CLIMATE CHANGE AND DEVELOPMENT

CONSULTATION ON KEY RESEARCHABLE ISSUES

SECTION 4: SOUTH ASIA REGION
SECTION 4.1. SOUTH ASIAN REGIONAL SCOPING STUDY
TERI

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Introduction

This study commissioned by DFID was carried out with the objective to define regional priorities on the impacts of climate variability and change and identify its associated linkages with poverty and sustainable development.

The purpose being to define DFID's research programme on climate change with the emphasis to improve the quality of life of the poor and the vulnerable. As the programme is targeted towards developing countries, the approach followed under the study is a needs-based assessment in these countries targeting different stakeholders to set the stage for the development of a more informed regionally driven programme.

Approach followed

The study was carried out using different approaches. This includes,

Literature review

A detailed literature review of studies on climate variability and change provides insights on the nature of studies that have been supported in South Asia. Literature on developmental aspects has been looked at through a broad lens of adaptation, basically on enhancing the resilience of communities and reducing vulnerability to climate variability and change.

Both published and unpublished literature on different studies and developmental plans/ programmes in South Asia have been looked at and summarised in the report. The purpose being to identify gaps and prioritise issues that need further attention. Relevant literature from different sources including journals, books, IPCC reports and websites were reviewed for this purpose.

Text Box Contributions

Text-box contributions from different stakeholders have been invited to gather their perspective on a range of issues targeting response from a wider community from the climate and the development community.

Regional workshop

A regional workshop was conducted towards the end of the study to discuss the outcomes of the draft report. The workshop was held to discuss and validate research priorities identified and synthesised in the report. A range of stakeholders both from the climate change and development community were contacted for this purpose.

Climate change and development in South Asia: an overview

This report analyses climate change vulnerability and adaptation studies for South Asia, and seeks to assess key literature from mainstream development sectors from a climate change perspective. It further discusses in detail the sectoral challenges in addressing these concerns and presents an assessment of literature for seven countries in South Asia comprising Nepal, Bangladesh, Bhutan, Pakistan, Maldives, Sri Lanka and India.

Vulnerability to climate change in South Asia

Despite differences in physical and socioeconomic characteristics, the countries of the South Asian region have much in common as far as vulnerability to climate change is concerned. For instance, the IPCC Third Assessment Report cautions against increased risk of flooding in Nepal, Bangladesh, Pakistan, and north India during the wet season. Low-lying coastal cities like Dhaka, Karachi, and Mumbai are likely to face the brunt of sea level rise impacts. The countries of this region share potential threats to freshwater availability, human health, mountain ecosystems, mangroves and coral reefs.

IPCC (2001) highlights the following findings about adaptation capacity in Asia.

- Priority areas for adaptation are land and water resources, food productivity, and disaster preparedness and planning—particularly for poorer, resource-dependent countries.
- Adaptations already are required to deal with vulnerabilities associated with climate variability, in human health, coastal settlements, infrastructure, and food security. The resilience of most sectors in Asia to climate change is very poor. Expansion of irrigation will be difficult and costly in many countries.
- For many developing countries in Asia, climate change is only one of a host of problems to deal with, including nearer term needs such as hunger, water supply and pollution, and energy. Resources available for adaptation to climate are limited. Adaptation responses are closely linked to development activities, which should be considered in evaluating adaptation options.
- Early signs of climate change already are observed and may become more prominent over 1 or 2 decades. If this time is not used to design and

implement adaptations, it may be too late to avoid upheavals. Long-term adaptation requires anticipatory actions.

- A wide range of precautionary measures are available at the regional and national level to reduce economic and social impacts of disasters. These measures include awareness building and expansion of the insurance industry.
- Development of effective adaptation strategies requires local involvement, inclusion of community perceptions, and recognition of multiple stresses on sustainable management of resources.
- Adaptive capacities vary between countries, depending on social structure, culture, economic capacity, and level of environmental disruptions. Limiting factors include poor resource and infrastructure bases, poverty and disparities in income, weak institutions, and limited technology.
- The challenge in Asia lies in identifying opportunities to facilitate sustainable development with strategies that make climate-sensitive sectors resilient to climate variability.
- Adaptation strategies would benefit from taking a more systems-oriented approach, emphasizing multiple interactive stresses, with less dependence on climate scenarios.

A sector-wise summary of potential adaptation options in South Asia is presented below.

Sector	Adaptation options
Agriculture	Adjust cropping calendar and crop rotation Develop and promote use of high-yielding varieties and sustainable technological applications
Water resources	Develop flood- and drought-control management systems Reduce future developments in floodplains Use appropriate measures for protection against soil erosion Conserve groundwater supply, water impoundments, and efficient water resource systems
Ecosystems and biodiversity	Assess risks to endemic species and ecosystems Introduce integrated ecosystem planning and management Reduce habitat fragmentation and promote development of migration corridors and buffer zones Encourage mixed-use strategies Prevent deforestation and conserve natural habitats in climatic transition zones inhabited by genetic biodiversity of potential for ecosystem restoration
Coastal resources	Protect wetlands and allow for migration Prepare contingency plans for migration in response to sea level rise Improve emergency preparedness for weather extremes (e.g.

	cyclones and storm surges) Evaluate coastal subsidence rates in sensitive coastal regions Implement coastal zone management Protect marine resources
Human health	Build heat-resistant urban infrastructures and take additional measures to reduce air and water pollution Adapt technological/engineering solutions to prevent vector-borne diseases/epidemics Improve health care system, including surveillance, monitoring, and information dissemination Improve public education and literacy rate in various communities Increase infrastructure for waste disposal Improve sanitation facilities in developing countries

Source: IPCC (2001)

Development priorities in South Asia

Poverty alleviation is high on the agenda as a top development priority in most countries in South Asia. Population growth, paucity of resources, and lack of economic opportunities create pressures on ecologically fragile areas and natural resources. Therefore a need to focus on these listed concerns is felt. Several foras including the South Asian Association for Regional Cooperation (SAARC), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) and South Asia Cooperative Environment Programme (SACEP) promote regional cooperation to address most of these issues.

However, a sustained movement at a localised scale is required to facilitate meeting the basic needs of many who are deprived of access to food, safe drinking water and sanitation and shelter requirements. In this regard projects that merit high priority at the regional level include those relating to cooperation on water and energy. Also of importance are studies on poverty alleviation with focus on agriculture, and those relating to dealing with natural disasters (Twelfth SAARC Summit, 2004). Several programmes to deal with these issues are internally underway and targeted by the governments of each country. Besides, there are major bilateral and multilateral initiatives taken forward by the World Bank, the Department for International Development, the Canadian International Development Agency and the Asian Development Bank. A review of development strategies considered by some of the country governments highlights the following:

- In India, the 10th Plan of the government has set a high growth target of 8% to induce rapid reduction in income poverty and attain ambitious human development goals. Though there have been considerable improvements in certain sectors regarding those on education and health, India still lags behind in addressing gender-sensitive indicators such as maternal mortality or the gender gap in secondary education, and the high incidence of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) and other infectious diseases. The 10th Plan has accordingly proposed an increase of almost 80% in public social expenditures. The new government has stressed its resolve to energetically pursue the goals of poverty reduction through shared growth, equity, and inclusive social development (Box 1).

Box 1: Highlights Of The National Common Minimum Program

The National Common Minimum Program (NCMP) reiterates that the United Progressive Alliance government will ensure that economic reforms are oriented primarily to spreading and deepening rural prosperity, improving the quality and delivery of public services, and bringing about a visible and tangible difference in the quality of life of ordinary citizens of India. Overall, the NCMP emphasizes the commitment of the UPA Government to carry out economic reforms with a human face. Its main goals are:

- generate employment and pro-poor growth by increasing public investment in agricultural research and extension, rural infrastructure, and irrigation
- ensure a doubling of rural credit over the years 2004–2007
- increase investment in the development and expansion of physical infrastructure such as roads, highways, ports, power, railways, water supply, sewage treatment, and sanitation
- raise public spending on education to 6% of GDP, with at least half to be spent on primary and secondary education
- raise public spending on health to at least 2–3% of GDP over the next 5 years, focusing mainly on primary health care
- eliminate the revenue deficit of the federal government by 2009 to release more resources for investments in social and physical infrastructure
- catalyze economic growth in Jammu and Kashmir and the North Eastern states by investing in infrastructure
- strengthen social security, health insurance, and other schemes to improve the lives of informal sector workers, while rejecting the idea of automatic hire and fire

- In Bangladesh the percentage of people below the poverty line has decreased from 70.6 percent to 46.5 since 1973-74. The Government has plans to reduce half the proportion of people below the poverty line by 2010. Main areas of focus include promoting pro-poor growth, social development and good governance.

- Bhutan has plans to achieve universal primary education by the year 2007. The primary school gross enrolment rate

increased from 67 % in 1990 to 72 % in 2000. Significant improvements have also been achieved in terms of decreased infant and maternal mortality rates, lower child malnutrition and better access to clean drinking water. While health care coverage is as high as 90%, the Government plans to improve delivery of health services.

This study aims to review ongoing country developmental programmes either undertaken by governments or through bilateral and multilateral assistance in the context of adaptation to climate variability and change.

Climate change and development linkages

Some of the important climate sensitive sectors are notably agriculture, water resources, coastal areas and human health. Agriculture remains the mainstay of several economies in South Asia besides also being the largest source of employment in the region. With nearly three-fifth of the cropped area in the region being rainfed, the economy of South Asia hinges very critically on the annual success of the monsoons. In the event of a failure, the worst affected are the landless and the poor whose sole source of income is from agriculture and its allied activities.

As the impacts of climate change become evident, it is quite clear that actions to cope with the crisis at hand would have to encompass an integrated approach including adaptation. The ability to adapt clearly depends on the state of development and is determined by factors such as wealth, access to technology, education, awareness, services and infrastructure as well as access to resources. Underdevelopment constrains adaptive capacity especially because of lack of resources to hedge against extreme but expected events.

A two-fold link can be seen between climate change and development. One, the impacts of climate change can severely hamper development efforts in key sectors. e.g. increased threat of natural disasters and growing water stress will have to factored into other sectoral developmental plans. Second, development policies and programmes will themselves influence the ability to adapt to climate change. e.g. policies for forest conservation and sustainable energy will, if correctly targeted and implemented, enhance the resilience of communities and thereby reduce the vulnerability of their livelihoods to climate change.

Several regional studies including the APN study on water resources, WWF study on GLOFs, OFDA and USAID study on droughts and floods have been carried out using a range of

approaches from modelling based analysis to community oriented interaction. Annex I sites examples of studies and programmes being implemented in South Asia at a regional level.

The following section below reviews various climate change studies conducted in South Asian region in recent years including the preparation of the National Communications document, the National Adaptation Programme of Action (NAPA) in least developed countries like Bangladesh, Nepal, Maldives and Bhutan and the National Capacity Self-Assessment (NCSA) for Global Environmental Management targeted in some countries in the region.

While the objective of the NAPAs is basically to develop country-wide programmes that cover the immediate and urgent adaptation activities that address the current and predicted negative impacts of climate change, including extreme events, the principal objective of the NCSA process is to identify and assess critical capacity constraints and to develop a prioritised overview of capacity needs in the area of global environmental management. In addition to the overall objective of developing a comprehensive, nationally-driven assessment of capacity development needs, the NCSA process will also help in assisting governments in attaining a number of secondary objectives including better understanding and responding to critical cross-thematic environmental challenges.

Agriculture, food security and climate change

Agriculture is the dominant source of income and employment in most of the countries in South Asia. The green revolution had mixed responses from different countries. For instance: In Bangladesh the per capita food production growth rate has been negative over the period 1971-96. The catastrophe in 1998 further worsened conditions and it is only over recent years that the per capita food availability has risen. Nepal, Sri Lanka and Bhutan on the other hand have witnessed declining yields over time. In Maldives, the situation has been rather stable. The only two countries in South Asia who have fared comparatively better on the agricultural front are Pakistan and India. These countries, so far, have effectively managed food crisis during unprecedented drought conditions in 2000-2001 (Human Development in South Asia, 2002).

While in other countries in South Asia the problem is related to declining yields, near crisis situation in Pakistan and India arrives due to climatic phenomenon, basically due to the occurrence of droughts and floods. About 75 % of the world's major natural catastrophes between 1970 and 1997 have occurred in the Asia-Pacific region (GEO, 2003).

Studies on climate change

Under an enhanced greenhouse condition, the variability of monsoons in Asia is projected to increase resulting in recurring droughts or floods which would affect agricultural production and increase the vulnerability of the large agrarian population. Acute water shortage conditions combined with thermal stress is predicted to adversely affect the yield of many food crops in the region. These impacts may be attenuated by considering adjustments at the farm level – including changes in cropping patterns, improving water management and irrigation systems and adapting to altered planting schedules and tillage practices.

Climate change impacts on agriculture would increase the number of people at risk of hunger. The impact of climate change on food security will be higher in countries with low economic growth potential that currently have high malnourishment levels. Among the cereals, wheat production potential in the sub-tropics is expected to be affected the most, with significant declines anticipated in several regions including South Asia (IIASA, 2002). For eg., wheat yields in central India may drop by 2% in a pessimistic climate change scenario (GoI, 2004).

The decline in yields in some cases might be offset by increase in carbon dioxide depending mostly on the type of crop being

grown and the scenario chosen. A number of studies have analysed the impacts of climate change on agricultural crops, for eg., rice, in Bangladesh. The estimated impacts on rice yield shall vary between -6% to +14% depending on different climate change scenarios (Rosenzweig and Iglesias 1994 and Matthews et al 1994). Recently, Karim et al, 1996 have analysed the impact of climate change on high-yield rice varieties in Bangladesh using CERES-rice model. The findings reveal that:

- Impacts on rice yields vary significantly across various locations
- Higher CO2 levels have a positive influence on rice yields
- Higher temperatures have negative influence on rice yields in all seasons and almost all locations
- The net effect of temperature and carbon fertilization is negative on rice yields

In addition to the above impacts, agricultural areas in tropical Asia, and Bangladesh in particular, are vulnerable to many environmental extremes such as floods, cyclones, and storm surges. Agricultural production from Bangladesh has been severely affected due to floods over the years. For example, on an average during the period 1962-1988, Bangladesh lost about 0.5 million tonnes of rice annually as a result of floods that accounts for nearly 30% of the country's average annual food grain imports (Paul and Rashid 1993).

In Bhutan, for instance upland crop production, practised close to the margins of viable production, can be highly sensitive to variations in climate. A temperature increase of 2 °C would shift the cultivating zone further into higher elevation. This means that crops that are sensitive to low temperatures can be introduced into higher elevations with this temperature rise. Although this may seem a useful aspect, a closer examination indicates that the landforms at this altitude are mainly steep slopes, appropriate only for protection forests, and unsuitable for agriculture. Warming may have positive impacts on crop yields if moisture is not a constraint. But increases in the occurrence of extreme events or pests may offset any potential benefits. Both crops and livestock would be affected by increased incidence of alien/invasive pests and diseases.

Climate change is expected to increase the severity and frequency of monsoonal storms and flooding in the Himalayas, which could aggravate the occurrence of landslides. In addition to the danger to life and property, some of the generated sediments may be deposited in the agricultural lands or in irrigation canals and streams, which will contribute to deterioration in crop production and in the quality of

agricultural lands (NEC 2000). Soil loss is a major cause of decline in agriculture production in Nepal and the negative effects of climate change may further aggravate this situation. The impact of rise in temperatures on wheat and maize are expected to be negative.

In the hot climate of Pakistan, cereal crops are already at the margin of stress. An increase of 2.5°C in average temperature would translate into much higher ambient temperatures in the wheat planting and growing stages. Higher temperatures are likely to result in decline in yields, mainly due to the shortening of the crop life cycle especially the grain filling period. The impact of this to some extent would be offset by the carbon fertilisation effect and by adopting strategies such as full irrigation and shifting of planting dates. More recently, the National Communication (MoE 2003) highlighted that crops like wheat, cotton, mango, and sugarcane would be more sensitive to increase in temperatures compared to rice.

Extreme events of rise in temperature and changes in rainfall patterns will have adverse impacts on agricultural production in Sri Lanka. The changed rainfall scenario suggests an increase in amplitude of rainfall extremes causing adverse environmental impacts. Frequent floods will lead to increased soil erosion, landslides, and damage to agriculture through flooding of low-lying areas. Temperature and moisture changes will also force farmers to change the cropping patterns that have so far been tuned to traditional climates. It is estimated that even a 1 ℃ warming would necessitate major adjustment of the finely tuned crop calendar. Climate scenarios produced by the CSIRO indicate that temperature changes are significant for Sri Lanka by the year 2070. The increase in mean temperature would increase the maxima of the existing temperature cycle. It is reasonable to assume that these changes will manifest themselves in the frequency of warmer spells, warmer months, and warmer seasons. In warm, semi-arid regions, deficiency of moisture would be a major constraint.

Most cropping activities for e.g., coarse grain, legumes, vegetables, and potato are likely to be affected adversely due to the impacts of climate change. The highest negative impact is estimated for coarse grains and coconut production. An increase in the frequency of droughts and extreme rainfall events could result in a decline in tea yield, which would be the greatest in regions below 600 metres (Wijeratne 1996). With the tea industry in Sri Lanka being a major source of foreign exchange and a significant source of income for labourers the impacts are likely to be grave. More recently, under an ongoing AIACC project, Peiris et al (2004) confirmed that changes in monsoon rainfall pattern and increase in maximum air

temperature are two key factors on the variability of coconut production in the principal coconut growing regions. The projected coconut production after 2040 in all climate scenarios, when other external factors are non-limiting, will not be sufficient to cater the local consumption for the increased population. Among the different stakeholders in coconut industry, the coconut oil (CNO) industry would be most affected.

Adaptation in the context of development

Development programmes in the agriculture sector in South Asia have differed largely across countries based on the approach, the objectives and motivating impulses to trigger responses. Broadly, while the first generation programmes till the 70s had a definite focus on promoting growth, the second generation programmes have been quite diverse focusing on empowerment of the poor, protection of the environment/ natural resources and enhancement of the capabilities of the poor. While community development programmes were targeted from the very beginning in India and Pakistan, in other countries in South Asia the move was rather late.

Several programmes include, the Village Aid Programme and the Integrated Rural development Programme (IRDP) facilitating digging canals, increasing connectivity and adaptation of improved farm practices in Pakistan; the IRDP and the Minimum Needs Programme for infrastructure development and programmes on watershed management and on capacity building in India; Grameen Bank programme for rural credit to rural poor and the Bangladesh Rural Advancement Committee on providing education and training in Bangladesh and irrigation Projects in Sri Lanka. Nepal, Bhutan and Maldives have also several such examples to site.

In Bangladesh, ongoing projects intend to address food insecurity and food production shortfalls by crop diversification and generation of other employment opportunities aiming at community development, agricultural development, credit facilities, and infrastructure improvement. Fish and shrimp production for domestic consumption and exports are promoted with special emphasis on rural poverty alleviation & employment generation. This is done by improving the capacity of local users to manage aquatic resources in a sustainable and equitable way thereby conserving aquatic biodiversity.

All these developmental programmes play an important role in enhancing the resilience of the poor. Rain water harvesting and integrated development of watersheds in rainfed areas help in increasing agricultural resilience to erratic weather events

under a climate change scenario. Additionally, at a more macro level, policies and plans can seek to improve production and distribution systems to cope with fluctuations in crop yield. New technologies and practices are more readily acceptable to farming communities if well ingrained in the indigenous system. Therefore modified traditional methods for conservation of natural resources could be adopted to cope with these changes.

Kishore Sherchand, Nepal

Urgent need in agriculture would be to focus on crop productivity trends and impacts due to climate change. Carbon sequestration, crop species and habitat change.

There is also need for effective climate and weather forecast and its application in agriculture such as crop yield prediction, cold-waves, droughts and flood disaster prediction. Impacts on monsoons for better preparedness and developing suitable adaptation strategies.

Water resource management and climate change

Many developing countries are already facing severe water shortages which would be further aggravated with changing precipitation patterns under a changing climate regime. Climate change challenges existing water resources practices by adding additional uncertainty. Changing precipitation patterns would affect the replenishment of rivers reducing their flows during the critical summer months when the demand is the highest. Water quality would also emerge as an important issue in this context which has the potential to endanger human health. Reduced flows in rivers would affect the dilution capacity of pollutants thus affecting the water quality and further reducing usable sources. Increases in temperatures under global warming, would deteriorate water quality in most polluted water bodies by increasing oxygen consuming biological activities and decreasing the saturation concentration of dissolved oxygen.

Increased glacial melt due to warming is also predicted to affect river flows. Increased warming might result in increased flows initially with reduced flows later as the glacier disapppears. Available records suggest that Gangotri glacier is retreating by about 30 m yr-1. A warming is likely to increase melting far more rapidly than accumulation. As reported in IPCC (1998), glacial melt is expected to increase under changed climate conditions, which would lead to increased summer flows in glacier fed river systems for a few decades, followed by a reduction in flow as the glaciers disappear.

Understanding the impacts of climate change

As floods in Bangladesh are caused by intense monsoon precipitation over the basin areas of the Ganges, Brahmaputra and Meghna (GBM) rivers, future changes in precipitation regime have four distinct implications.

1. the timing of occurrence of floods may change, with a possible change in the seasonality of the hydrological cycle
2. increased precipitation in the GBM basins may increase the magnitude, depth, and spatial extent of floods
3. timing of peaking in the major rivers may also change that may change the likelihood of synchronization of flood peaks of major rivers
4. increased magnitude, depth, extent and duration of floods will bring a dramatic change in land-use patterns in Bangladesh.

A study carried out under the BDCLIM (Bangladesh Climate) project sought to examine possible changes in flooding in Bangladesh under a given climate scenario. IPCC, 2001 indicates that the average annual runoff in the Brahmaputra basin would decline by 14% by the year 2050 as a result of climate change. Nishat, 2002 made an attempt to examine the implications of climate change for the National Water Management Plan of Bangladesh. Conclusions include, excessive rise in evaporation rates, reduction in dry season trans-boundary flows resulting in an increase in irrigation water requirements; sea level rise of 0.5m to exacerbate drainage congestion and other potential impacts include more frequent flash floods, higher frequency of tropical cyclones, rise in storm surge depths, and slower accretion of new coastal lands.

The availability of water in Bhutan is heavily dependent on heavy rainfall, glaciers or snow, land use practices, and user demand. A reduction in the average flow of snow-fed rivers, combined with an increase in peak flows and sediment yield, would have major impacts on hydropower generation, urban water supply, and agriculture. An increase in rainfall intensity may increase run-off, enhance soil erosion, and accelerate sedimentation in the existing water supplies or reservoirs.

The population of Maldives mainly depends on groundwater and rainwater as a source of freshwater. Both of these sources of water are vulnerable to changes in the climate and sea level rise. With the islands of the Maldives being low-lying, the rise in sea levels is likely to force saltwater into the freshwater lens. The groundwater is recharged through rainfall. Although the amount of rainfall is predicted to increase under an enhanced climatic regime, the spatial and temporal distribution in rainfall pattern is not clear (Ministry of Environment and Construction 2005).

Studies reported in Nepal's initial national communication indicate no major changes in the hydrological behaviour due to rise in temperatures. However, changes in precipitation are expected to have major impacts. A preliminary analysis of river discharge shows decreasing trends for Karnali and Sapta Koshi but increasing trends for Narayani (DHM 1996). Shrestha et. al., 2003 suggest that the number of flood days and consecutive days of flood events has been increasing.

A survey done by ICIMOD and UNEP, highlights that 26 lakes in Nepal are categorised as dangerous due to threat to glacier lake outburst floods (GLOFs) (WWF 2005). As highlighted by IPCC (2001), glacial melt is expected to increase under changed climate conditions, which would lead to increased summer

flows in some river systems for a few decades, followed by a reduction in flow as the glaciers disappear.

Wescoat, 1991 studied the potential impacts of climate change on the Indus River basin. The study concluded that the total annual run-off from the upper basin is likely to increase by 11% to 16%. It estimated that although increased run-off could be advantageous for water supply and hydropower production it could aggravate problems of flooding, waterlogging, and salinity in the upper basin. Also, even with an overall water surplus, shortages might occur in local areas of the highly productive Punjab rice–wheat zone and in the unglaciated valleys of the upper basin. These areas currently lack adequate storage, conveyance, and irrigation management. Studies also indicate a negative impact on cotton, detrimental to the economy as it is the main cash crop of Pakistan.

Studies indicate that much of the water from heavy rainfall events in Sri Lanka would be lost as run-off to the sea.

Adaptation in context of development

Studies carried out in Nepal suggest that development projects should be critically analysed for eg., dams could potentially exacerbate vulnerability to another potential impact (GLOFs), as the breach of a dam following a GLOF might result in a second flooding event.

Dr Ahsan Uddin Ahmed, Bangladesh Unnayan Parishad

Most of the adverse impacts of adaptation to climate change in Bangladesh deal with water-related extreme events and related issues including disaster preparedness and management.

It is not sure whether the local institutional arrangements are adequate to foster adaptation at all levels of the current governance system and what institutional requirements, including policy inputs, that might be necessary to develop a conducive institutional regime. The primary focus must be on institutions related to water resources sector, however sectors such as disaster management, rural development, agriculture, forestry and fisheries also need to be included in the analysis.

Water management would have to adopt an integrated approach, which entails supply, as well as demand side adaptation. Integrated water resources management is in fact increasingly being regarded as the most effective way to manage water resources in a changing environment with competing demand. An integrated approach would involve modifying or extending infrastructure to collect and distribute water, adoption of decentralized rainwater harvesting programs and undertaking appropriate water pricing initiatives to tame end use demand along with removal of perverse subsidies.

Disaster management and climate change

Understanding the impacts of climate change

In Bhutan, the entire northern upper land has glacier/snow-fed lakes in the mountaintops. Increased temperature and greater seasonal variability in precipitation will lead to accelerated recession of glaciers and result in increase in the volume of these lakes (IPCC 1998). This might result in flash floods causing severe damages in terms of loss of lives, economy, and infrastructure in the valley. In 1994, a glacier lake outburst in the Lunana region flooded and damaged everything in the lower valleys of Punakha and below, illustrating the high degree of vulnerability to such extreme events.

Beach erosion is now among the most serious environmental issues facing the islands of Maldives. On many islands, the sand at the beach and shoreline are being washed off at a greater rate than it is accreted. The process of coastal erosion and accretion is extremely complex with interrelations to climatic, geological, oceanographic, biological and terrestrial processes affecting the growth and stability of the reefs and island structures. Over 80% of the land area in the Maldives is less than 1 m above mean sea level. Being so low-lying, the islands of the Maldives are very vulnerable to inundation and beach erosion. Presently, 50% of all inhabited islands and 45% of tourist resorts face varying degrees of beach erosion. Coastal infrastructure is also highly vulnerable to the impacts of sea level rise and extreme events. Given the geophysical characteristics of the islands and the population pressure, all human settlements, industry and vital infrastructure lie close to the shoreline. According to the State of Environment 2004, more than 73% of the inhabited islands have buildings less than 100 feet away from the shoreline. 2 % of the islands have building right at the shore line. And more than 55 % of the islands have buildings less than 50 feet from the shoreline.

In Nepal, DHM (2004) found that almost 20% of the present glaciated area above 5000 m altitude is likely to be snow and glacier free with an increase of air temperature by 1° C. Similarly, a rise in 3° C and 4° C temperatures would result in the loss of 58 to 70 % of snow and glaciated areas with threat of GLOFs.

Pakistan comparatively is less vulnerable to changes in sea level but for the port city of Karachi. Karachi's greatest vulnerability to climate change may come from increased monsoonal and tidal activity, resulting in periodic flooding. The National

Communication also warns against significant flooding impacts in the coastal zone, particularly in the low-lying deltaic regions. These areas would become more vulnerable to flooding because high sea levels provide a higher base for storm surges to build upon. Higher seawater levels would also increase the risk of flooding due to rainstorms, by reducing coastal drainage. A rise in sea level would raise the water table, further reducing drainage in coastal areas. All these effects could have possibly devastating socioeconomic implications, particularly for infrastructure in low-lying deltaic areas.

Significant erosion is already evident on many of Sri Lanka's beaches. This is likely to increase significantly with accelerated sea level rise. A rise in sea level would tend to cause a shoreline recession except where this trend is balanced by the influx of sediment. In a 30 cm sea level rise scenario, the study projects a possible shoreline recession of about 30 m and for a 100 cm scenario, the shoreline retreat is expected to be about 100 m. A one metre rise in sea level could drown most of the coastal wetlands in Sri Lanka. Another important concern is related to the intrusion of salt water. Salt-water intrusion is already affecting approximately 15,000 hectares of paddy fields in the Galle district. Sea level rise would also have adverse effects on infrastructure facilities, such as ports, harbours, and coast protection structures. MENR, 2000 reports that the extent of land loss due to 0.3 to 1 m sea level rise in Sri Lanka is as follows:

Sea level rise scenario (m)	Land loss on south-west coast (km2)	Area inundated around lowlands adjacent to marshlands, lagoons, and estuaries of south-west coast (km2)
0.3	6.0	41.0
1.0	11.5	91.25

Moreover, high intensity rainfall will contribute to short term inundation with impacts on life and infrastructure. Flash floods would be a significant problem in low-lying areas, while in hilly areas the problems may be landslides and destabilization of road/rain embankments (MENR 2000).

Adaptation in the context of development

Bangladesh has its own Participatory Disaster Management Programme (PDMP) with the focus towards disaster management and prevention, and also adaptation to climate change. There is no national policy in place yet to comprehensively address climate change risks. The disaster management project mainly focuses on soft measures to reduce the impact of disasters in Bangladesh. In particular, it aims to increase awareness on practical ways to reduce disaster risks and losses, to strengthen national capacity for disaster

management (with emphasis on preparedness), enhance knowledge and skills of key personnel in handling disasters, establishing disaster action plans in the most disaster prone areas promoting local–level risk reduction measures, and improving early warning systems. The UNDP Comprehensive Disaster Management Programme (CDMP) aims to establish a systematic approach to prediction, monitoring, protection, evacuation, land use zoning, and information dissemination to build adaptive capacity, which in turn requires comprehensive and appropriate information produced and delivered at the right time, to the right people and agencies.

Bangladesh's interim poverty reduction strategy paper (I-PRSP) recognizes the direct links between poverty and vulnerability to natural hazards. It notes that the incidence of disasters is likely to increase rather than decrease particularly due to the impacts of global warming. Climate change so far is not mentioned in the context of planning vulnerability reduction measures.

In India, till date natural disasters had not been adequately factored into the planning process. The experience of disasters in recent years has realised that episodic shocks have the potential to disrupt development process quite substantially unless contingency plans are already in place and fiscal and monetary policies can be adjusted with sufficient flexibility. Although Disaster Management has not been conventionally a subject for Five-Year Plans, but given the increasing severity and occurrence of disasters – earthquakes, cyclones, floods, droughts - and the significant set back and threat they pose to the development of a region or state, the Government of India in its Xth Plan document has addressed the issue on disaster preparedness and mitigation strategies to minimize the periodic shocks to the country's development efforts. Though the focus has been discussed, integration into the planning process might take some time.

The Plan highlights that disaster mitigation components need to be built into all Plan projects, so as to minimise both the likelihood of damage and the cost of post-disaster restoration and rehabilitation. This will mean some additional outlay for projects coming up in disaster-prone areas, first for building a comprehensive data-base on risks and actions already taken, and secondly for undertaking a vulnerability analysis and risk assessment for the project in question. In addition, the construction of specific disaster-prevention projects (flood defences, cyclone shelters) would need to be considered in the context of the growing incidence of disasters.

Coastal areas and climate change

Sea level rise in coastal areas would inundate land areas and displace population living in these areas. It will also result in an increased risk to life and property. Low-lying coastal cities will be at the forefront of impacts; in South Asia these cities include Karachi, Mumbai, and Dhaka—all of which have also witnessed significant environmental stresses in recent years. Salt-water intrusion in underground aquifers will be an additional cause of concern in these regions.

Bangladesh has one of the most densely populated, low-lying, coastal zones in the world, with 20-25 million people living within a one-metre elevation from the high tide level. The coastline in Bangladesh totals about 735 km, of which 125 km are covered by the Sunderbans - the major natural mangrove forest. The sectors of Bangladesh coastal resources identified as most vulnerable to climate change and sea level change are agriculture, aquaculture, fisheries, forestry, and tourism. The possible effects of sea level change are inundation, salt-water intrusion, flash floods, droughts, and storm surges.
Reduced dry-season freshwater supplies from upstream sources resulting from climate change are expected to further exacerbate salinity conditions in the coastal area of Bangladesh (IPCC 1998).

A recent study by Bangladesh Centre for Advanced Studies (BCAS) and Resource Analysis from the Netherlands (Al-Farouq and Huq, 1996) analysed the impacts of sea level change on Bangladesh. The study concluded that following one metre rise in sea level, Bangladesh could face a catastrophic situation, including permanent inundation of about 15–18% of its low-lying coastal areas, loss of the Sunderbans, displacement of over 10 million people, and loss of valuable agricultural land.

Effective adaptive responses to climate change and sea level rise include measures such as creation support and extension services to improve or change agricultural practices, efficient mechanisms for disaster management, development and introduction of desalinisation techniques, and the plantation of mangrove protection belts [Coastal Zone Management Studies: Bangladesh. http://www.vu.nl].

Adaptation in the context of development

Bangladesh has planned activities relevant to adaptation to coastal flooding. This includes the Integrated Coastal Zone Management (ICZM) Programme of the Government of Bangladesh. Under the ICZM Project a study is being currently carried out with the purpose of providing policy guidelines for

integrating climate change vulnerability issues in coastal zone projects. This includes carrying out a vulnerability mapping exercise of the entire coastal zone in Bangladesh. The development of such a knowledge base could facilitate better incorporation of climate risks in future projects. In addition to the above mentioned activities towards reducing coastal flood vulnerability, Bangladesh is contemplating to implement a number of activities in coastal zones. Again, the general objective of each of these activities is not adaptation to climate change impacts. It may, however, be expected that these planned activities would be synergistic with adaptation to climate change. Several projects being implemented under the National Water Management Plan have the potential to address future adaptation to floods in coastal regions.

However it is felt that besides country level strategies being adopted, a larger arrangement at the regional level will be required to address trans-boundary institutional arrangements. For e.g., a regional disaster warning centre is planned to be set up by the year 2007, in South and Southeast Asia to alert countries on natural disasters including tsunami warnings.

Public health and climate change

There are very few studies that have attempted to look at the effects of climate change on health in developing countries, including South Asia. Warmer and wetter conditions are likely to increase the potential for a higher incidence of heat-related and infectious diseases. Although malaria has been eradicated from the Maldives, climate change is likely to induce a threat of malaria outbreaks. Poor sanitation in the islands of Maldives alongwith conducive environment for the spread of diseases might lead to the outbreak of water related and waterborne diseases such as diarrhoea (Ministry of Environment and Construction 2005). Studies carried out in Nepal indicate the risk of malaria, kalaazar and Japanese encephalitis under different climate change scenarios. The subtropical and warm temperate regions are predicted to be particularly vulnerable to malaria and kalaazar.

In Sri Lanka, expansion and shift in malarial transmission zones is expected. Moreover, the seasonal pattern of malaria transmission is likely to undergo a change, from the high transmission season which now occurs from November to February being curtailed, and the minor mid-year peak being enhanced with high rates of transmission occurring in September. Areas bordering the non-endemic wet zone of the country are likely to become highly vulnerable to malaria (MENR 2000).

In India, malaria is endemic in all parts except at elevations above 1,800 metres and in some coastal areas. The principal malaria-prone areas are Orissa, Madhya Pradesh, Chhattisgarh, and the north-eastern parts of the country. According to the World Bank, in 1998 about 577,000 Disability- Adjusted Life Years (DALYs) were lost due to malaria. Presently, the transmission is open for 12 months in eight states (Andhra Pradesh, Chhattisgarh, Karnataka, Kerala, Maharashtra, Orissa, Tamil Nadu and West Bengal), nine to 11 months in the north-eastern states (Gujarat, Haryana, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh and Uttaranchal). The states of Himachal Pradesh and Jammu and Kashmir have transmission windows open for five to seven months, respectively. Increase in temperatures and humidity levels are likely to result in an increase in the transmission windows from 9 to 12 months. The transmission windows in the states of Jammu and Kashmir and Rajasthan may increase by three to five months as compared to the base year. In some states in South India with already high mean temperatures of more than 32°C, the transmission window for the spread of malaria is expected to decrease by a couple of months.

Livelihoods and climate change

Global warming may cause forest damage through change in their composition and extinction of various species. In Nepal, tropical wet forests, warm temperate rain forests and cool temperate vegetation is expected to be slowly invaded by warm temperate vegetation. Vegetation patterns are predicted to be very different under the incremental scenario than existing types having an impact on livelihoods dependent on these resources (DHM 2004).

The main impacts of climate change on the forestry sector in Pakistan are likely to be due to the latitudinal and altitudinal shifts in ecological zones. With rapid changes in the climate the stress on several tree species is expected to lead to extinction of some species. Standing forest communities and their regeneration also face major threat from excessive rainfall accompanied by widespread erosions and landslides. The vulnerability of Pakistan's coastal mangrove forests to the rise in sea level is a matter of great ecological concern. The mangrove forests along the Indus Delta are an especially diverse ecosystem. They provide fuelwood and fodder to local inhabitants and are breeding grounds for an estimated 90% of shrimps that are exported. Pakistan's national communication report states that detrimental impacts of climate change on rural livelihoods would result in more people being forced to seek employment in urban areas.

The climate change scenarios predicted for Sri Lanka indicate significant changes in temperature and precipitation by the year 2070. The forest composition is likely to change and affect timber production. Somaratne and Dhanapala (1996) estimate a decrease in tropical rainforest of 2-11% and an increase in tropical dry forest of 7-8%. This study also indicates that increased temperature and rainfall would result in a northward shift of tropical wet forest into areas currently occupied by tropical dry forest. The most vulnerable forest areas in Sri Lanka are likely to be the Sinharaja Forest Reserve and Peak Wilderness Forest Reserve. These changes would probably lead to the elimination of most Sri Lankan endemic species. With a likely increase in extreme events like droughts, the incidence of forest fires may also increase. Favourable conditions for pests and diseases might impact the quality of forests. Threat to mangroves due to rise in 20 cm sea level is also predicted.

Adaptation in the context of development

Most of the Biodiversity conservation projects in the Sunderbans reserved forest are carried out with the main objective to protect the rich biodiversity of the Sunderbans and

enhance the rural livelihoods of the local population, through sustainable natural resource management. Empowerment of coastal fishing communities for livelihood security by enhancing socio-economic capacities in income generating activities, and improved access to extension and social services is being aimed thereby improving the capacities of communities to cope with natural disasters.

In Trashigang, Silambi and Dhaksa in Bhutan, projects relating to promotion of improved cooking stoves are being promoted. The aim is to improve the living conditions of the local communities, gradually reducing fuelwood consumption and protecting the forests. Several other projects also focus on prevention of deforestation and increase in forest cover for e.g., the Ringphu Sustainable Development Project aims at improving the living conditions of local communities by protection of the forests. Some of the forest and water catchments conservation projects aim at protection of the forests and promote conservation of water. In Bhutan many projects are aimed at enhancing capacities of communities and institutions to understand the links between biodiversity conservation and climate change promoting sustainable utilisation of resources.

Studies in Nepal and Bangladesh to identify inks between development and climate change have been carried out with the objective to mainstream climate change within economic development planning and assistance policies.

The need for a National Policy on Climate Change has been expressed in Bangladesh. Work is currently underway to develop the National Adaptation Plan of Action (NAPA). Bangladesh is a party to various international environmental conventions, including the UNFCCC, UNCCD, UNCBD and the RAMSAR Convention on Wetlands. It has submitted its first National Communications to the UNFCCC in late 2002. It has also produced a National Planning Tool for the implementation of the Ramsar Convention on wetlands that draws linkages between Ramsar and other biodiversity issues.

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Currently, the Government of the People's Republic of Bangladesh (GOB) is drafting/ finalizing the Poverty Reduction Strategy Paper (PRSP), which is planned to serve the country as a planning document, defining short- to medium-term development pathways for the country. PRSP is also thought to replace the traditional Five Year (Development) Plans. Since the PRSP is getting more emphasis in shaping up the future development pathways, it needs to be analyzed in relation to its adequacy to highlight issues concerning adaptation to climate change and mainstreaming adaptation in development thinking.

An early diagnosis could increase effectiveness of 'climate-safe' development programmes

and help avoid development schemes that are likely to be affected by adverse impacts of climate change.

Formulation and adoption of PRSP is a generic process, pushed by the World Bank, in a number of developing countries including Bangladesh. It is not clear whether similar activities are ongoing in other regional countries in South Asia. If so, an analysis of PRSP for each of the countries involved can be initiated under a regional programme.

Development organisations like CARE in Bangladesh are working with rural households to improve resilience and reduce vulnerability to climate change. The main objective of the study is to build local capacity and identify measures to address climate change impacts.

The primary goal for the next five years in Nepal has been set on alleviating poverty overarching sectors including agriculture and tourism. Although the plan acknowledges the important influence weather can have on overall economic performance explicit attention to climate risks is still lacking.

Ecosystems and climate change

Coral reeves are in particular vulnerable to the cause and impacts of global warming. The low-lying islands of the Maldives are surrounded by coral reefs. These coral reefs not only provide protection for the islands, but also help in the promotion of tourism and fisheries. Studies show that the corals are very sensitive to changes in sea surface temperature. Unusually high sea surface temperatures in 1998 had caused mass bleaching on coral reefs in the central regions of the Maldives. If the observed global temperature trend continues, there would be a threat to the survival of the coral reefs in the Maldives (Ministry of Environment and Construction 2005).

The Global Coral Reef Monitoring Network (GCRMN) project is being carried out in 3 countries in South Asia including India, Sri Lanka and the Maldives. The focus of the first phase of the project was on awareness raising and development of capacity for biophysical monitoring. In the second phase emphasis was placed on recognising the importance of socio-economic monitoring for effective management of coral reefs. The third phase currently underway has been designed to develop an understanding on raising community awareness to stimulate protection of coral reeves.

The CORDIO project aims at assessing damage to coral reeves, analysing its socio-economic effects and recovery in the Indian Ocean. The project is spread over countries of Maldives, Sri Lanka and India in South Asia.

Hydroelectric plants are highly dependent on predictable runoff patterns. Given that Nepal's electricity infrastructure heavily relies on hydropower, nearly 91 % of it, power generation in Nepal is under threat due to GLOF and high variability in run-off. Uncertainties in climate projections and lack of reliable hydrological records however in this case remain an important constraint for effective anticipatory planning.

Adaptation in the context of development

In Nepal, the Development Plan is accompanied by a Medium Term Expenditure Framework (MTEF) which provides a prioritization of resources and ensures consistency of annual budgets with the 5-year Development Plan. The sectoral MTEF papers for some of Nepal's vulnerable sectors lack consideration of climate change induced risks, for example the MTEF paper for the power sector does not recognize risks to hydropower plants due to the variability in runoff, floods (including GLOFs), and sedimentation.

As part of their ongoing development projects and plans, efforts are on to address risks related to GLOFs. According to the study, a preliminary discussion on prioritization of adaptation responses highlights potential for both synergies and conflict with development priorities. Micro-hydro, for example, serves multiple rural development objectives and could also help diversify GLOF hazards. On the other hand, storage hydro might conflict with development and environmental objectives but might be a potential adaptation response to increased variability in stream-flow and reduced dry season flows which are anticipated under climate change.

In line with the Bank's Power strategy and the government's revised Hydropower Development Policy, Nepal's hydropower potential is planned to be developed further to improve access to electricity in rural areas and promote private participation in the power sector. The Rural Energy Development Programme (REDP) in Nepal aims to enhance rural livelihoods and preserve the environment by supporting the installation of micro hydro power systems.

Conclusions: prioritization of issues, gaps, and the need for further research

With an increase in understanding on issues related to vulnerability and adaptation over time, there has been a strong mention of identifying the links between climate change vulnerability and adaptation and development issues. Initial concerns rose highlighting that climate change might have huge impacts on development projects and there is a need to incorporate climate concerns while planning them. The line of thought on issues developed further with the understanding that many development projects have the potential to enhance the resilience of communities to cope with climate variability and long term change, thereby promoting adaptation. An increased need is thus felt to identify initiatives promoted by governments or through bilateral and multilateral support for further strengthening keeping in mind long term goals on adaptation.

The high vulnerability of countries in South Asia can be highlighted by billions living in the region, so if disaster were to strike there is a tremendous loss to infrastructure, life and property. This is further marked by increased exposure of the region to occurrence of extreme events. GEO, 2002 states that the pace of development in the Asia-Pacific region is affected due to frequent occurrence of natural disasters including droughts, floods and cyclones. Trends have shown that in the past century there have been more than 3500 disasters in this region that has killed more than 27 million people. The threat increases with climate change. Environmental vulnerability is likely to be exacerbated by climate change, with higher temperatures, changed precipitation patterns, sea level rise, and greater intensity or frequency of extreme events. It has also been mentioned that global climate change might trigger similar changes or might result in even worse trends in the future.

Besides, agriculture has always been the mainstay of South Asian economies. It still contributes to nearly 25 % of the total GDP with a large proportion of people still dependent on the sector for a living. With most of the land still rainfed, the outputs from the sector is highly sensitive to the vagaries of weather.

Over the years, climate change research activities in South Asia have grown considerably in scope with most of the countries having submitted their initial national communications to the UNFCCC. The least developed countries are in the process of developing their NAPAs and others who are involved in

preparation of NCSAs. However, climate change so far is been studied in isolation of the broader development context.

This consultative exercise has revealed a variety of research gaps with sector-specific priorities listed below. The issues are similar to those highlighted in the India country report.

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A generic programme on capacity building of all the government officials on issues related to vulnerability to climate change and potential adaptation activities should be initiated on a regional scale. This is primarily a country-based programme, however may be greatly facilitated by a regional pool of experts/trainers and through development of a common regionally applicable training module. The information already available in the scientific domain can be collated and synthesized to develop a common regional training module. Once a pool of trained people are created in each country, subsequent trainings can be arranged in each country.

Dr Kishore Sherchand, Nepal

Points highlighted are as follows:

- Experts on climate change are still not competent. They need exposure and capacity building
- Follow up works are still scanty and not well planned
- Databases are weak. Remote sensing technology and modelling technologies non-existent due to no ownership of satellites
- Adaptation not well developed and need further research
- Overall, climate change studies and their application are not up to the mark. The government's attention and public awareness seem to be still weak
- Climate models unable to capture complex terrain features, and there is a need to develop models with such capacities

There is a need for greater understanding on the regional and local dimensions of vulnerability keeping in mind integrated approaches, building scientific and technological knowledge base on the modelling, impacts and vulnerability of climate change; awareness raising and capacity building at all levels in the society, focus on action-oriented research with involvement of all relevant stakeholders and concentration on sectors that have lacked thorough research so far.

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Annex 1: List of ongoing and completed climate change and development projects in South Asia

Bangladesh

1. The OECD Bangladesh study on Climate change and development

The project discusses in-depth policy responses and challenges faced in mainstreaming them with impacts of climate change on two critical systems: coastal flooding and the coastal mangrove forests of the Sundarbans.
http://www.**oecd**.org/data**oecd**/46/55/21055658.pdf

2. Studies undertaken for the reduction of flood related vulnerability

In response to the frequent problems associated with coastal flooding, both inside the embankments and outside, the Government of Bangladesh has undertaken measures to: (a) increase discharge capacity of the coastal rivers; and (b) deal with hindrances that do not allow passage of floodwaters from inside coastal embankments. A number of projects have already been completed and several more are currently underway.

- Khulna-Jessore Drainage Rehabilitation Project (KJDRP).

  Funded by the Asian Development Bank, the KJDRP was implemented between 1995 and 2000 under the aegis of the Bangladesh Water Development Board (BWDB). The principal objective of the project was to achieve the national goal of poverty reduction by reducing drainage congestion of the rivers and channels in the coastal districts of Khulna and Jessore; increasing agricultural production; and creating on-farm employment.
  http://www.adb.org/Documents/PCRs/BAN/pcr-ban-21087.pdf

- Coastal Embankment Rehabilitation Project (1996-2003)

  The World Bank-IDA, the EC and the Government of Bangladesh jointly funded this project. The overall objective of the project is to improve living conditions of the coastal population by taking a series of measures towards rehabilitation of coastal embankments. The measures of embankment rehabilitation include improved operation and maintenance of infrastructure; afforestation along embankments to facilitate land stabilization (creation of tree cover on the slope of embankments); and coastal (mudflat) afforestation.

http://www.dhvanr.com/apus/render.php?type=2&id=67&template=default&PHPSESSID=721ed68618a9ccb15d6ed15500641dda

- Noakhali Khal Re-excavation Protection Project (1999-2003)

The objective of the project was to protect coastal lands in the target areas from saline water intrusion, provide drainage facility, reduce cyclone damages, and increase crop production. BWDB is the implementing agency on behalf of the government.

- Meghna Estuary Study - Phases I and II (MES)

The long-term objective of MES is to understand estuarine processes, problems and opportunities so that the knowledge-base can be utilized for achieving the following:

i) to improve the physical safety and social security of the people living in the coastal areas and on the islands in the estuary; ii) to retain and increase the operational knowledge of the hydraulic and morphological processes in Meghna estuary; and iii) to develop appropriate approaches and techniques for efficient land reclamation as well as effective river bank protection measures.
http://www.kellnielsen.dk/fap5b.htm

On the basis of outputs of the study, the government promptly launched an Estuary Development Program (EDP) in July 2002, to be implemented by the Ministry of Water Resources. The general objective of the action program is to increase physical safety of the areas, thereby enhancing social security of the vulnerable people living in the estuarine areas.
http://www.iczmpbangladesh.org/profac/bwdb.htm#bwdb25

- Protection of towns and transportation infrastructure projects To protect important towns from tidal flooding, a number of projects have been undertaken by the MOWR. The important one's being;

  - Bhola Town Protection Project, been implemented over a period of about 11 years starting from 1992-93
  - Chandpur Town Protection Project, been implemented since 1997 to protect Chandpur town from erosion

Another set of projects that are synergistic with adaptation to climate change; involve the installation of adequate drainage

infrastructure along the coastal road network, a major means of adaptation towards facilitating flood drainage.

- Flood Drainage Rehabilitation Project in Completed Rural Development Project: Implementing Agency: ADB, major objectives of the project is to implant flood drainage infrastructure in rural roads which have been completed under the Rural Development Project-18 along the entire south-western region of the country.

http://www.adb.org/Documents/News/2000/pi2000164.asp

- Construction of Low Cost Bridge/Culvert in Rural Roads (Phase I & II): Beginning in 1995, a large number of small scale bridges and culverts, as required, have been constructed along rural roads under the project. Although the project has been designed to include the entire country, a good proportion of such drainage infrastructure has been built in the coastal areas.

http://www.lged.org/dev_activities/dev_activities.htm

3. Gorai River Restoration Project (GRRP)

The GOB implemented a two-phase project to resuscitate Gorai and restore its flow conditions by dredging the mouth of the river. The objective of the initial (feasibility) phase of the project was to prevent environmental degradation in the SWR, specifically around Khulna, the coastal belt and in the Sundarbans, by undertaking restoration of the Gorai river and hence ensuring freshwater flow in the wet season and augmenting these flows during the dry season. Based on the favorable findings of the initial phase, a number of engineering interventions have been recommended: - Flow Divider, Ganges Gorai revetment, training works along the Gorai and restructuring of river training works, Dredging of clay layers in the Gorai off take and Installation of bottom vanes.
http://www.wldelft.nl/proj/pdf/3uk00168.scherm.pdf

4. The Integrated Coastal Zone Management (ICZM) project, Government of Bangladesh.

This project offers great potential for the identification and implementation of future measures that would contribute to the overall process of coastal zone adaptation. In addition to making provisions for adaptation to coastal flooding, ICZM could also facilitate the future management of the Sundarbans forest. The ICZM Project Development Office (PDO) is currently undertaking a climate change study with the purpose of providing policy guidelines for integrating climate change vulnerability issues in projects relating to the coastal zones of Bangladesh. The ICZM project is also undertaking vulnerability

mapping of the coastal zone. The development of such a knowledge base could facilitate better incorporation of climate risks in future projects in the coastal zone.
http://www.iczmpbangladesh.org

In addition to the above-mentioned activities towards reducing coastal flood vulnerability, Bangladesh is contemplating to implement a number of activities in the coastal zone. Again, the general objective of each of these activities is not adaptation to climate change impacts. It may, however, be expected that these planned activities would be synergistic with adaptation to climate change. Several projects under the National Water Management Plan of Bangladesh have been identified which are expected to contribute to the future adaptation to coastal floods under climate change.

5. Trans-boundary dimension in addressing climate change adaptation

The study also highlights the importance of the trans-boundary dimension in addressing climate change adaptation. The effect of water diversion upstream on dry season flows and salinity levels in the Sundarbans was in fact comparable to (if not higher than) the impact that might be experienced several decades later as a result of climate change. Adaptation to climate change might therefore not just be local but might require cross-boundary institutional arrangements such as the Ganges Water sharing treaty to resolve the current problems of water diversion.

6. Initial National Communication in Response to its Commitments to UNFCCC. Implementing agency: UNEP, Finished 2002.

7. National Adapation Programme of Action, UNDP--Ongoing

The Initial National Communication (INC) to UNFCCC of Bangladesh has identified various sectors that are vulnerable to climate change. The INC also suggested sectoral adaptation measures, most of which constituted “no regrets” strategies. Bangladesh’s NAPA will build on these and other findings (including those in previous V&A studies) to identify and implement those adaptation activities requiring immediate and urgent action. These activities will be integrated within national and local economic and social development goals, plans and frameworks, especially in relation to rural citizens, the urban poor and other more vulnerable members and other facets of the community.
http://www.gefonline.org/projectDetails.cfm?projID=2026

8. National Capacity Self Assessment for Global Environmental Management, UNDP-- Ongoing

The primary goal of the NCSA process in Bangladesh is to identify, through a country-driven consultative process, priorities and needs for capacity building to protect the global environment.
http://www.gefonline.org/projectDetails.cfm?projID=2533

9. Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS), UNDP-- Completed.

The overall objective of the study was to enhance the existing national and regional capacity to develop least-cost greenhouse abatement strategies that promote environmentally sustainable economic development in twelve countries, namely: Bangladesh, Democratic People's Republic of Korea (DPRK), India, Indonesia, Mongolia, Myanmar, Pakistan, People's Republic of China (PRC), The Philippines, Republic of Korea (ROK), Thailand and Viet Nam.
http://www.gefonline.org/projectDetails.cfm?projID=385

10. World Bank: Bangladesh Climate Change and Sustainable Development (2000)

The World Bank report Bangladesh Climate Change and Sustainable Development (2000) aimed to mainstream adaptation in the regular development strategies and operations in Bangladesh. It reviewed possible climate change impacts in Bangladesh, but particularly focused on an overview of adaptation options for various sectors, including fairly specific suggestions for some of them. In addition, it includes a review of sixteen development activities (mainly by the ADB and the World Bank, and also by the Netherlands and DFID) in the light of adaptation to climate change.

11. CIDA/CARE Bangladesh Reducing Vulnerability to Environmental Change Project

CARE Bangladesh is conducting a project in Bangladesh's six coastal districts, working with 6000 rural households to improve resilience and reduce vulnerability to climate change. The main objectives of the study is to build local capacity to disseminate environmental change information and forecasts (including 600 farmer schools) and to extend proven grassroots techniques and measures to address climate change impacts.
http://www.careusa.org/careswork/projects/BGD076.asp

12. GEF/ ADB Biodiversity Conservation in the Sunderbans Reserved Forest Project

The main objective of this project is to protect the rich biodiversity of the Sunderbans and enhance the rural livelihoods of the local population, through sustainable natural resource management. Activities include (i) improvements in

the organization and management of the reserve; (ii) incorporation of biodiversity conservation considerations in fisheries and forestry, management of wildlife resources, and integrated conservation planning; (iii) increasing local support for biodiversity conservation by local communities through education, awareness activities, and ecotourism development, and (iv) establishment of biodiversity monitoring systems. The project is funded by a GEF grant (implemented through the World Bank) and the ADB, with co-financing from the Palli Karma-Sahayak Foundation, the Nordic Development Fund, the Netherlands, as well as the Bangladesh government, NGOs, and local beneficiaries.
http://www.adb.org/Documents/Profiles/LOAN/30032013.ASP

13. ADB Chittagong Hill Tracts Development Project

In accordance with Bangladesh's National Water Plan and Flood Action Plan (which was developed after the 1997/1998 floods), the project aims to improve the development of the water resources sector through participatory rehabilitation and management of small-scale water resources infrastructure, and will support policy work and sector reforms. It will assist stakeholders to form water management associations and to upgrade physical facilities including (i) flood management, (ii) drainage improvement, (iii) water conservation, and (iv) command area development.
http://www.adb.org/Documents/Profiles/LOAN/32467013.ASP

14. ADB Second Aquaculture Development Project-- completed
The report notes that Bangladesh's inland fisheries resources are among the richest in the world, due to the climate, water and soil conditions, particularly related to the annual flooding. However, fisheries have declined due to over fishing, and flood control and irrigation schemes. The project has addressed this decline in several ways.

15. UNDP Empowerment of Coastal Fishing Communities for Livelihood Security (2000-2005)
The project has three main objectives: (i) empowerment of communities, (ii) enhancement of socioeconomic capacity through savings, credits and income generation activities, and improved access to extension and social services, and (iv) improved capacity to cope with natural disasters. It also aims for sustainable conservation and management of coastal marine and estuarine fisheries resources and habitats.
http://www.un-bd.org/**undp**/factsheets/Fisheries.pdf

16. GEF/UNDP Coastal and Wetland Biodiversity Management at Cox's Bazar and Hakaluki Haor (2000-2007)
The main objective of this project is to establish an innovative management system for Ecologically Critical Areas (ECAs), which will help conserve biodiversity. It focuses on a coastal area as well as inland wetlands.
http://www.gefonline.org/projectDetails.cfm?projID=668

17. *UNDP Support to Disaster Management (1996 –2002) UNICEF/DFID/DENMARK*
This disaster management project mainly focuses on soft measures to reduce the impact of disasters in Bangladesh. In particular, it aims to increase awareness of practical ways to reduce disaster risks and losses, to strengthen national capacity for disaster management (with emphasis on preparedness), to enhance the knowledge and skill of key personnel with disaster management responsibilities, to establish participatory local disaster action plans in the most disaster prone areas, to promote local–level risk reduction measures, and to improve the effectiveness of warnings and warning dissemination systems.
http://www.adb.org/documents/ppars/ban/ppa_ban_18045.pdf

18. UNDP Comprehensive Disaster Management Programme (CDMP)
The project aims to establish a systematic approach to prediction, monitoring, protection, evacuation, land use zoning, and information dissemination to build adaptive capacity, which in turn requires comprehensive and appropriate information produced and delivered at the right time, to the right people and agencies. The climate change component will collect and update existing knowledge, increase capacity to predict climate impacts (based upon a regional climate model), establish an institutional system to disseminate knowledge and mainstream risk reduction, and improve the capacity to implement adaptation measures at national and local levels.
http://www.un-bd.org/**undp**/factsheets/CDMP.pdf

19. IFAD Income Diversification Project--- Ongoing
The project intends to address food insecurity and food production shortfalls by crop diversification and generation of other employment opportunities. It would take the homestead as its entry point, to target new opportunities to the wishes of the beneficiaries. The project would contain four main components: community development, agricultural development, credit facilities, and infrastructure improvement. The project is likely to contribute to vulnerability reduction, both directly and indirectly.
http://www.ifad.org/lrkm/region/pi/ba_280.htm

20. World Bank/GEF/DFID Aquatic Biodiversity Project--ongoing
The project aims to increase fish and shrimp production for domestic consumption and exports, consistent with sustainable resource management and with special emphasis on rural poverty alleviation, employment generation, improved capacity of local users to manage aquatic resources in a sustainable and equitable fashion, and conservation of aquatic biodiversity.

21. ADBJamuna-Meghna River Erosion Mitigation Project
The project aims to protect to vital irrigation systems, where riverbank erosion is threatening the embankments. Besides environmentally friendly structural measures, the project will also invest in riverbank erosion information management systems (including monitoring forecasting and warning), disaster preparedness and management support, social development support to vulnerable settlers in areas affected by riverbank erosion, and institutional capacity building. In this way, the project is highly likely to contribute to adaptation to current climate risks as well as climate change. The latter however, is not explicitly taken into account, and not mentioned anywhere in the document.
http://www.adb.org/Documents/Resettlement_Plans/BAN/Jamuna_Meghna_River/default.asp

Bhutan

1. National Greenhouse Gas Project - Completed
Funded by: GEF, Implemented by: UNDP.
The programme was a part of developing first National communication to the UNFCCC.The direct objective of this project was to reduce the rate of growth of greenhouse gas emissions in Bhutan. An institutional mechanism was developed to coordinate the activities that are necessary to develop policy options related to climate change and comply with the provisions of the UNFCCC, including the submission of Bhutan's First National Communication to the UNFCCC.
http://www.gefonline.org/projectDetails.cfm?projID=298

2. National Biodiversity Conservation Strategy and National Action Plan- Completed
Funded by: GEF, Implemented by: UNDP.
The project is operationally closed. The draft BSAP has been accepted by the CBD Secretariat as the national report to the Conference of the Parties-4.
http://www.gefonline.org/projectDetails.cfm?projID=193

3. Integrated Management of Jigme Dorji National Park- Completed
Funded by: GEF, Implemented by: UNDP.

This is a full project supporting the Royal Government of Bhutan in strengthening the integrated management of Jigme Dorji National Park, Bhutan's largest and one of the most diverse protected areas containing globally significant biodiversity. The project will be implemented according to two components. The first will strengthen Park management and the second will involve the incorporation of local communities within the Park in implementing a Community Natural Resource Management Plan.
http://www.gefonline.org/projectDetails.cfm?projID=192

4. Trust Fund for Environmental Conservation- Approved may-1991
Funded by: GEF, Implemented by: IBRD
The trust fund provides reliable recurrent funding for the establishment and management of a national system of protected areas, and development of the institutional and human resource capacities needed to manage the national system. This project is testing the feasibility of a trust fund mechanism for providing long-term, sustainable finance for biological conservation programs in the protected areas.
http://www.gefonline.org/projectDetails.cfm?projID=542

5. Climate Change Enabling Activity (Additional Financing for Capacity Building in Priority Areas) Funded by: GEF, Implemented by: UNDP.
The programme involves: Technology Transfer: (I) Identification/submission of technology needs (ii) Capacity Building to assess technology needs, modalities to acquire and absorb them, design, evaluate and host projects B. Capacity building for participation in systematic observation networks C. Studies leading to the preparation of national programs to address climate change improvement of emission factors.
http://www.gefonline.org/projectDetails.cfm?projID=1364

6. National Adaptation Programme of Action (NAPA) Funding: GEF, Implementing agency: UNDP- Ongoing.
http://www.gefonline.org/projectDetails.cfm?projID=2352

7. National Capacity Self-Assessment for Global Environmental Management- Ongoing
Funding: GEF, Implementing agency: UNDP - Ongoing.
http://www.gefonline.org/projectDetails.cfm?projID=1781

8. Linking and Enhancing Protected Areas in the Temperate Broadleaf Forest Eco- region of Bhutan (LINKPA)- Ongoing
Funding: GEF, Implementing Agency: WWF Bhutan.
To strengthen management of biological corridors and protected area network in the broadleaf forest eco-region based on a landscape scale conservation approach.

http://www.gefonline.org/projectDetails.cfm?projID=1852

9. Assessment of Capacity Building Needs and Country Specific Priorities in Biodiversity – Ongoing
Funding-GEF, Implementing Agency- UNDP.
http://www.gefonline.org/projectDetails.cfm?projID=1567

10. Improved Community Cooking Stove – an alternative to mitigate fuel wood pressure in North Trashigang
Bhutan Youth Development Association (BYDA), an NGO in Trashigang. Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The project seeks to gradually but drastically reduce fuel wood consumption in North Trashigang. The project is based on the fact the local people can be made aware on their environmental problems and its adverse consequences, and take timely action to address these problems through joint community efforts.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

11. Ringphu Sustainable Development Project – Ongoing
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP.The main objective of the project is to prevent deforestation and increase the forest cover of Ringphu village. Through this objective they aim to improve the living condition of the community school as well as the local community involved.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

12. Community Based Initiatives for Resources Management in Dhaksa - Ongoing
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The main aim of the project is to conserve the forest of Dhaksa area from deforestation in the long run. The project's objective is to install improved stoves in the Community School, establish rural water supply system to benefit the local communities of proper Gongdu, Tshamlabi, Basic Health Unit and the RNR Center.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

13. Silambi Natural Resources Conservation & Management Project - Ongoing
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The project aims to conserve the local environment and to improve the living condition of the local communities of Silambi geog. Their main objectives are: prevent local forest from further depletion by

using the fuel efficient stoves, increase forest cover by plantations and to create awareness among school children and local people on the importance of natural resource conservation.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

14. Serzhong Water Supply and Forest Conservation Project- Ongoing
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The project aims to prevent deforestation and improve the living condition of local population through sustainable development. Their main objective is to save the local forest from deforestation by cutting down the consumption of fuel wood and thus saving the life expectancy of the local trees. They would also carry out plantations to improve the forest cover and create awareness among local people and students on importance of conservation of natural resources.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

15. Tsakaling Forest and Water Catchment Conservation Project - Ongoing-
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The project aims to protect the three water catchment areas (Thowangchu, Lamchutor, and Gangkalamjug) in Tsakaling Village, which are at risk of drying up due to human activities. Not only this, the biodiversity of the area and livelihood of the Tsakaling village are also likely to be degraded with out the conservation initiatives at this juncture.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

16. Karsa Yungma Water Catchment Management & Water Supply Project- Ongoing-
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The main objective of the project is to regenerate Karsa Yungma water catchment in order to sustain and revive the volume of drinking water for Pang Communities and for the main Nagor village communities.

16. Replicating Environmental Friendly-Measures by Promoting Sustainable Livelihoods in Mongar Dzongkhag- Ongoing-
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The project seeks to help the farmers of Mongar Dzongkhag to take-up activities that is sustainable and look for an alternative source to generate

income in the households and depend less on the natural resources and help replicate the natural environment in the long run.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

17. Kholongchu River Bank Protection Project at Bumdeling -Ongoing-
Global Environment Facility Small Grants Programme (GEF/SGP) Project, Implemented by UNDP. The project seeks to conserve the natural environment for sustainable development by containing of the river waters of Kholongchu and Nagpola into the paddy fields, which also is a winter habitat of the rare and endangered Black-Necked Cranes.
http://www.undp.org.bt/GEF/SGP/project_portfolio_info_sheet.htm

18. For ICIMOD literature on GLOFS in Bhutan
http://www.rrcap.unep.org/glofbhutan/choose/choosemain.htm

Maldives

1. National GHG Inventory and Vulnerability Assessment for the Maldives: Completed
It was the first project developed and executed for climate change, in order to build the capacity of Maldives to meet the obligations of the UNFCCC. With funding from Global Environment Facility (GEF), UNDP provided the assistance to carry out activities that would specifically enable Maldives to meet its reporting obligation under the UNFCCC. At the end of the project in 2001, a national inventory of GHG sources and sinks and a national assessment of the vulnerability of Maldives to climate change and sea level rise were identified. National options for mitigation and alternative options for adaptation to climate change and predicted sea level rise were identified and an implementation plan was developed.
http://www.gefonline.org/projectDetails.cfm?projID=310

2. Renewable Energy Technology Development and Application Project (RETDAP)
Funding: GEF, Implementing Agency-UNDP, Ongoing
The objective of the proposed exercise is to assist the Government of Maldives in defining and if possible, formulating and finalizing an OP-6 Full Project Brief to submit for GEF financing in the promotion of renewable energy. Depending on the conclusions drawn and recommendations made after the completion of the pre-project development activities, a project brief either for a PDF-B Proposal or Full Project Brief, whichever is deemed relevant.

http://www.gefonline.org/projectDetails.cfm?projID=1029

3 National Adaptation Plan of Action (NAPA) Funding GEF, Implementing Agency: UNDP Ongoing
The objective of the programme is to develop a country-wide programme that cover the immediate and urgent adaptation activities that address the current and predicted negative impacts of climate change, including extreme events.
http://www.gefonline.org/projectDetails.cfm?projID=2353

4. Assessing Technology Needs to Address Climate Change (TNA) Implementing agency: UNDP-Ongoing
The goal of the TNA is to provide the basis for policy choices, which direct and guide selection, adoption, implementation and use of sustainable technologies that will assist Maldives to address issues of climate change. A TNA will typically produce a portfolio of technology transfer projects and undertake capacity-building activities to facilitate and accelerate the development, adoption and diffusion of sustainable technologies in particular sectors, enterprises, locations and communities
http://www.climatetech.net/events/pdf/issues_paper_tna.pdf

5. National Capacity Self-Assessment (NCSA) for Global Environmental Management Funding: GEF, IMPLEMENTING agency: UNDP, Ongoing
The principal objective of the NCSA process is to identify and assess critical capacity constraints and to develop a prioritised overview of capacity needs in the area of global environmental management. In addition to the overall objective of developing a comprehensive, nationally-driven assessment of capacity development needs, the NCSA process will also assist the Government of the Maldives in attaining a number of secondary objectives. These include: ·Better understanding and responding to critical cross-thematic environmental challenges such as the problem of sea-level rise and coastal erosion. Gaining an improved understanding of resource limits and carrying capacities, particularly in key economic sectors such as tourism and fisheries.
http://www.gefonline.org/projectDetails.cfm?projID=1835

6. Renewable energy based economic development. SPV/ Wind based rural community development centres in remote islands in the Maldives- UNIDO, Ongoing
The immediate objective of the project is to set up two renewable energy based pilot community development centres (CDC) at two of the selected islands powered by renewable energy hybrids and provide the following services: - provide lightning and necessary power to run primary health centres - vocational training and market/enterprise/employment

information services directed at economically active population - information services to help revitalise the local and traditional industries - use of wind/solar hybrid distillation systems as a means of drinking water supply in the island (if found feasible) - provide more employment opportunities to women in pursuing traditional crafts thereby increasing opportunities for income generation.
http://www.unido.org/en/doc/25115

7. National Biodiversity Conservation Strategy, and Action Plan and Country Report to the CBD Focal area- Biodiversity. Funding- GEF, Implementing Agency- UNDP, Completed
Maldives met its obligations under the Convention on Biological Diversity and prepared its first national report to the Conference of the Parties.
http://www.gefonline.org/projectDetails.cfm?projID=210

8. Atoll Ecosystem-based Conservation of Globally Significant Biological Diversity in the Maldives' Baa Atoll
Funding- GEF, Implementing Agency- UNDP, Ongoing
The goal of the Project is to work with island communities to identify and remove threats to Biodiversity in selected atolls.
http://www.gefonline.org/projectDetails.cfm?projID=1099

9. GCRMN Project
The Global Coral Reef Monitoring Network (GCRMN) is a global, interagency initiative under the stewardship of the Intergovernmental Oceanographic Commission of UNESCO, UNEP, IUCN and the World Bank. Its aim is to aid the long-term development of coral reef monitoring programmes in all coral reef countries. Since 1997 the UK Department for International Development (DFID) has provided funds to IOC-UNESCO to develop the GCRMN in 3 countries in South Asia - India, Sri Lanka and the Maldives. During the first phase of funding there was a focus on awareness raising and the development of capacity for biophysical monitoring across the region. A second phase of funding begun in 1999 and an emphasis was placed on recognising the importance of socio-economic monitoring for the effective management of coral reefs, this phase ended in 2002 and a third dimension has been added to the work of the GCRMN South Asia. This is designed to develop the understanding within South Asia of the process of converting information into action. This is in response to the realisation that few attempts at using information to inform and influence reach the right people in the right format to stimulate the kind of change that is needed.
http://www.gcrmn.org

10. CORDIO: Coral bleaching and mortality: Assessment of the extent of damage, socio-economic effects, mitigation and recovery.
CORDIO is an operational program under ICRI (International Coral Reef Initiative). It is supported by Sida (Swedish International Development Cooperation Agency), the Government of Finland, the Dutch Trust Fund of the World Bank, WWF (World Wide Fund for Nature) and IUCN (World Conservation Union). The CORDIO project is focused on research and monitoring of coral reefs of the Indian Ocean. CORDIO is implementing about 45 projects in 11 Indian Ocean countries (Kenya, Tanzania, Mozambique, Madagascar, Mauritius, Seychelles, Comores, Reunion, Maldives, Sri Lanka, India). About 50 scientists at local institutions in these countries carry out the projects.
http://www.cordio.org

Nepal

1. Enabling Activities for the Preparation of Initial National Communications Related to the UNFCCC. Completed.
Nepal Ratified the UNFCCC in July 2004. With support from UNEP it began preparing its initial national communications to comply with the provisions of UNFCCC. This project covered a sectoral vulnerability and Adaptation Assessment in Nepal and identified the further research needs in different sectors.
http://www.gefonline.org/projectDetails.cfm?projID=453

2. OECD Development and Climate change, Nepal: Completed.
The project was jointly overseen by the EPOC Working Party on Global and Structural Policies (WPGSP), and the DAC Network on Environment and Development Co-operation (ENVIRONET). The overall objective of the project was to provide guidance on how to mainstream responses to climate change within economic development planning and assistance policies, with natural resource management as an overarching theme.
http://www.oecd.org/dataoecd/6/51/19742202.pdf

3. UNEP/ICIMOD GLOF inventorization, Completed.
This three-year study was a collaboration between UNEP and the International Center for Integrated Mountain Development (ICIMOD) in Katmandu. It concluded that as a conservative estimate, 20 glacial lakes in Nepal (and 24 in Bhutan) are at high risk of bursting their banks in the coming five years, causing the so-called Glacial Lake Outburst Floods (GLOFs). The rising GLOF risk is attributed to increased glacier melt related to global warming. Adaptation options include engineering works to reduce water levels in the lakes, and early

warning systems to alert people in the region about impending floods.

4. Austrian Development Cooperation GLOFS research project, Completed.
A research project funded by Austrian Development Cooperation also analyzed GLOF risks in Bhutan and Nepal. The research in Bhutan also included the design of mitigation measures, including the erection of protection walls for some of the houses downstream, the installation of an early warning system (at the study site, floods are estimated to take seven hours to reach the main populated areas), the introduction of a hazard zonation concept, as well as awareness raising.

5. Participatory Disaster Management Programme, (PDMP) UNDP, completed.
This programme was started in December 2001 and ended in May 2004. Although the main consideration of the project was Disaster management and prevention, it indirectly also addressed the component of Adaptation to climate change. PDMP was implemented in 11 VDCs and one municipality in 6 disaster prone districts of Nepal. The main focus of the programme was to build capacity of the Self Governing Community Organizations on Sustainable disaster management.
http://www.undp.org.np/projects/pdmp/index.php

6. Climate change and Development: Nepal
Focus on water resources and Hydropower. By- Shardul Agrawala, Vivian Raksakulthai, Maarten van Aalst, Peter Larsen, Joel Smith and John Reynolds. Organisation for Economic Co-operation and Development (OECD), 2003. Analysis of recent climatic trends reveals a significant warming trend in recent decades, which has been even more pronounced at higher altitudes. Climate change scenarios for Nepal across multiple general circulation models meanwhile show considerable convergence on continued warming, with country averaged mean temperature increases of 1.2°C and 3°C projected by 2050 and 2100. Warming trends have already had significant impacts in the Nepal Himalayas – most significantly in terms of glacier retreat and significant increases in the size and volume of glacial lakes, making them more prone to Glacial Lake Outburst Flooding (GLOF). Continued glacier retreat can also reduce dry season flows fed by glacier melt, while there is moderate confidence across climate models that the monsoon might intensify under climate change. This contributes to enhanced variability of river flows. A subjective ranking of key impacts and vulnerabilities in Nepal identifies water resources and hydropower as being of the highest priority in terms of

certainty, urgency, and severity of impact, as well as the importance of the resource being affected.

7. Climate change: water resources and hydropower. The most critical impacts of climate change in Nepal can be expected to be on its water resources, particularly glacial lakes, and its hydropower generation. Water supply infrastructure and facilities are at risk from increased flooding, landslides, sedimentation and more intense precipitation events (particularly during the monsoon) expected to result from climate change. Greater unreliability of dry season flows, in particular, poses potentially serious risks to water supplies in the lean season. Hydroelectric plants are highly dependent on predictable runoff patterns. Therefore, increased climate variability, which can affect frequency and intensity of flooding and droughts, could affect Nepal severely. GLOF and increased run-off variability threatens the potential for hydropower generation. GLOFs have already been associated with the loss of a newly built multi-million dollar hydropower facility in 1985, as well as significant loss of other infrastructure such as bridges, roads, livelihoods, and human life. Given that Nepal's electricity infrastructure heavily relies on hydro power - nearly 91% of the nation's power comes from this source – a reduced hydropower potential might imply that Nepal will have to seek for alternative sources of power generation, including from fossil fuel sources. In other words, failure to adapt to climate induced risks to hydropower might also be critical from the perspective of greenhouse mitigation. However, uncertainties in climate projections and lack of reliable hydrological records remain an important constraint for effective anticipatory planning.

8. Climate Change Impact Study on Himalayan Glaciers/Tibetan Plateau. Ongoing
This project is initiated at the regional scale, including Nepal, China and India, where climate change impact study will conduct on Himalayan Glaciers and the Tibetan Plateau. WWF Nepal Program will focus on Ngozumpa and Khumbu Glaciers in the Khumbu region. WWF India will work on Dokriani and Chhota Shigri glacier for the impact study. WWF China will focus on climate change impact at the water source of theYangtze River at the Tibetan Plateau.
http://www.panda.org/downloads/climate_change/himalayaglaciersreport2005.pdf

9. Climate Witness Project, WWF Nepal Ongoing
Through the Climate Witness Project, WWF Nepal Program will work together with local communities to collect and document climate impact stories from the region with proper scientific validation. It will generate discussion, participation and action on climate issues from the general public and various

stakeholders to policy makers. It will also enable spokespeople from impacted local communities, to travel and tell their stories to different international audiences. The focal areas of this project are Sagarmatha National Park (SNP) and Kangchenjunga Conservation Area (KCA).
http://www.worldwildlife.org/climate/projects/witness/nepal.cfm

10. Rural Energy Development programme, Implementing agency UNDP. Ongoing
Rural Energy Development Programme (REDP) (started in 1996) has promoted a holistic approach for promoting rural energy systems in the form of micro-hydro; solar power; biogas; and improved cooking stoves, in the remote villages, which do not have access to the national gridline. The support has been significant in developing national and local capacity for decentralized energy planning and policy reform in the favour of rural energy development in Nepal.
http://www.undp.org.np/projects/redp/index.php

11. Strengthening disaster management capacity in Nepal. UNDP ongoing
This programme aims at strengthening the Disaster management capacity in Nepal from local community levels to strengthening the institutional and policy mechanisms. The programme framework includes developing national and local capacity for managing disaster risks by undertaking disaster trend analysis, preparing GIS based hazard map and district disaster management plans in the pilot districts.
http://www.undp.org.np/projects/sdmc/index.php

12. Power development project (World Bank) Approved
In line with the Bank's Power strategy and the government's revised Hydropower Development Policy, it aims to develop Nepal's hydropower potential, improve access to electricity in rural areas, and promote private participation in the power sector. Bilateral donors (USA, Germany, Norway) will provide technical support to prepare the investment pipeline, while the World Bank will take the lead in providing investment funding for private development of small- and medium-sized hydro plants.
http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000094946_01041107222025

13. National Capacity Self-Assessment (NCSA) for Global Environment Management
Implementing agency UNDP. Approval date: January 10, 2005
The main goal of the project is to identify, through a country-driven consultative process, priorities and needs for capacity

building to protect the global environment, taking into account the three global conventions on biodiversity, climate change and desertification/land degradation, and also to explore synergies among and across these areas to direct actions towards achieving the goal of sustainable development.
http://www.gefonline.org/projectDetails.cfm?projID=2222

14. An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts
In Nepal, India and China, WWF Nepal Program, March, 2005
This overview report is the product of a regional level project "Himalayan Glaciers and River Project" initiated by WWF Nepal Program, WWF India and WWF China Program to develop a regional collaboration and to formulate a coordination strategy to tackle the climate change impacts on glaciers and to address the mitigation and adaptation options.
WWF sees the impacts of climate change on glaciers and its subsequent impact on freshwater as a major issue, not just in the national context but also at a regional, transboundary level. The WWF offices in Nepal, India and China are taking the initiative to develop a regional collaboration to tackle climate change impacts in the glacial ecosystem and address adaptation measures. This report is the outcome of a regional collaboration of the three countries, providing an overview of climate impacts on glaciers with a focus on key areas that needs future intervention.
http://www.panda.org/downloads/climate_change/himalayaglaciersreport2005.pdf

Some important literatures on Climate Change Issues for Nepal (Published)

OECD report on Development and Climate Change Project (2003) (The study has identified water resources and hydropower as the most significant in terms of vulnerability to climate change) –really good report on climate change with reference to hydro resources.
http://www.iges.or.jp/en/from/cop10/adaptation/oecd.pdf

o National Communication Report by Department of Hydrology and Meteorology submitted to Ministry of Population and Environment as requirement to United National Framework Convention on Climate Change (UNFCCC) (2004) http://www.mope.gov.np/environment/pub.php

o Clean Energy Nepal's Climate Change Fact Sheet, (2003) http://www.cen.org.np

o ICIMOD's Inventory of Glaciers, Glacial Lakes and GLOFs: Monitoring and Early warning systems in the Hindu Kush Himalayan Region (2001)

o Institute of Environmental and Social Transition, USA & Nepal 'Adaptive Capacity and Livelihood Resilience: Adaptive Strategies for responding to Floods and Droughts in South Asia' http://www.i-s-e-t.org/asproject/

o Asia Pacific Network Project/Institute for Development and Innovation' Global Change Impact Assessment for Himalayan Mountain Region for Environmental Management and Sustainable Development' - http://www.idi.org.np/activities.html#global

Pakistan

1. Enabling Activities for the Preparation of Initial National Communications Related to the UNFCCC- Completed
Funded by: GEF, Implemented by: UNEP. This project assisted the national Government to comply with the provisions of the UNFCCC.
http://www.gefonline.org/projectDetails.cfm?projID=489

2. Fuel Efficiency in the Road Transport Sector-Completed
Funded by: GEF, Implemented by: UNDP
Project seeks to reduce emissions through improving vehicle fuel efficiency and urban infrastructure, based on well-known methods, which Pakistan does not currently have capacity to implement. Builds capacity of officials to review transport options, expands pilot project to tune-up urban vehicles, evaluates ongoing programs, and develops options with regard to technology transfer, regulations and pricing.
http://www.gefonline.org/projectDetails.cfm?projID=391

3. Sustainable Development of Utility-Scale Wind Power Production (Phase 1)-Ongoing. Approval date: March 22, 2004,
Funded by: GEF, Implemented by: UNDP
The overall project objective is to facilitate a low C02 path for development through establishing and demonstrating commercial viability of a package for widespread harnessing wind energy in remote areas.
http://www.gefonline.org/projectDetails.cfm?projID=1260

4. Expedited Financing for Interim Measures for Capacity Building in Priority Areas (Phase II). Funded by: GEF, Implemented by: UNEP. Approval date: December 11, 2003
http://www.gefonline.org/projectDetails.cfm?projID=2408

5. National Capacity Needs Self-Assessment for Global Environmental Management in Pakistan-Ongoing. Funded by: GEF, Implemented by: UNDP Approval date: July 17, 2003
http://www.gefonline.org/projectDetails.cfm?projID=2177

6. Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS)- Completed Funded by GEF, Implemented by UNDP. A regional project including Pakistan apart from other Asian countries. The project's development objective was to limit the growth of GHG emissions from Asia and to build a substantial pool of expertise in the region for addressing issues of global climate change. Expertise was developed in areas such as estimation and measurement of GHGs, identification of technologies and initiatives for reducing GHGs, and economic and social analyses for identifying cost-effective mitigation options, GHG abatement initiatives and develop/implement least cost abatement strategies.
http://www.gefonline.org/projectDetails.cfm?projID=385

7. Country Case Studies on Climate Change Impacts and Adaptations Assessment - Phase I
A global project consisting of Antigua and Barbuda, Cameroon, Estonia & Pakistan. Completed. Implementing Agency- UNEP, Funded by GEF.
The objective of the project was to test and improve methodologies and guidelines through a series of country studies for assessing climate change impacts and adaptation.
http://www.gefonline.org/projectDetails.cfm?projID=167

8. Protected Areas Management Project- Completed Funded by GEF, Implemented by: IBRD. The project worked at improving the participatory planning and management of three priority protected areas -- Hingol, Machiara and Chitra Gol National Parks -- across a range of ecosystem types.
http://www.gefonline.org/projectDetails.cfm?projID=87

9. First National Report to the CBD and establishment of a CHM- Completed Implementing Agency- UNEP, Funded by GEF.This project assisted the national Government to meet its obligations under the Convention on Biological Diversity.
http://www.gefonline.org/projectDetails.cfm?projID=430

10.Mountain Areas Conservancy Project (MACP)- Ongoing Funded by GEF, Implemented by UNDP.
The objective of the project is to support the conservation of biodiversity in Krakoram-Hindu Kush in the western Himalayan Mountain in northern Pakistan. This is an area approximately 1.1 million ha in size in four montane ecological zones. One site on the confluence of the Himalaya and

Karakoram ranges is famous for more than 250 varieties of medicinal plants and species, including the endangered Kot (costus roots). Another site in the alpine habitats is an important flyway for over 200 species of birds. Project activities would include the development of Village Conservation Plans; education and awareness campaigns, training in monitoring the impacts of wildlife resource use, village ecodevelopment, and establishment of a trust fund to cover the recurrent cost of implementing the village conservation plans.
http://www.gefonline.org/projectDetails.cfm?projID=505

11. Conservation of habitats and species of global significance in Arid and Semi-arid Ecosystems in Balochistan- Ongoing, Funded by GEF, Implemented by UNDP.
The Project Objective is to promote conservation and sustainable use of globally significant habitats and species in the Torghar and Chagai Conservancies. The immediate objectives are 1) To raise awareness of local communities and stakeholders about biodiversity conservation and sustainable use of natural resources. 2) To create an enabling environment for community based biodiversity conservation and natural resources management. 3) To build institutional capacity of local communities, NGOs, and government institutions to conserve and make sustainable use of biodiversity. 4) To strengthen the Conservancies and establish management regimes for conservation and sustainable use of biodiversity 5) to diversify and improve rural livelihoods and reduce pressure on habitats through better agro-pastoral practices and sustainable resource use alternatives.
http://www.gefonline.org/ projectDetails.cfm?projID=1721

12. Protection and Management of Pakistan Wetlands – Ongoing Funded by GEF, Implemented by UNDP.
The project shall strengthen government and local capacity to protect, and manage the selected representative and globally significant wetland ecosystems, to ensure sustainable human development maximizing ecological and economic benefits for the present and future generations.
http://www.gefonline.org/projectDetails.cfm?projID=1257

13. Promoting Best Practices for Conservation and Sustainable Use of Biodiversity of Global Significance in Arid and Semi-arid Zones- Ongoing Funded by GEF, Implemented by UNDP.
It's a global project covering Burkina Faso, Mali, Nigeria, Senegal, Egypt, Jordan, Kuwait, Morocco, Syria, Tunisia, Mongolia, Pakistan, Brazil, Jamaica, and Mexico. The project will identify and disseminate best practices for conserving and sustainably using biodiversity of global significance in the arid & semi-arid ecosystems of 15 countries worldwide.
http://www.gefonline.org/projectDetails.cfm?projID=23

14.The Sindh Programme: IUCN
The goal of the Sindh Programme is to provide “Good governance for the sustainable development of Sindh”. Under this general vision it incorporates and builds upon ongoing projects of IUCNP in Sindh, and also it undertakes a majority of new initiatives in collaboration with members and partners. To achieve this end, the Sindh Programme works within the following priority technical areas: Coastal and Marine, Freshwater, Forestry, Biodiversity. Under the above priority technical areas, the programme concentrates on the following: Ecosystem Management: For example Manchar Lake and/or Narro & Jabba, Water: Wetlands, coast, mangroves/riverine forests, drought management, Climate Change, Sustainable Agriculture and agro-biodiversity, Arid Land Management and Sustainable Use initiatives In all of the above, gender is a crosscutting theme.
http://www.iucn.org/places/pakistan/sp.htm

15.The Balochistan programme: IUCN
(March 2002-Feb 2007), funded by Royal Netherlands Embassy, aims at improving the quality of life of people through strengthening the institutional and human capacity in the province for sustainable and equitable use of natural resources. While poverty alleviation and gender sensitivity are the cross cutting themes, the programme works, through different kinds of means and partnerships, on knowledge management, empowerment and governance in the Forest, Water and Rangeland sectors of the province. While working in Gawadar and Qila Saifullah districts of the province, the programme also aims at working on some innovative water related projects.
http://www.iucn.org/places/pakistan/bp.htm

18.Environmental Rehabilitation Project in NWFP and Punjab (ERNP)- IUCN
Environmental Rehabilitation in NWFP and Punjab (ERNP) was a seven-year (1996-2003) Project funded by European Union (EU), Government of Pakistan and local communities. It was executed by the Department of Forestry, Fisheries and Wildlife, Government of NWFP, Murree Kahuta Development Authority and Department of Forestry, Fisheries and Wildlife, Government of Punjab. The project was implemented in cooperation with IUCN - The World Conservation Union, with Agriconsulting S.p.a. (Italy) providing specific technical assistance. Its overarching goal was to halt and reverse the ongoing process of environmental degradation. In line with the National Conservation Strategy (NCS) the project methodology was based on the use of integrated measures of rehabilitation of natural resources, and sustainable socio-economic development. Thus the fundamental approach is the full

involvement of the local population in the management of their resources.
http://www.iucn.org/places/pakistan/ernp.htm

16.The Pakistan Environment Programme (PEP)
Initiated in July 1994, this programme has supported the twin purposes of (a) capacity building of the partner organizations themselves as the key institutions for sustaining the environment agenda in Pakistan, and (b) capacity building for the environment in the country at large, through activities of the PEP partners. The goal of PEP is to "improve Pakistan's capacity to achieve environmentally sustainable forms of economic and social development." This is consistent with the country's aspirations for a rich natural resource base that will both fuel more equitable and sustainable economic development for the benefit of its people and make a positive contribution to a healthy global environment. The Program was implemented for seven and a half years, with an extension of three years commencing from December 2002.
http://www.iucn.org/places/pakistan/pep.htm

17.Programme Support for Northern Pakistan (PSNP)
Programme Support for Northern Pakistan is a watershed agreement between the SDC and IUCN Pakistan. This marks the shift after a decade of productive partnership, from project mode of financing to programmatic support. PSNP runs concurrently with the run off SPCS Support Project to benefit from, and carry forward the essential institutional mechanisms developed over the past three SPCS support phases. It is also unique in being a sub-national framework support covering Northern Areas along with NWFP. Its governing philosophy is the integration of IUCNP initiatives in Northern Pakistan and subsequently to include all NRM/sustainable development initiatives funded by SDC and other environmental donors. The Programme support has two distinct objectives and two distinct sets of target beneficiaries. The objectives include institutionalization of a culture of learning, remembering and reorientation through effective knowledge management and promotion and sustainability of sustainable development processes and initiatives in Northern Pakistan.
http://www.iucn.org/places/pakistan/psnp.htm

18.The Sustainable Development Networking Programme
This programme started in 1992 by UNDP and managed by IUCN. It has been working since then to promote access to information on sustainable human development by different sectors of society. At the time SDNP was established, there was little electronic networking in Pakistan and so it took on the role of a pioneer in promoting the use of electronic mail and networks. Thus SDNP has been instrumental in initiating a

number of activities to help achieve the development objectives of the project and to promote sustainable human development. It has made some efforts to improve the implementation of Agenda 21 through the NCS in Pakistan by facilitating increased access to information, knowledge and expert advice and by increased communications between stakeholders locally, nationally and globally.
http://www.iucn.org/places/pakistan/sdnp.htm