income-generating cultural service for local people. For example, the Sundarban Tiger Reserve (Box 5.3), part of the extensive area of mangrove forest that spans the border between India and Bangladesh, provides ecotourism-centred livelihood opportunities (jobs as vendors, boatmen and guides) for the local population, although only a small number of households currently participate and efforts are being directed towards encouraging increased participation due to both the potential to improve livelihoods and the conservation benefits to the Sunderbans from increasing local peoples 'stake' in the ecosystem (Guha and Ghosh, 2007).

Box 5.3: Sunderbans

The world's largest mangrove forest, the Sunderbans, is located at the apex of the Bay of Bengal and is presently spread over an area of 25,000 sq. km. in India and Bangladesh, out of which the Indian part consists of 9,630 sq. km. (Chopra et al, 2006). Progressive reclamation of the Sunderbans due to population growth as well as the relatively greater productivity of aquaculture has resulted in the loss of substantial masses of mangrove forest along with its biodiversity in both countries. Building of upstream river infrastructure has contributed to increased salinity in the coastal mangroves in Bangladesh (Islam, 2004). Mass shrimp fry collection is a threat to the coastal ecosystem, causing damage to the nursery grounds of many species, newly planted mangroves, and reserve forests (BRAC, 2008). Additionally, introduction of new species has also been detrimental to the mangrove forest ecosystem (Hoq 2007; Ali, 2006).

Arable agro-ecosystems

In the region as a whole, demographic trends in population indicate a greater increase in urban rather than rural populations in the last decade, but with large rural populations

remaining in all countries. As indicated earlier, poverty is concentrated in these rural areas. In 2003 the percent of the labour force involved in agricultural activities was over 90 percent in Bhutan and Nepal, the proportion falling in India to 58 percent, with 53 percent and 46 percent respectively in Bangladesh and Pakistan.

Permanent agro-ecosystems (arable, permanent cropland) constitute a significant proportion of the landscape in Bangladesh (58%), India (52%) and Pakistan (25%), much lesser proportions being evident in Nepal and Bhutan. A very high proportion (>95%) of these agro-ecosystems occur in a mosaic with natural vegetation in these latter countries whereas in India, Bangladesh and Pakistan only 22%, 10% and 6% respectively have been recorded in association with natural vegetation (Table 5.5).

Table 5.5: Land-use for agriculture

Country	Cropland / natural vegetation mosaic (sq.km.)	Arable and permanent cropland (sq.km.)		Irrigated land as a percent of total agricultural area (%)	
	1992-1993	1993	2003	1995-2000	1995-2000
Bangladesh	8,424	82,340	84,190	36.8	52.4
Bhutan	1,221	1350	1280	8	7.4
India	370,788	1,697,370	1,697,390	27.7	30.9
Nepal	28,482	23,990	24,900	26.6	27.7
Pakistan	11,465	214,000	201,300	64.8	72.5

In the region, seasonal cropping patterns reflect the annual monsoonal cycle with *kharif* crops being planted with the onset of the monsoon and *rabi* crops grown on residual soil moisture in the dry season. There is however a wide diversity of cropping systems and rotations, that is also dependent on topography and access to irrigation facilities. Agro-ecological zonation provides a typology of cropping systems which is now well established in the region (e.g. Jayaraman and Srivastava, 2003) and has served as a basis for considering adaptation strategies for poverty alleviation (Hazell and Fan, 2003).

The ecosystem goods and services of these agro-ecosystems are extractive in the provision of food and fibre in the context of subsistence agriculture of the rural poor. However in provision of these goods, managed agro-ecosystems may also generate positive and negative impacts on ecosystem services elsewhere. Positive effects include the preservation of scenic rural landscapes and ensuring groundwater recharge. Nitrate run-off from cropland to downstream catchments and soil erosion from overgrazed hillsides constitute negative effects. Agro-ecosystems also provide, and benefit from, scale-dependent ecosystem services including the following.

- *Siltation, soil nutrient renewal in river basins* (Alexander et al, 1998). The average mechanical denudation rate for the Ganges and Brahmaputra basins together is about 365 mm 10^3 yr^{-1}. Of the total suspended sediment load (1037 million tonnes) transported by these rivers, c.51% of the total load is delivered to the coastal area of Bangladesh and the remaining is deposited within the lower basin, offsetting

subsidence. Of the deposited load, about 289 million tonnes (about 28% of the total load) are settled on the foodplains of these rivers (Islam et al, 1999). Karim et al (1991) estimate that soil nutrient recharge through flooding of the Ganges is equivalent to 58.75 kg ha^{-1} for potassium, 5.0 kg ha^{-1} for phosphorus and 31.3 kg ha^{-1} for sulphur.

- In-situ *biological nitrogen production through the flooding of anaerobic soils* (Kirk, 2004). Rice grown intensively (3 crops per annum in the absence of fertilizer or manure addition and with complete removal of straw) can yield a total of 9 – 10 t ha^{-1} per annum (Dobermann et al, 2000). It has been estimated that biological N fixation in standing water and at the soil-water interface is about 50kg N ha^{-1} per crop, (Ladha et al, 2000).
- *Integrated pest management in the maintenance of arthropod food webs, and the natural regulation of crop pests*. Heong and Escalada (1998) reported that Asian rice farmers commonly spray insecticides in the early stages of the crop to control leaf-feeding insects due to misconceptions about the damage caused and the ability of rice to maintain yield. Participatory on-farm experiments have demonstrated that the mean number of insecticide sprays can be reduced with the added benefit of protection of developing food webs from bund living insect predators, important in suppression of brown plant hopper outbreaks within rice fields (Cohen et al, 1994; Joshi et al, 1992).
- *Hydrological services*. At the regional scale, the recharge of extensive shallow aquifers in the Indo-Gangetic basin has underpinned the Green Revolution of the rice-wheat system covering 13.5 million ha of prime agricultural land in Bangladesh, India, Nepal, and Pakistan (Gupta and Abrol, 2000). Shallow aquifers and coupled with high hydrostatic pressure have lead to the extensive use of tube-wells for agricultural development. In the last decade however ground water exploitation (Shah and Gujarat, 2003), principally for agriculture, has reached very high levels in some western states of India (e.g. Punjab, 94%, Haryana, 84%) leading to lowering of ground water tables, soil salinizaton and the build up of arsenic (Rahman and Hassan, 2006; see Box 5.4).

Box 5.4: Arsenic poisoning in Bangladesh

Since 1993, when high arsenic concentration was discovered, 20 million people in Bangladesh have been affected by arsenic poisoning and 70 million are at risk. The poor are especially vulnerable to arsenic poisoning because they are not able to buy expensive tube wells that dig deep into the ground. It has been estimated that 74 percent of poor households use arsenic contaminated water (Rahman and Hassan, 2006). Poor women in particular are more vulnerable than men to this public health crisis because they are nutrition-poor and unable to fight the poisoning. In addition to bodily harm, women who have been affected by arsenic poisoning face social repercussions since they become 'unmarriageable' (Crow and Sultana, 2002). Additionally, chemical run-off from fertilizers has also contaminated groundwater by leaching nitrate, which causes methemoglobinemia or 'blue baby syndrome' (Rasul and Thapa 2004).

Biodiversity

In the whole of South Asia, increasing human and livestock population are acting as major pressures on the region's rich biodiversity. Major threats to protected areas in all countries include grazing all year round, poaching for high value products, illegal timber harvesting and unsustainable tourism. Wildlife killing also takes place as a result of conflict with the human population living in the vicinity of the parks. The report of the National Forest Commission set up by the government of India (GoI, 2006) highlights that established protected areas are ecologically small and incomplete biomes surrounded by human habitation, which in most cases are adversely exploiting these areas.

There are several indicators[31] being currently used, to look into the changes in the status of biodiversity and the response measures at country-level. Information for some of these indicators has been compiled in Tables 5.6 (state and trend indicators) and 5.7 (response indicators) for South Asia.

[31] see: CBD headline indicators, Global Biodiversity Outlook 2006, Forest Resources Assessment by FAO, European Environment Agency, SEBI2010, Countdown 2010, 2010 Biodiversity indicators partnership

Table 5.6: Data on state and trend indicators of biodiversity in five countries of South Asia

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

* This includes 25 birds, 1 freshwater fishes, 6 reptiles, 20 mammals (Source: Third NBSAP submitted to CBD)
+extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate (Source: IUCN red list, 2001).
** FAO, 2003 ***Edwards, 1996 ++ Latif and Shinwari

Table 5.7: Data on response indicators of biodiversity in five countries of South Asia:

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

* UNEP-WCMC @ FAO (Food and Agriculture Organization). 2006. Global Forest Resources Assessment 2005. Rome
# UNEP-WCMC World Database on Protected Areas ** IUCN red list † Threatened species are those listed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU).

6. Drivers of ecosystem change in South Asia

6.1 Indirect drivers

Demographic drivers

Population growth in the five countries is projected to rise to 1856 million in 2025 and expected to be concentrated on the poor areas of the region as these are the areas with high fertility rate combined with a young age structure[32] (Table 6.1). For the five countries under discussion the average total fertility rate (TFR) has been declining, but is still much higher than the average replacement level. Crude birth rate and death rates in South Asia have declined over last 25 years and average life expectancy in the five countries has risen from 50.2 years in 1980 to 63.4 years in 2004. Migration is another determinant of the demographic transition in the region, but there is not enough information on migration in the region to predict the future trend[33].

Table 6.1: Demographic details in South Asia 1980-2004

Year	Indicators	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	5.0	5.6	7.0
	Under-five mortality rate	205	227	173	195	153
	Life expectancy at birth (years)	49	45	54	48	55
	Population aged 15-64 (% of total)	53	55	57	55	54
1990	Crude birth rate (per 1000 people)	35	38	30	38	41
	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
	Population aged 15-64 (% of total)	56	55	59	55	53
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)	3.0	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
	Population aged 15-64 (% of total)	61	57	62	57	57

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

Economic drivers: consumption, production and globalisation

There is emerging evidence that the South Asian region is experiencing growth-induced

[32] Current age structure is also a key determinant of population growth over the next few decades, because of the growth momentum inherent in young populations.

[33] 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.

changes in household consumption patterns as well as in the structure of production[34], both of which are expected to increase the materials and energy intensity in economic activities (Table 6.2). However, studies on the impact of such changes on ecosystems and ecosystem services are hard to identify. Similar research gaps exist with respect to growing urbanization, increasing trade openness, development and adoption of new technology, and infrastructure expansion in the region. Throughout the region, infrastructure development has had significant negative impacts on ecosystems and ecosystem services, such as those provided by coastal mangroves in Bangladesh (the Sundarbans)[35] the coastal ecosystems of Sindh-Balochistan[36] and on river flows and siltation in forest ecosystems in Nepal[37].

Table 6.2: Economic drivers in South Asia

Indicator	Period/ Year	Bangladesh*	Bhutan	India	Nepal	Pakistan
Average annual growth rate of GDP (%) [1]	1985-95	4.2	5.7	5.5	5.0	5.2
	1995-2005	5.4	6.9	6	3.9	3.7
Average annual growth rate of per capita GDP (%) [1]	1985-95	1.8	3.0	3.4	2.5	2.6
	1995-2005	3.4	3.9	4.3	1.6	1.2
Gross capital formation (% of GDP) [2]	1990	17.1	32.5	24.1	18.4	18.9
	2005	24.5	60	33.4	28.9	16.8
Trade (% of GDP) [2]	1990	19.7	57.6	15.7	31.6	38.9
	2005	39.6	82	44.7	48.7	35.2
Urban population (% of total) [2]	1975	9.9	4.6	21.3	4.8	26.3
	2004	24.7	10.8	28.5	15.3	34.5
Energy use (kg of oil equivalent per capita) [2]	2000	145	..	504	334	463
	2004	164	..	530	340	489

** The corresponding period of given data for Bangladesh are 1986-96, 1996-2006*

1. http://earthtrends.wri.org/country_profiles/index.php?theme=5

2. World Bank, 2007

Socio-political drivers

Socio-political factors (governance and policy changes) determine and affect how human interact with environment. Political freedom, press freedom, civil liberties in the countries influences public participation in environment management and related decision-making process. As Table 6.3 shows, 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 while Bhutan has comparatively more press freedom in the region. The role of increased human security[38] on environmental conservation and sustainability is potentially positive but as yet un-researched.

[34] In India, for instance, there has been doubling of calories derived from fat over a 20-year period and the percentage of all cereals in household expenditure has been declining. This conforms to economic theory, which predicts that as income rises the share of income spent on food declines (Engel's Law) and there is a shift from primary starchy staples to more fat, protein, fruits and vegetables (Bennett's law). Similarly, the South Asian countries are varyingly experiencing a structural shift from predominance of agriculture to a dominant non-agricultural sector.

[35] ESPA Situation analysis report: Bangladesh.

[36] ESPA Situation analysis report: Pakistan

[37] ESPA Situation analysis report: Nepal

[38] Human security is understood as the survival and dignity of human beings through freedom from fear and freedom from want.

Table 6.3: Socio-political factors in South Asia

Socio-political factor	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

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

Other indirect drivers

Cultural values[39], norms, beliefs can act as drivers of ecosystem change because they influence people's perception and interaction with ecosystems (Box 6.1). There has not been much research in this area in the past. Scientific and technological progress (e.g Green revolution, genetically modified crops engineering) can be and has been elements of important consequences for the ecosystem.

Box 6.1: Buddhism and the environment in Bhutan

In Bhutan, people's attitude towards the environment is deeply influenced by tradition and Buddhist beliefs and values. Traditionally nature has been revered as having mystic abilities. Places are believed holy in association with mystical beings, deities or religious events and are thus held sacred. This traditional respect, along with a primarily agrarian economy and low population density has helped in the preservation of ecosystems. Most Bhutanese still hold true to their traditional and Buddhist values but this faith in the religious beliefs is slowly eroding with change. The older generation still believes in cause and effect and has inherent respect for nature but among the younger generation these beliefs hold less sway. (*Participant's observation in country workshop*)

6.2 Direct drivers

Monsoon-governed hydrological processes

Variability in the Indian summer monsoon is time honoured and failure of the monsoon has led to famine induced loss of human life, in periods leading up to the Green Revolution. Dash and Hunt (2007) and Gadgil (2003) review the dynamical processes inherent in global climate circulation and their relationship to the onset, duration and intensity of the monsoon. Whilst it has been argued that the monsoon is intrinsically a self regulating climate system (Webster et al, 2002), the underlying reasons for variability in the monsoon on inter-annual and inter-seasonal scales arise from incomplete understanding of monsoon processes and the poor performance of current climate models where ocean, atmosphere, land surface and mountain processes interact. Nevertheless whilst the role of the hydrological cycle is highly complex the expectation of river flow through landscapes is considered to be a cultural 'given', and as such it is a regional service. This is especially so in the Himalayan region[40]. Sarkar and Kafatos (2004) and Prasad et al (2007) have illustrated that inter-annual variability of vegetation over the Indian sub-continent is clearly linked to variation in monsoonal precipitation and the occurrence of aerosol cover. Moreover there is usually a considerable spatial and economic disconnection between the beneficiaries of hydrologic services and the managers of water flow through those landscapes. Amongst Himalayan

[39] Culture refers to the characteristics of a group of people and one individual can assimilate the values and norms of a number of cultures.
[40] UNAP http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN015817.pdf

countries this has manifested itself in the need for legislation for trans-boundary sharing of water resources at county and state level (Mishra et al, 2007).

Climate change

Extensive and on-going syntheses of the potential impacts of climate change have been produced at regional, Asia (e.g. IPCC, 2007; Murdiyarso, 2000; Iglesias et al, 1996), sub-regional (e.g. Sharma et al, 2000; Luo, 1999; Rama Krishnan, 1998; IPCC 1997a, b) and country levels (e.g. Mirza et al, 2003; Mirza and Qader, 2002; Kumar et al, 2001; O'Brien, 2000; NEC, 2000; Siddiqui et al, 1999; Mehrotra, R. 1999; Ali, 1999, 1996; Ravindranath and Sukumar, 1998; Karim et al, 1996; Wescoat, 1991). The consequence of glacier retreat and snow melt in the Himalayas in response to global warming have been explored by scenario analyses examining the sensitivity of Himalayan hydrology, and river flow regimes and discharges to climate change (e.g. Sharma and Shakya, 2006; Mirza et al, 2003; Sharma et al, 2000). The effect of climate change on hydrology of the region will be multifaceted: ranging from regional variations in precipitation characteristics, glacial shifts, mean run-off frequency and intensity of droughts and floods, soil moisture, as well as water supplies for irrigation and river systems. For example studies of the Chenab, a tributary of the Indus in the Western Himalayas showed that the average snowmelt and glacier-melt contribution to the annual flow of water is 49.1%, and a significant proportion of run-off is derived from snow in the dry season, when water demand is highest (Singh et al, 1997).

The overall impacts of climate change on the region through influences on the monsoon have been summarized by Sathaye et al (2006) as follows:

Water resources: The hydrological cycle is likely to be altered and the severity of droughts and intensity of floods are likely to increase. A general reduction in the quantity of available run-off is predicted.

Agriculture: Simulations using dynamic crop models indicate a decrease in yield of crops as temperature increases. However, this is offset by an increase in CO_2 at moderate rise in temperature. At higher warming, a negative impact on crop productivity is projected due to reduced crop durations in the absence of any changes to existing crops and cropping practices. Greater variation (more extreme events) in the spatial and temporal distribution of monsoonal rainfall which governs cropping practices (Kumar et al, 2004) are predicted and will adversely effect the rural poor.

Forests: Climate impact assessments indicate show a shift towards wetter forest types in the northeastern region of India and Bhutan with and drier forest types in the northwestern region in the absence of human influence. Increasing atmospheric CO_2 concentration and climate warming may also result in a doubling of net primary productivity (Ravindranath et al, 2005). Equivalent studies for Pakistan indicate that several forest biomes would expand in area as a result of climate change in the absence of human interventions given ecological timescales on which succession could take place (Siddiqui et al, 1999).

Coastal zones : Climate change scenarios predict increases in the frequency of tropical cyclones in the Bay of Bengal and particularly intense events are projected during the post-monsoon period. Sea level rise is projected to displace populations in coastal zones, increase flooding in low-lying coastal areas, and cause loss of crop yields from inundation and salinization in Bangladesh, India and Pakistan.

Agriculture

Whilst the underlying reasons for the success of the Green Revolution in the region and its contribution to poverty alleviation have remained a matter for debate (Osmani, 1998), the

continued cultivation of modern high yielding variety (HYV) crops has highlighted the depletion of the natural resource base.

The Indo-Gangetic Plain extending from the Swat Valley in Pakistan through the northern states of India into Nepal and Bangladesh provides an example of an extensive (80 million hectare) agricultural ecosystem (rice-wheat) that relies on hydrological services from the region. Within this system the widespread extensive use of tube-well irrigation in the IGP has resulted in the lowering of ground water tables and depletion of aquifers. This has resulted in instances of increased soil salinity and in the case of resource poor farmers the use of shallow tube wells which, in Bangladesh, has resulted in the loss of clean water provision and exposure to contaminants, particularly arsenic. Intensive mechanised agriculture in the IGP has also resulted in the loss of soil organic matter and resource-conservation technologies are now being adopted with recognition that the natural resource base is being exhausted (Abrol et al, 2000). Loss of agro-biodiversity in terms of crop cultivars and landraces is of equal concern.

Deforestation

The Himalayan mountain ecosystem in Pakistan and Nepal in particular has been severely degraded as a result of uncontrolled deforestation leading to increased soil erosion and hill forest fragmentation. Gautam (2000) has estimated that this has adversely affected poverty levels in a large proportion (45%) of the hill populations of Nepal.

Alien invasive species

Biological invasions as a result of increasing globalisation of trade is considered second only to habitat destruction as a threat to biodiversity. The Indian subcontinent is considered one of 12 megadiversity countries in the world and ~40% of species in the Indian flora are considered as alien of which 25% are considered invasive (Raghubanshi et al 2005). Whilst many of these invasives are aggressive colonizers of agro-ecosystems, *Mikania micrantha* and *Lantana camara* represent a particular invasive treat to natural forests.

7. Impact of ecosystem changes on the poor in South Asia

Changes in the flow of ecosystem services affect the well-being of the poor, directly or indirectly, through multiple pathways (Box 7.1). It is generally presumed that environmental degradation affects the poor more adversely (than the non-poor), owing to their relatively greater dependence on nature's resources combined with limited diversification/exit options. Thus, to cite a few examples, degradation in Pakistan's coastal fisheries has made the poor fishermen severely indebted (Birwani et al, 1999, discussed in detail in Box 7.2); soil erosion owing to hill forest degradation in Nepal has pushed farmers below poverty line (Gautam et al, 2003); the problem of soil salinity in Bangladesh has lowered nutritional diversity[41] of poor households and force women members to travel up to 5km to collect drinking water (Crow and Sultana, 2002); and land degradation in dryland areas has led to increased migration due to constraints on available resources (Shah and Gujarat, 2003; Shah, 2005). However, very few studies provide detailed empirical evidence on the manner and degree of such impact on the poor, relative to the non-poor (Markandya, 1998). Still fewer studies identify the complete 'impact pathways' from drivers to responses in dynamic settings. The complex

Box 7.1: Environmental degradation and poverty – multiple pathways

Environmental degradation reduces the stock/productivity of natural capital and limits or denies the poor their income generation capability, which in turn makes them more dependent on environment. In Nepal, for instance, lowered agricultural productivity resulting from loss of soil nutrients and severe erosion as a consequence of hill forest degradation and fragmentation has lowered rural communities' income and livelihood support (Gautam et al, 2003).

Loss of ecosystem functions not only reduces the direct access for food and fuel but also creates a scarcity of these goods in local markets leading to increased prices. Environmental degradation also raises the risk of natural hazards and extreme events for the poor on account of insufficient coping capacity, adaptation capability and resilience.

Ecological damage has been found to be the cause of increasing prevalence of diseases in many developing countries (Duraiappah, 2004). Malaria, for instance, 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. Ettling et al (cited in Duraiappah 2004) report that the direct and indirect costs from malaria consume approximately a third of the household income of the poor as compared to only about 4 percent that of the rich. Global warming and deforestation are expected to contribute to an additional 50-80 million malaria cases per year by 2100 (Donhoe, 2003).

Lack of resources compels the poor to live in areas with lower environmental quality, which increases their vulnerability to illness. Lack of skills makes them depend mostly on manual work for livelihood, but this capability is very often constrained by low nutrition. Poverty prevents people from getting adequate health care and getting cured fully from any illness in a short time, which further reduces their ability to work and earn. Such 'poverty traps' often push the poor towards greater dependence on ecosystems and further environmental degradation.

[41] Since saline water is unable to support homestead gardens for growing vegetables and for rearing livestock.

nature of such pathways is well illustrated in Aggarwal's (2006) discussion of globalisation's effects on local ecosystems and the consequent impact on the vulnerability of the poor people who depend on these resource systems.

Box 7.2: Poverty-environment links in the marine fisheries sector of Pakistan

Pakistan's marine resources are a direct source of livelihood for over a million people dispersed along a 700 mile coast line. More than 15,000 fishing vessels of various sizes are engaged in fishing. Almost one third are shrimp trawlers mainly owned by non-local investors. The provincial and federal governments have acted on the premise of adequate stocks, setting no limits on the number of fishing vessels, restricting catch sizes or protecting threatened species. Increasingly, traditional practices are being replaced by new fishing methods (e.g. trawling, use of winches, etc) that are environmentally harmful. Degradation of the marine habitat has contributed to reduced fish catch and depletion of fish stocks. Technology upgrades along with depleting catches have made local fishermen increasingly dependent on loans to finance not only their capital expenditures but also the running expenses. In the absence of institutional credit, the fisherman's only recourse is the exploitative informal credit system. Rising costs and decreasing catches have resulted in falling income levels and increased indebtedness.

The poverty of fishermen is linked to the loss of their resource rights. The former landlords have taken possession of the coastal creeks and link permission to fish in the creeks to the sale of the catch to designated traders (*beoparis*). Further, there is a clear case of policy failure due to arbitrary changes in zoning laws, as well as to weak enforcement. Until recently, the fishing waters off the Sindh and Balochistan coasts were divided into three zones: the coastal zone extending up to 12 nautical miles and coming under provincial jurisdiction; a buffer zone between 12-35 nautical miles to protect fish stocks; and the exclusive economic zone (EEZ) - waters beyond and up to 200 nautical miles - that are fished largely by deep sea trawlers. Both the buffer zone and the EEZ fall in the federal government's policy remit. In 2001, the federal government abolished this zone and, subsequently, trawlers have begun to ingress into the coastal zone. The local fishermen complain they denude fish stocks by intercepting the inbound fish spawning runs, and degrade the ocean habitat with their drag nets.

One of the major causes of destruction of Pakistan's coastal fishing grounds is the degradation and depletion of mangrove forests in the Indus delta. Ecosystem degradation in the Indus delta has been linked to reduced fresh water outflows on account of upstream diversions. The present level of silt discharge, estimated at 100 million tons per year, is a four-fold reduction from the original level before the rivers were dammed. The combination of salt-water intrusion (some reports show this as 30 km inland) and reduced silt and nutrient flows has changed the geomorphology and hydrology of the delta considerably. The area of active growth of the delta has reduced from an original estimate of 2600 sq. km (growing at 34 metres per year) to about 260 sq. km. The delta is being transformed by strong wave erosion, an increasing dominance of sand at the delta front and an increase in wind-blown sand deposits as a result of losses in vegetation. Proposals to increase upstream diversions under the Indus Water Accord would result in a further reduction in existing sub-optimal flows and aggravate an already critical situation.

Birwani et al, 1999

The factors which are at the root of the downward spiral of poverty-environmental degradation, namely, high discount rate[42], risk aversion[43], poor health, and population growth[44] are not the consequence of poverty alone but a myriad of other factors. Lack of connectivity to local markets and exclusion from capital markets[45] result in limited livelihood options for the poor and is often a cause of degradation-causing dependence. Macro economic shocks resulting in inflation, unemployment and fall in real wages could result in environmental degradation, but there are very few studies on such links. Insecure or incomplete property rights fail in providing incentives to the poor to invest in future conservation of resources (Box 7.3). An ignorance of important ecosystem linkages is often the primary reason behind failures of resource management policies in the region (Box 7.4).

Box 7.3: Wetlands and property rights

Freshwater wetlands in Assam (India) and Bangladesh are usually leased out for a period of three to five years at a time. This system allows rich middlepersons to obtain the leases. The lesse hires fishers to do the fishing. In most cases fishers of foreign origin are employed at very low wages or on a share-harvest basis. The marketing of the fish is totally controlled by the lessee. Fishers are not allowed to sell their share in the market. They have to sell it back to the lessee at a low price fixed by the lessee. This system of management does not allow the local fishing communities to have a role in the management paradigm. As the lease period is fixed, the lessee seeks to maximize income through intensive methods (such as pumping out the water from the wetlands) that are highly degrading for the ecosystems.

Contribution from participants to ESPASSA country workshops

Box 7.4: Ecosystem linkages

In Aghapur village, located on the fringe of the Keoldeo National Park in Rajasthan (India), grazing and livestock rearing was the main occupation of 300 households. The cattle used to graze in the national park area till 1955 under a community-monitored system. The area is famous for a number of bird species including Siberian cranes. The grazing of cattle resulted in trampling of grass, making it ideal for laying of eggs. The declaration of the National Park led to a total ban on grazing, which resulted in loss of livelihood for the grazers and also decreased the number of migratory birds. Since the grazing was banned the grass started growing unobstructed which harmed the birds' feathers while landing on water surface. Also, in the absence of trodden grass, the birds lost the ideal breeding ground. Loss of livelihood also resulted in illicit activities.

http://ces.iisc.ernet.in/PBR/PBR%20of%20Rajasthan%20Executive%20Summary.pdf

[42] Poverty induces people to focus on satisfying immediate needs rather than achieving future security in resources. Therefore, poor have a high rate of time preference and environmental degradation leads to even higher rates of discount. This reduces the incentives to conserve natural resources as the net present value (NPV) of future benefits from conservation is reduced.

[43] The poor living at the subsistence level choose investments with low risk (low return) because of low capacity to bear losses in a high risk (hence, high return) investment.

[44] Poverty increases population pressure (fertility response), which raises the demand for land in agriculture and pasture, and in turn increases deforestation (main cause of deforestation is expansion of agriculture and pasture land).

[45] The access to credit requires ownership of collateral and therefore capital markets are wealth constrained. Due to asymmetric information, which induces adverse selection and moral hazard, credit to poor carries a high-risk premium or discount rates.

Ecosystem dynamics are believed to involve interactions amongst the constituent biotic and abiotic variables that operate at different temporal and spatial scales (Holling, 1986). Human interventions tend to influence, and be influenced by, such interactions; thus, as Aggarwal (2006) observes, 'the different elements of social and economic organization (such as technology, institutions, values, and cultures) co-evolve with ecological variables'. Institutions function at the interface of ecological and human systems – governing the access to natural resources and their joint use – and have their own dynamics. Here again the scale issue becomes important with different socio-economic and institutional variables displaying changes at different rates (slow, fast) and over varying spatial levels (micro, macro, meso) (Gibson et al, 2000).

The significance of ecosystem dynamics has received little attention in the economic approach to the analysis of poverty-environment interactions, especially at the empirical level. An important concept associated with ecosystem dynamics is that of ecological resilience[46], which has important implications for the analysis of poverty/well-being impacts of ecosystem changes. According to Maler (2000), it is the resilience of the ecosystems that determine their capacity to respond to human disturbances. Lower resilience of ecosystems implies greater vulnerability of the poor people who depend on that ecosystem for their livelihood.

Some of the studies on the dependence of the poor on ecosystem services (e.g. Jodha, 1986; Chopra et al, 1990) have drawn the inference 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 usually lack (Narain et al, 2007). The study by Narain et al (2007), based on data from 535 households in 60 Indian villages, finds that the private asset of livestock in fact complements common resources, and that except in the case of particularly rich households, there is no substitutability between private assets and common-pool resources.

The experience in South Asia also shows that the poor cannot afford to adopt coping strategies by spending on mitigation and defensive activities for minimizing the damages from environmental degradation. In fact, the distributional asymmetry appears to be such that the rich benefit more from ecological conservation than the poor, while the latter suffer relatively more damages from degradation. Thus, for instance, asset-rich households in Nepal appear to have gained more from community forestry in Nepal than their poorer counterparts (Adhikari, 2005). Similarly, Kerr's (2002) study of watershed development projects sponsored by different donor agencies in 70 villages in Maharashtra (India) reports that, despite a common focus on poverty alleviation, the projects most successful in achieving conservation and productivity benefits also had strong evidence of skewed distribution of benefits toward larger landholders. Kumar's (2002) social cost-benefit analysis of the Joint Forest Management (JFM) institution in the Jharkhand region of central India uses the data on actual rates of extraction of forest products by different classes of participating households and concludes that under present JFM arrangements the non-poor are likely to gain more from the forest at the expense of the poor. All this evidence has led us to infer that conservation is a necessary but probably not sufficient condition for poverty alleviation.

[46] Gunderson et al (1997, p.3) define this as the 'magnitude of the disturbance that can be absorbed before the system redefines its structure by changing the variables and processes that control behaviour'.

8. Policy responses to ecosystem degradation in the South Asian region

Analysis of response policies for the management of ecosystem services is a critical part of a Situation Analysis or similar assessment process. Other global assessments like IPCC and MA have exclusively focussed on the evaluation of responses, with special emphasis on why a particular response succeeds while another fails. The first step in analysis of response is an acceptable typology of response. This may be disciplinary (economic, legal or social response) or actor-wise (the decision making level at which the response is conceived, formulated) (MA, 2005). The next stage of the analysis is the measurement of effects and effectiveness of response policies followed by an evaluation of response successes and failures in the light of their constraining and enabling condition. In our analysis response covers a broad range of policies aimed at abatement of river pollution, forest management, Protected Area management, watershed management, wetland and coastal zone management and biodiversity conservation.

Feasible policy responses for the management of ecosystems and the resultant maintenance of ecosystem service delivery in a particular country are governed by the country's legislative framework. During the early 1970s, and in some cases earlier, a number of environmental laws were developed in India, Pakistan, Bangladesh, Nepal and Bhutan largely focussed on forest and bio-diversity conservation, wildlife protection, protected area management and prevention of air and water pollution. This legislative foundation provides for the use of a wide range of policy instruments and institutions to incorporate issues relating to efficiency, income distribution and poverty into ecological conservation.

National policy responses in the region – classified as formal (regulation by government) and informal (regulation by the civil society and local communities) – differ with respect to the varying roles of government, civil society and market. Currently, the governments in the region place a regulatory emphasis on command and control instruments and direct public investments (Box 8.1) rather than incentive-based economic instruments like taxes, subsidies and marketable permits. These centralised policy responses, with very high transaction costs as well as problems of coordination, have not been particularly successful

Box 8.1: Direct Government Investment: A Case Study of Ganga Action Plan (GAP)

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, which requires both private and public investments. In the case of cleaning Ganges, there is public investment through the project Ganga Action Plan (GAP) and there is private investment by industries on pollution control technology. There are 68 heavily polluting industries in Gangetic basin generating 2.6 million kilolitres of effluent every day and the daily cost of treating this amount of effluent is estimated to be Rs. 1.014 million. Allowing for user and non-user benefits of improvements in the water quality of the river, 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 and the estimated benefit cost ratio is 1.68.

Markandya and Murty, 2000

in facilitating the sustainable use of ecological resources in the region, as the following section illustrates.

Experience of the World Bank in forest sector projects in India shows that states with more open fiscal and institutional reforms (e.g. Andhra Pradesh) enjoy more success in reaping benefits from the projects (Box 8.2). According to the report cited, the Bank projects have proved to have potential for alleviating poverty by building the grassroot capacity for forest protection and regeneration in the communities adjacent to the forests. The same report recognizes that interdepartmental coordination is weak at national and state levels, and sustainability strategy, production strategies, and marketing issues are given inadequate attention. The current strategy of substituting funds received from donors for state and central funds and lack of coordination between the donors are proving ineffective in reaping benefits in the forestry sector.

Box 8.2: Foestry sector reforms for poverty alleviation

In its report on the potential of the forestry sector to contribute to poverty alleviation, the World Bank (2006) notes that reforms need to focus on four critical enabling factors: achieving more secure tenure and management rights for forest dwellers; strengthening forest management, monitoring, and control systems; providing access to more efficient market systems; and developing more effective and flexible institutional models. Concurrently, programs need a stronger development orientation to broaden livelihood opportunities.

Five areas are emerging where economic analysis could support policy reform and program implementation: reviewing alternative tenure and access rights systems and their relationship to forest livelihoods conservation, forest productivity, and public expenditures; evaluating the economics of silviculture for community-managed forests; assessing local incentives by allocating communities good-quality forest along with degraded land; analyzing the costs and benefits of farm forestry; and reviewing current benefit-sharing schemes.

World Bank, 2006

Collective action (involving all the stakeholders of conservation) is now seen in the region as an institutional alternative to formal regulation. There are many success stories of community-initiated action on natural resources management (e.g. Mishra, 2008). Similarly, in the case of industrial pollution there is empirical evidence from the region that local communities can effectively exert pressure on polluting factories to undertake compliance measures (Murty et al, 1999). Some of the more recent policy responses for the conservation of forest and agricultural ecosystems and biodiversity are a mixture of formal and informal regulations. In some situations, granting legal rights to forest-dependent communities has reduced conflicts between government and forest communities and provided incentives for local community participation (Box 8.3). The new environmental policies in the region (e.g. The Biological Diversity Act, 2002 in India; see Box 8.4) recognise that effective natural resources management requires promotion of multi-stakeholder partnerships involving government, local communities, land owners, and investors with inbuilt incentives for local communities and participatory practices.

Box 8.3: Community forestry in Nepal

During the last decade, Nepal has seen a fundamental restructuring of forest policies towards participatory resource management that seeks to combine the objectives of poverty alleviation and environmental conservation. About 7 million people or about 1.5 million households are benefiting from community and leasehold forestry in Nepal (Oli and Kanel, 2006). According to latest estimates, there are about 14,500 FUGs under the community forestry programme of the country managing about 124, 000 ha of forests and covering more than 35 percent of the population of the country (NPC, 2007). Similarly under the leasehold forestry programme, there are about 2,213 leasehold FUGs managing 10,000 hectares of forests, which is about 0.2 percent of the total forest area (Oli and Kanel, 2006). Studies have established that community (e.g. Kanel and Niroula, 2004) and leasehold forestry (Poudyal et al, 2007) contribute significantly to household incomes in rural Nepal. Some studies also establish a linkage between leasehold forestry and food security – Tamrakar and Kafley (2004), for example, report that food security of participating households in leasehold forestry increases by 16 percent.

Box 8.4: People's Biodiversity Registers in India

The Biological Diversity Act, 2002, in force since 15th April 2004, mandates the constitution of Biodiversity Management Committees (BMC) at the local level to maintain People's Biodiversity Registers (PBRs) in consultation with local people. The Registers shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them, details of the access to biological resources and traditional knowledge granted, the collection fee imposed and benefits derived and the mode of their sharing. The rules stipulate that the National Biodiversity Authority shall take steps to specify the form of the People's Biodiversity Registers, and the particulars it shall contain and the format for electronic database; and that the National Biodiversity Authority and the State Biodiversity Boards shall provide guidance and technical support to the BMCs for preparing PBRs.

Expected benefits of PBRs include:

a. Community regulation of access to biodiversity resources leading to sustainable harvests
b. Promoting knowledge-based sustainable management of agriculture, livestock, fish, forests and public health so as to enhance the quality of life of the community members
c. Conserving valued resources and value addition to biodiversity resources
d. Recording of biodiversity related knowledge, pertaining to management and coupled to opportunities to generate funds through imposition of collection fees for access to local knowledge
e. Sharing in the benefits of commercial application of local knowledge

Gadgil, 2006

There are also examples of cases in which the market agents (consumers, producers and stockholders) have incentives for voluntarily reducing pollution without any type of regulation. Consumers regulate the market for pollution intensive commodities by expressing preference for green products or commodities produced using cleaner technologies. Investors have incentives to invest in industries using cleaner technologies because a good environmental performance by a company may result in upward evaluation of its stocks (Gupta and Goldar, 2005). As a result, the efficiency improvements made by industry through innovations in production technologies to reduce pollution could result in win-win situation for the industry concerned (Murty and Kumar, 2006).

Some of the recent policy responses in the region are incentive-based, using prices, taxes and subsidies. There are subsidies for bio-fuels, renewable energy, bio fertilisers and pesticides, and the prices of eco products carry a market premium. There are a growing number of initiatives in the region to generate information for designing and implementing incentive-based mechanisms such as PES (payments for ecosystem services) for ecological conservation (Box 8.5).

Box 8.5: Incentive-based mechanisms for watershed protection services

A recent action-learning project in India in developing incentive-based mechanisms (IBMs) for watershed protection services and improved livelihoods at micro- and macro-scales derive the following lessons:

- Local money that is generated among the stakeholders carries a higher 'moral value' than externally sourced funds.
- IBMs can lead to a greater voice for the marginalised, as they demand negotiation and dialogue.
- IBMs can typically complement incomes of stakeholders receiving payments rather than raise them significantly.
- Poor people, especially graziers, run the risk of exclusion if consultations are not undertaken carefully.

Agreement is facilitated by effective stakeholder engagement; a match between the spatial and temporal scale of decision making and biophysical processes; expert views as well as local hydrological monitoring that help build awareness of linkages between land-use practice and watershed protection services among stakeholders; win-win land-use practice options that create benefits for upstream as well as downstream stakeholders; functional local-level institutions and transparency in the transaction process. The lack of clear community rights on common lands makes implementing IBMs on a larger scale a risky exercise both for upstream and downstream stakeholders.

Agarwal et al, 2007

In the case of fragile rural ecosystems, the current policy responses have generally led to a gradual erosion of traditional knowledge and management practices. In many cases this has resulted in local communities losing control of the natural resource base and a consequent increase in the adoption of individual extractive strategies. However, there are a few

instances where traditional knowledge have been successfully marketed contributed to the sustainable livelihood of local people (Box 8.6).

Governments in South Asia have been a party to many of the multilateral environmental agreements on global environmental problems such as greenhouse gas emissions, ozone

Box 8.6: Benefit Sharing along the CBD Model

This is an example how the monetary value of provisioning services of forest ecosystems coupled with the indigenous knowledge of the locals can help the poor tribal in improving their material condition through benefit sharing mechanism advanced under the Convention on Biodiversity (CBD). Launched by TBGRI in 1995, the model provided for compensating the Kani Tribe for revealing the secret of a rare plant, *Trichopus zeylanicus*, known in local parlance as *aarogyappacha*, endemic to Agasthyar Hills, a biological hotspot. This arrangement led to the development of a commercially successful herbal drug called Jeevani in partnership with a well-known ayurveda house. The initiative has since come to be recognised by the UN Environment Programme and the World Trade Organisation as a global model in benefit-sharing and recognising the intellectual property rights of indigenous people. In September 1995, TBGRI entered into a technology transfer pact with Arya Vaidya Pharmacy, Coimbatore for commercial production of Jeevani. The pharmacy agreed to provide seed funding of Rs 10 lakh and royalty of two per cent on the ex-factory price in exchange for the technology transfer and the right to manufacture the drug for seven years. On its part, the institute agreed to plough back 50 per cent of the licence fee and royalty into welfare programmes for the tribal community which had helped identify the plant in the first place.

Several ways of transferring the benefits to Kani Tribe was discussed. Kani Tribe, being an unorganized nomadic tribe has no institutional arrangement nor they were equipped to receive such benefits. Suggestion to transfer the money to the State Tribal Welfare Department was mooted by many. But it was not taken up as it was found that in that way the real benefit will never reach them. The tribals finally agreed to a registered trust, with about 60% of the Kani families of Kerala becoming members of the trust, with support from TBGRI, local Government officials and NGOs. In March 1999, the amount due to the Kanis at that time (Rs. 5, 35,000/- approx.) was transferred to this trust with the understanding that only the interest accruing from this amount will be used for the welfare activities of the Kani Tribe. This benefit sharing model is now acclaimed as the first of its kind, which implemented, in letter and spirit the Article 8(j) & 10 (c) of the Convention on Biological Diversity (CBD), and is now recognized as the 'Kani Model'.

'Jeevani' was able to capture the market in India as well as abroad, including countries like USA and Japan. This necessitated a regular supply of fresh leaves of Trichopus zeylanicus. Since the wild collection may not be dependable, TBGRI scientists developed a protocol for cultivating this plant. Cultivation studies revealed that the plant is habitat-specific and that the therapeutically active principles are produced only when it is cultivated in and around its natural habitat. TBGRI however trained 25 families to cultivate this plant around their dwellings in the forest. In the first year itself each family earned about Rs. 8000 on sale of the leaves from cultivation of *Trichopus zeylanicus* from a half-acre plot maintained by each family.

Abridged from Time, 1999

depletion and bio-diversity loss. Climate change is a major threat to development in the region (see Chapter 6) and the development of effective regional policy responses is urgently required. Two policy development strategies that could be used to begin to address climate change are: (a) using economic instruments, price or quantity instruments (carbon pricing or tradable carbon permits); and (b) technology policy development. The 'polluter pays' principle could be used as the basis for establishing a carbon pricing system, which would promote competition among the polluters to choose low cost abatement technologies and invest in innovation. However, a lack of information could be a barrier to implementation of a carbon pricing system and policies for setting environmental standards, disseminating information on the threats posed by pollution and climatic change and removing the barriers to technology access may be required to facilitate the efficient functioning of a regime of carbon pricing. South Asia could benefit from international co-operation on sharing abatement technology as well as expertise in designing effective economic instruments for pollution control.

9. Ingredients for a successful policy response to ecosystem management

Management of ecosystem services need to be a policy priority given that their provision by natural ecosystems worldwide is declining due to human interventions. Analysis of policies from case studies belonging to India and the Hindu Kush region broadly suggests that, in order to design and execute effective response policies for ecosystem management in a way that contributes to alleviating poverty and deprivation, the following policy design elements should be considered:

a. ***Unpacking the drivers of ecosystem change*:** The focus must be on clear cut understanding of all types of drivers, actors involved and the degree and directions of those drivers (see Chapter 6). Sometimes economic drivers may not be apparent to decision makers who are more focussed on the bio-physical factors of ecosystem and ecosystem services change. The link must be understood and the direction of relationship identified.

b. ***Putting the right institution in place and making it work*:** An effective policy and institutional environment requires governance that is functional, cost effective, and involves stakeholders. Invariably, in the countries under consideration, problems of coherence among policy implementing agencies are encountered, leading to failures in policy implementation.

c. ***Indicators to map, assess and monitor*:** Poverty-environment links are often indirect, leading to diffused intervention and problems in monitoring. The design of good indicators (Box 9.1) require that the appropriate environmental data along with the relevant sustainability criteria are defined through technical studies and understood by stakeholders at all levels (Box 9.2). Priority setting exercises would require information of all available options at commensurate time and spatial scales (e.g. Table 9.3).

Box-9.1: A good indicator must have following features:

i. Measurable
ii. Reliable
iii. Valid/Relevant
iv. Policy Relevant
v. User Friendly
vi. Sensitive to Changes
vii. Analytically Sound
viii. Comparable
ix. Cost Effective
x. Context Dependent

Participants of stakeholder workshops

d. ***Economic valuation*:** Valuation of ecosystem services has the potential to effectively assist decision makers[47] in designing cost effective ESPA policies especially in an economically poor region like South Asia. Formation of values is influenced by the robustness and accuracy of the various market and non-market based valuation methodologies in capturing the services from the ecological production functions. Table 9.1 lists some of the recent valuation studies

[47] Valuation helps to: (a) capture the non-market ecosystem services; (b) helps decision-making in situations of trade off and alternate courses of action; (c) enables application of Extended Cost-Benefit Analysis (CBA) and green accounting; and (d) strengthens EIA in the context of sectoral and project policies and makes the appraisal criteria more acceptable, transparent and credible. However, valuation is only one element in the effort to improve the management of ecosystems and their services. Economic valuation may help to inform management decisions, but only if decision-makers are aware of the overall objectives and limitations of valuation.

from the region according to the methodology used and Table 9.2 present another illustrative set of valuation studies according to the particular ecosystem service valued. The studies clearly reveal the potential of economic valuation in drawing the attention of policymakers to the importance of ecosystem services.

Table 9.1: Application of main economic valuation techniques from the region

Methodology	Approach	Applications	Example
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 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)

Understanding ecological production functions through collaborative effort between economists and ecologists provides the necessary information on issues critical for carrying out the valuation exercise. Some of the relevant issues include:

i. State of the ecosystem and corresponding functional form of the ecological production function
ii. Drivers of change, their impact on the ecosystem and the resultant change(s) in the flow of ecosystem services
iii. Units and measurement of ecosystem services
iv. Additional perturbations creating changes in the flow of ecosystem services (basically marginal change in ecosystem benefits as a response to marginal change in drivers)
v. Spatial and temporal considerations relating to ecosystem change
vi. Gainers and losers in the process of ecosystem change
vii. Property rights for the ecosystem services

Table 9.2: Illustrative set of valuation studies from South Asia

Study	Ecosystem services	Illustrative estimates from quantification/valuation
Das (2007)	Storm protection by coastal mangroves in Orissa (India)	An estimated damage function along with a cyclone probability function and locational parameters establishes that the loss of one km of mangroves increases the expected damage to properties by about 1$ per capita.
USAID (2007), IUCN (2006)	Provisioning services (plants, fish, birds & wildlife) of *haor*s[48] in Bangladesh	Hakaluki *haor*, one of the largest wetlands in Bangladesh, has an estimated economic value of Tk 586 per year, using bio-economic models (IUCN 2006). Similarly, USAID (2007) has estimated the economic value of Hail *haor* to be Tk 36,990/area and Tk 454,924,600 in total returns. In some of the *haor*s, people practice an indigenous method of floating cultivation called *dhap* (hydroponics), which help farmers earn up to Tk. 16,000 in one season (Islam et al, 2000).
Kumar et al (2006)	Prevention of soil erosion, augmentation of groundwater, and flood control services provided by forests in India	Using data from representative experiments in different parts of India, the total soil loss prevented by 39 mha of dense forest in 2003 for the country as a whole is estimated to be around 482 mt; using hydrological balance methods, the differential water recharge due to dense forests is estimated to be 4128 million m3; and, a decrease in each hectare of dense forest is estimated to increase the value of flood damages by Rs 8125.75 per annum. State-wise estimates are generated as well.
Hirway and Goswami (2004)	Provisioning (fodder & fuelwood) and regulating (fisheries, storm protection, biodiversity, carbon sequestration, control of soil erosion & maintenance of water quality) services of mangroves in Gujarat (India)	Survey data from 400 households shows that 82 percent of livestock-owning households use mangroves as a source of fodder, while about 24 and 10 percent use mangroves, respectively, for fuel wood and timber. Each household on the average extracts 258 kgs of fuel wood annually from mangroves worth Rs. 515 in market prices. One hectare of mangroves yields Rs. 23,860 worth of fodder every year in Gujarat and in some parts of the state, the value of timber extracted is as high as Rs. 577 per hectare in a year. The annual value of all varieties of fish local to mangroves harvested by fishermen is estimated as Rs. 8000 per hectare of mangroves. The total annual benefits from all the regulatory services are estimated as Rs. 557.3 million.
Billah (2003)	Provisioning services of the Sunderbans (mangroves) in Bangladesh	There are 20,000 woodcutters (*bawalis*) and 7,000 seasonal honey collectors (*mouals*) who depend on the Sundarbans. The revenue generated from fuelwood, can be up to US$261,775 per year. NTFPs contribute Tk. 1.3 billion annually to the local economy.

[48] Backwater swamps in the form of bowl-shaped depressions located between the natural levees of rivers

Box 9.2: An analysis of management options in policy development for mangroves
(The schema is taken from Dahdouh-Guebas et al. 2006)

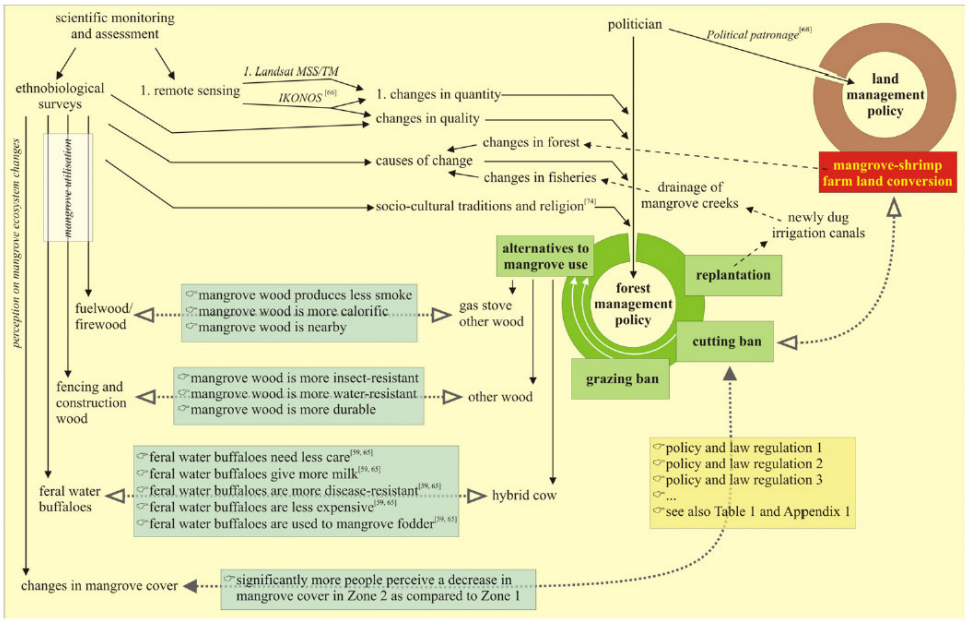

Figure 7
The use of ethnobiological survey data in management policy. The scheme shows forest management actions (central green circle with boxes), and what these actions are primarily based on (elements preceded by a number '1'). It also illustrates where ethnobiological elements could be used to improve the management (elements without a number). Contradictions or conformities between the management actions and the ethnobiological findings are given by the grey dotted arrows (contradiction = open arrow, conformity = closed arrow), and the boxes overlaying them provides a bulleted list with details. Unveiling such contradictions using ethnobiological surveys can help improve the policy. There is also one indication of conflict amongst policies (forest management policy *versus* land management policy), and impacts involved in the management are given as black dashed arrows. CWS = Coringa Wildlife Sanctuary. Superscripted letters refer to literature references.

Table 9.3 Opportunities to improve environmental (sensu ecosystem) services within existing agro-ecosystems (FAO, 2007).

	ENVIRONMENTAL SERVICE	FARM-LEVEL MANAGEMENT OPTIONS	LANDSCAPE-LEVEL MANAGEMENT OPTIONS	DEGREE OF COORDINATION REQUIRED[1]
Carbon sequestration and greenhouse gas offsets	Carbon sequestration in soils	Soil organic matter management and enrichment, reduced frequency of cultivation, adoption of conservation agriculture, soil conservation practices, improved grassland management		Low
	Carbon sequestration in perennial plants	Increased area/use of perennial crops, farm forest management, agroforestry, natural regeneration, lengthened fallow periods, silvopastoral systems	Afforestation, natural regeneration of trees and forests	Low
	Carbon emission reduction	Agricultural machinery emission management, avoided deforestation	Reduced forest and fallow burning	Low
	Methane emission reduction	Improved livestock feed, peat soil management	Protection of peat areas from disturbance	Low
Watershed protection	Water flow regulation	Increased irrigation-use efficiency, protection of wetlands, farm drainage, range management	Well-designed road and path construction, revegetation of bare lands	Low
	Water quality maintenance	Reduced agrochemicals, filtering of agricultural runoff, improved nutrient-use efficiency	Maintenance of perennial vegetative filters protecting waterways	High
	Erosion and sedimentation control	Soil conservation and runoff management, perennial soil cover, adoption of conservation agriculture, range management	Road, path and settlement construction; revegetation of stream banks	Moderate
	Salinization and water table regulation	Tree-growing	Strategic tree-growing in the landscape	Moderate
	Aquifer recharge	Plot- and farm-level water harvesting	Community/ subwatershed water harvesting	Moderate
	Flood control	Diversion and storage ponds	Drainage channels and storage ponds, maintenance of natural floods	High

Table 9.3 continued

	ENVIRONMENTAL SERVICE	FARM-LEVEL MANAGEMENT OPTIONS	LANDSCAPE-LEVEL MANAGEMENT OPTIONS	DEGREE OF COORDINATION REQUIRED[1]
Wild biodiversity conservation	Protection of habitat for wild terrestrial species	Breeding area protection, maintenance of pure water sources, wild food sources in and around farm plots, timing of cultivation, increased crop species/varietal diversity	Natural area networks in and around farms, public and private protected areas	Moderate
Wild biodiversity conservation	Connectivity for mobile species	Farm hedgerows, windbreaks, removal of impenetrable barriers	Natural area networks in and around farms	Moderate to high
	Protection of threatened ecological communities	Restoration or protection of farm patches of natural habitat	Maintenance of corridors connecting natural habitat fragments through farm and other lands	Moderate to high
	Protection of wild species	Elimination of threats from toxic chemicals, breeding area protection, non-lethal pest control practices	Barriers to exclude wildlife from farmlands, compensation to farmers for wildlife damage to stocks and crops	Low to moderate
	Protection of habitat for aquatic species	Prevention of waterway pollution by crop and livestock wastes and agrichemicals, protection or restoration of on-farm wetlands	Natural revegetation along stream banks, protection or restoration of wetlands	Low to moderate

10. Addressing stakeholder needs for poverty alleviation

10.1 Stakeholder engagement within ESPASSA

Effective and comprehensive stakeholder engagement was considered an integral part of the ESPASSA Situation Analysis due to the dynamic interrelationships between people and ecosystems. Stakeholder involvement in the project began at the outset and contributed to the situation analysis by: (a) enabling relevant data and information sources within the region to be identified and made available for the study; (b) providing input into the situation analysis on a continuous basis throughout the study period; (c) supporting a participatory assessment of information and knowledge needs leading to the identification of appropriate capacity-creation mechanisms; (d) ground-truthing the accuracy of the information being collected and the insights being inferred in the study; and (e) increasing the acceptability of the study's findings and thereby making it relevant for policymaking.

Methods of stakeholder engagement included the use of mass media (press releases and television interviews), organisation-level networks (distribution of leaflets), the internet (a dedicated project website), and national-level stakeholder workshops. Of the different methods used, it was the country workshops that generated the most comprehensive stakeholder input. At each country workshop the preliminary findings of the study were presented and discussions were held to capture the diversity of stakeholder views. Discussion topics included: perceptions regarding ecosystems and poverty, linkage between poverty and ecosystem services, major drivers of change, effectiveness of policy responses, knowledge gaps and capacity needs.

To capture diversity of opinions for a comprehensive picture to emerge every effort was made to invite representatives from as many stakeholder groups as possible. The consortium interacted with 203 individuals (35 from Bhutan, 50 from Bangladesh, 36 from Pakistan, 51 from Nepal and 31 from India) representing development policy makers and planners, ecosystem managers, resource users, research and academia, civil society, media and donors (Figure 10.1).

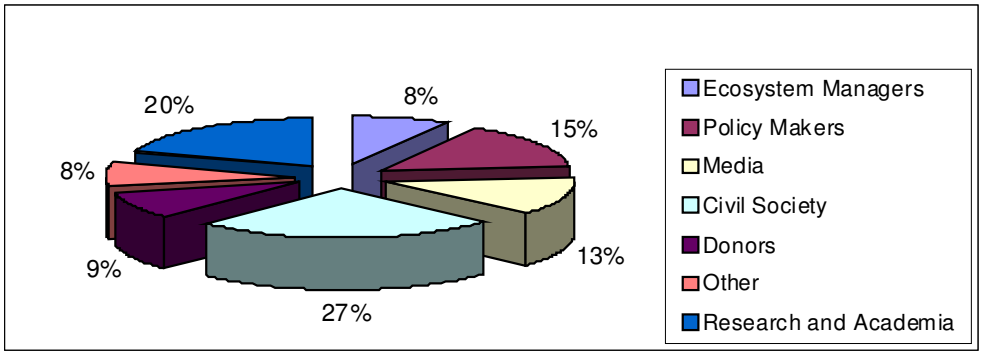

Figure 10.1: Regional stakeholder representation in the development of the Situation Analysis

One common response that was received in all the five country workshops is that the increasing rates of growth in the region during the past decade will be difficult to sustain given the demands on ecosystem services, both in terms of inputs for production as well as a waste absorption system. In this context, it was unanimously accepted that although all human beings depend on ecosystem services – tangible or intangible – from the poverty

perspective, it is the people living in close proximity of ecosystems like forests, sea shores etc. are the one that are most vulnerable to degradation and climatic aberrations.

10.2 Stakeholder perceptions

Ecosystem services

Ecosystems were unanimously perceived as *naturally* defined areas that generate a flow of goods and services over time. Humans sustained by an ecosystem were seen to be a part of that ecosystem. The tangible and intangible benefits of ecosystem services were well recognised, as were the interdependence and relatedness of various ecosystems. There was a realisation that little is known about ecosystems within the region, such as wetlands and 'wastelands', or the highly varied nature of dependence on these and other ecosystems. Ecosystem services were generally viewed in accordance with the MA taxonomy and there was recognition that some ecosystem services are still 'unrealised' (i.e. there are ecosystem services that are unknown or not thought of as services at the current time). Many stakeholders observed that natural systems and the flow of services are inextricably and often irreplaceably linked to human needs in varying spatial contexts. Across the five countries, stakeholders perceived ecosystems as the major sources of livelihoods of the poor in direct as well as indirect ways.

Dimensions of poverty

Various dimensions of poverty came out explicitly during the stakeholder workshops. The definition of poverty extended well beyond the notion of '$1 a day', to include lack of or breakdown of access to natural resources, health, social relations, self-esteem, community institutions, traditional knowledge, and cultural and spiritual values. Conflicting interests of varying stakeholders (such as between ecotourists and the 'ecosystem people') bring to the fore the political economy in the region, highlighting the fact that powerlessness is an important dimension of poverty because it is the powerless who suffer most when such conflicts arise. The fact that poor are more critically affected by ecosystem degradation, due to reduced access and a lack of alternatives, was also apparent. Migration and change of profession (not by choice but under duress) was seen as the most prevalent coping strategies for the resource-dependent poor, but these strategies result in homelessness, lowered self-esteem and feelings of alienation and rootlessness.

Poverty and ecosystems

Stakeholders reached the following conclusions relating to poverty and ecosystems:

- The lack of explicit government policy on ecosystems services, the absence of a suitable accounting system, the lack of awareness amongst people at large, and the lack of research evidence to convince decision makers to recognise and institutionalise the management of ecosystem services have jointly played a role in the degradation of ecosystems in South Asia and impacted on the poor.
- Aberrations in the functioning of ecosystems like unexpected flooding, landslides, long droughts, drying of springs, increased invasive species on productive lands, reduced production of natural products like NTFPs or fish, impact the poorest people first who directly depend on supply of these products for subsistence.

- 'It is not the poverty that is the key driver of degradation but it the institutional failure', is an important message that came out of the stakeholders' workshops. Also it was emphasized that poverty-environment nexus is not uni-directional relationship; it occurs simultaneously.
- Distortions take place in cases like policy of offering subsidies on fertilisers and pesticides to farmers to enhance crop productivity (to help alleviate poverty) but the policy is oblivious of the resultant impact on quality of soil.
- While the supply base of ecosystems services is shrinking, demand for the same is ever growing. Also, gestation period for growth of most of the services/products, being long, short-term remedies are often redundant.
- Ecosystems are not treated as 'natural capital', a form of capital that has tremendous potential to generate employment and income.

Trends and Drivers of change

Growing awareness regarding degradation of all ecosystems leading to increasing vulnerability of natural resources to climate change was evident during the discussions across groups and across countries. Market and governance failure were the two important reasons that emerged from the discussions. Although anthropogenic pressure was recognised as an important driver impacting the capacity of flow of ecosystem goods and services, discussions also highlighted the issue of 'intensity of resource use' and the fact that non-natural resource dependent community exerts relatively more pressure, which was attributed to increasing consumerism and globalisation. The indirect drivers impacting bio-geo physical aspects of ecosystems, like population growth, economic development and trade, developmental activities like big dams and mining projects, lack of inter-sector coordination, lack of trust, breakdown of traditional and community institutions, increased urban demand, corruption, commercial pressure and marketisation of ecosystem products etc also emerged during the discussions. There is also degradation that results from extremist activities. Apart from the destructive activities of the extremists themselves, deployment of temporary paramilitary or permanent military establishments also exert pressure, especially on forests, contributing to deforestation. Ecosystems were seen to affect people in different poverty groups in different ways.

Policy responses

The stakeholders agreed that policy making was generally lacking in ecological understanding. A blanket or 'one size fits all' approach is used that often misses out on the epistemology of ecosystem science. The interlinking of environmental security with socio-economic dimensions of poverty is often missing. For decision making in conservation, a bottom up approach always requires appropriate validation before it receives sanction from the government. Policy formulation and implementation is a consultative process and needs to be inclusive. There are many examples of top-down planning in government policies that have resulted in policy failures. Inappropriate policies have also exacerbated conflicts between people, government, and the environment. Stakeholders highlighted gaps between policy and practice (e.g. Genetic Resources and Benefit Sharing draft bill of 2002 in Nepal) and the way changes in policy driven land-use and tenurial rights have had good (inclusive management) and bad (increased shrimp farming) impacts. Loopholes in laws and ineffective policy/programme implementation were also identified as problems within the region.

10.3 Knowledge gaps, research requirements and capacity building

Stakeholders were asked to consider the problems faced in successfully managing ecosystems in South Asia for poverty alleviation outcomes and to identify specific knowledge gaps, research requirements and areas of capacity building that would help to address these problems. The responses received from stakeholders are outlined below in Table 10.1.

Table 10.1: Knowledge gaps, research and capacity needs identified in stakeholder workshops

Knowledge gaps	Research needs	Capacity needs
Identification of the whole range of ecosystem services for specific ecosystems and changes over a period of time	○ Interdependence ○ Thresholds and resilience ○ Models to predict changes in the flow of ecosystem services at different scales with alterations in ecosystem states	○ Inter-disciplinary research ○ Knowledge networks in the region ○ Adequate validation of ethnological knowledge
Quantification of well-being impacts of changes in ecosystem services and their economic valuation	○ Ecosystem-wellbeing mapping at the empirical level	○ Use of valuation methods
Creating markets (such as PES) for ecosystem services	○ Value addition at local level, market linkages at appropriate scales, community based eco-tourism and local community's participation in ecosystem conservation	○ Effective strategies for raising awareness to modify resource-intense activity as well as develop 'willingness-to-pay' among users
Effective policy responses	○ Revisiting success stories, monitoring them, and generating insights for replication ○ Causal factors of failed policy, or community's efforts towards conservation ○ Use of rights and entitlements to modify behaviour for improved ecosystem management ○ Methods for creating synergies between various governmental and non-governmental programmes	○ Creation and maintenance of an integrated database on poverty-environment links for the whole region ○ Data collection techniques and design of monitoring systems ○ Revival of traditional institutions and indigenous knowledge
Adaptation strategies (technology-based as well as lifestyle changes) in the face of climate change		○ Scenario-based analysis ○ Risk assessment

11. Lessons learnt and future research priorities

As a result of the MA (MA 2003, 2005) underscoring the importance of ecosystem services for human well-being, there is now widespread discussion within the global scientific community on the scientific approaches, methods and tools that will improve capacity to assess the links between ecosystem services and well-being (e.g. improved methods of valuation, GIS tools for mapping ecosystem services and aspects of poverty)[49].

The ESPASSA stakeholder review workshops strongly endorsed four critical issues that needed to be addressed when considering ecosystem services and poverty alleviation:

- Knowledge gaps persist in the identification of the whole range of ecosystem services. The scale and units of ecosystem services remain a challenging area of research. There is a need to develop research capacity for quantification of ecosystem services and in developing trans-disciplinary approaches for rigorous valuation.
- Although the degree and dimension of drivers impacting ecosystem services need further attention in research, economic valuation of some of the impacts especially falling in the domain of regulating and cultural services needs to be demonstrated in a convincing manner
- Research into ecosystem-poverty links remains inadequate and is necessary for the development of programmes of poverty alleviation that focus on livelihoods at household and community levels (leading to greater community level understanding). Empirical research addressing the 'worth' of ecosystems is needed to address this knowledge gap.
- Case-study analysis provides a mechanism by which the role of ecosystems and goods and services can be exemplified. Such analyses require a multi-dimensional approach from all stakeholder perspectives.

Research priorities

A. Poverty – Ecosystem mapping

The poor rely on ecosystem services at regional and local level. A common feature of many priority-setting and targeting initiatives addressing poverty is the use of spatial poverty maps particularly at the state level. Whilst poverty maps have been variously used for planning and management, their definition is often "contextual depicting more the attributes/indicators of poverty rather than the spatial representation of income poverty per se" (Jayaraman and Srivastava, 2003).

To understand the way in which land-use and demographic changes will impact on the poor and to formulate effective response policies, there is a need for an improved quantification of the spatial distribution of the poor (including consideration of seasonal and urban migration at country level) throughout the region (Henninger, 1998). There is a need to update existing poverty maps and to align them with spatial information on the landscape domains of the poor. This may need to be done in a geographically selective manner but equally

[49] Carpenter et al (2007) argue that the MA framework lacks a robust theoretical basis for linking ecological diversity to ecosystem dynamics and, in turn, to ecosystem services underlying human well-being.

exhaustively with respect to ecosystems. Without these basic underpinning data sets, strategic policy development cannot be undertaken and will be piecemeal at best.

1a. Poverty: There are some sources that provide detailed mapping for Bangladesh, Nepal and specific districts of India but high resolution income poverty mapping throughout the region (e.g. block level) is lacking, especially for Bhutan.

1b. Landscape: Across the study region there is enormous natural, agro-ecological and socio-economic diversity and there is a paucity of disaggregated data with which to link landscape features, particularly ecosystem structure and habitats, with poverty pockets in terms of livelihoods. There are a number of data sources (see 4.4) from which landscape mapping can be derived but a coherent landscape feature dataset has not been identified during this analysis. An interlinking (and expansion) of the various landscape mapping initiatives is required to develop a common mapping resource base for the region.

B. Indicators

A major knowledge gap in advancing future research concerns the methodology to quantify further contextual dimensions of poverty and access to ecosystem services. The focus of previous work in the region, as illustrated by this Situation Analysis, has been on environmental degradation rather than ecosystem services per se. This is insufficient to meet the needs of research and development programmes (such as ESPA) that have the alleviation of poverty, through changes in the management of ecosystem services, at their core. Without this quantification, such programmes remain a discussion of concepts and ideals rather than providing tangible outputs upon which policies can be developed and against which they can be monitored.

Livelihood indicators are required to capture the wider (non-income) dimensions of poverty and more directly link *livelihoods* through to *ecosystem services* derived from the landscape. Current analysis is largely based on $1/day although there have been some earlier attempts to consider other indicators e.g. access to water, herd size etc (Kam et al, 2004). This needs to be done for the region as a whole, recognising that the indicators will differ depending on the dominant landscape features (ecosystems) on whose services the poor depend. The sustainable livelihoods approach provides a conceptual means of addressing the linkage between poverty and ecosystem services (Erenstein et al, 2007) but ecosystem assets have yet to be implemented in the poverty context (but see Sullivan and Meigh, 2007). There is a need for capacity building at this interface, particularly into research on community and household level understanding.

The indicators for the linkages between poverty and ecosystem services comprise a wide variety of elements ranging from economic values to livelihood assets and additionally need to address sustainability and vulnerability. These indicators must capture both the degree and direction of ecosystem service delivery (for a given situation or context) (Flavio and Kumar, 2007). There are international efforts to develop suites of indicators to quantify the delivery of ecosystem services and similar, but context-specific, indicators need to be developed for the region.

C. Drivers

1. Climate change

a. Currently global and regional climate models provide regional monsoonal prediction with high uncertainty. To improve understanding for the purposes of hydrological modelling and the direct impacts that this has on water cycling and resultant ecosystem services, there is a need to improve prediction of features (onset, duration breaks) of monsoonal rainfall on time scales relevant to the livelihoods of the poor (intra-, inter-seasonal and decadal).

b. It is expected that climate change will influence the agroecological zonation of individual crops with concomitant effects on yields and food security. There is a continuing need to develop crop modelling in relation to agroecological zones for all major crops in both the *kharif* and *rabi* seasons (Challinor et al, 2006; Aggarwal, 2003).

c. There is a need to examine existing coping strategies of the poor to the consequences of monsoonal variation to inform and improve development of policies that deliver future adaptation and mitigation strategies for climate change.

2. Regional hydrological flow and water cycling

    a. Continued glacial retreat and increased variation in the pattern of monsoonal rainfall as a result of climate change will result in major alterations to regional hydrology. The scale and magnitude of the impacts of these changes on regulating and sustaining services (for example erosion and flood control and cropping regions) requires investigation in context to poverty distribution.

    b. At the river basin and catchment scale, there is a need to evaluate different and competing sectoral demands for water and develop frameworks that aid decision making to protect and improve ecosystems services for poverty alleviation.

3. Changes within agro-ecosystems

    a. Given the high concentration of poverty in agro-ecosystems, continued research focussing in particular on the provisioning and sustaining services underpinning natural resource management and crop diversification is essential. Implicitly the poor depend upon the ecosystem services but the nature of the dependence is not uniform throughout the year. There is a monsoonally influenced, cyclical pattern dependent on the cropping season and the nature of responses to natural phenomena like flood and drought. The seasonal patterns of dependence of the poor and their existing coping strategies require in depth evaluation in the whole region.

    b. A priority-setting exercise should be conducted to inform the research agenda in individual agro-ecological zones and countries given international donor interests and established funding streams (e.g. Table 9.3).

4. Changes in forest cover

    a. Forest ecosystems in the region are already subject to socio-economic pressures leading to forest degradation and loss, with adverse impacts on the livelihoods of the forest-dependent communities and projected climate change will exacerbate these problems.

b. Empirical research on forest vegetation characteristics and plant functional types, plant physiological parameters is required to improve model prediction of changes in forest extent, type and distribution in response to climate change scenarios.

5. Indirect drivers

a. While the role of direct drivers like land use change on provisioning of ecosystem services is increasingly understood, the intensity with which indirect drivers like trade and pricing structures impact on an ecosystem and ecosystem services is not clearly known. The role of macro- economic factors like trade, investment, fiscal and monetary reforms on services like aquaculture, timber extraction and soil erosion require analysis. Copeland and Taylor (2004), in their review of the literature on trade-environment links, identify a major shortcoming in the area of empirical research on the effects of international trade on renewable resources such as cropland, pastures, forests, fisheries, and water. Similarly, whilst there are some micro and meso studies on the relationship between price as driver and ecosystem services they do not have a focus at the livelihood level and equally localized studies cannot be generalized to arrive at a macro picture. This calls for an interdisciplinary approach amongst social and bio-physical scientists.

b. Illustrative important research questions are:

i. How is export policy impacting biodiversity (through aquaculture export), soil erosion (through processed food export) and virtual water?

ii. How are subsidies impacting coastal fisheries and coastal ecosystems in the Indian Ocean or mangrove clearing to create shrimp ponds in the Sundarbans?

iii. What is the minimum level of governance required for the functioning of markets for ecosystem services (e.g. watershed, ecotourism and carbon sequestration?

D. Policy making

1. Valuation: In designing an effective policy response in managing ecosystems, valuation of services has proved to be useful to eliminate the subjectivity and uncertainty in the decision making process. However, valuation of regulating and cultural services needs more attention with reliable data from hydrology and valuation tools from economic science.

2. Institutions: There are several case of PES from the region and it clearly emerges from the analysis that social trust and institutional frameworks are necessary conditions in order to succeed with innovative responses. The appropriate levels of governance in order to succeed in the management of ecosystems services (e.g. watershed services for both lowland and highland people or local people and pharmaceutical companies in relation to bio-prospecting) require continued research.

3. Social processes: In south Asia, recognition of the role of many actors and issues (e.g. gender equality, land rights, community, differential state and national governance structures) is inherent in the ecosystem approach and scientific research agendas must address the broad picture in which societal choice is involved.

E. Capacity building

Capacity building in the topics of ecosystems service identification, service valuation and payment is required both at institutional (governmental, policy and research) and community levels throughout the region. It was noticeable in the development of this situation analysis, that awareness and application of the concept of ecosystem services was limited.

F. A research strategy

Research gaps and priorities need to be addressed by national governments, NGOs, academic institutions, the private sector and the international community following agreed conventions (e.g.CCBD, UNCCD and Ramsar). On the basis of evidence gathered from the region, the following table provides a matrix of research themes and suggested roles for research agencies.1 = Relatively low priority; 2 = Medium priority; 3 = Highest priority.

Research Issues	National Government	NGOs	Research Institutes and Universities	Private sector	Global community
Poverty, incidence, types and occurrence	3	2	2	2	2
Poverty-Ecosystem Linkages	3	1	3	1	2
Understanding Drivers	3	3	3	2	2
Valuation of ES	2	2	3	3	1
Adaptation and Mitigation Measures and Its impact on ES	3	2	3	2	2
Equity, gender and governance	3	3	3	1	2
Scale Issue	3	2	3	1	1

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