Climate Change Impacts in South Asia

A consultancy report prepared for the South Asia Research Facility and AusAID

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"Adaptation to climate risks needs to be treated as a major economic and social risk to national economies, not just as a long-term environment problem" - Warren Evans, Environment Director at the World Bank (World Bank, 2006, p. 5)

Executive Summary

This report is the result of a desk-top study commissioned by the South Asia Research Facility to provide AusAID with advice on climate change issues in individual countries (Pakistan, Bangladesh and Nepal) and for South Asia as a region, to inform its policy and program development process.

Climate change poses a serious threat to development in South Asia, particularly in those areas where environmental, social and economic systems are already compromised. Most of the world's poor reside in South Asia and they will be especially susceptible to any disruption associated with climate change.

The report shows that Pakistan, Bangladesh and Nepal each have particular needs when addressing the challenges that climate change poses. The report outlines what other development partners (including other donors, whole of government, significant NGOs) and national organizations are doing bilaterally and regionally.

The report concludes with the recommendation that while Australian development assistance to region will need to take the reality of climate change much more fully into consideration, it must do so while addressing the social, economic and political causes of environmental degradation and uneven development.

This report recommends the following:

- AusAID should review its existing programs to see if they are vulnerable to future climate impacts and to see if they are able to flexibly respond to future predictions and uncertainties.

- AusAID should make stronger investment in programs which tackle poverty and disaster preparedness in the short term and which will also be increasingly valuable in addressing climate change into the future. The individuals who constitute South Asia's poor may not see long term climate change without more immediate investment in primary health care, sanitation, potable water and disaster mitigation. Strategies which address poverty and vulnerability with a view to long term sustainability under climate change scenarios potentially offer win/win solutions.

- Substantial new Australian ODA funding (in addition to existing ODA commitments) should be invested in climate change adaptation initiatives in the region.

- Adaptation options pursued in the Australian development program should be integrated with other development efforts and be broadly aligned with the targets outlined in the MDGs.

- Adaptation to climate change should be tackled in a manner that addresses its trans-boundary nature: Regional coordinated strategies are required to cope with the impacts of climate change. As Australia is a small donor to South Asia, the current

strategy of working in broad partnership with multi-lateral development agencies where possible is supported.

- Mitigation of climate change in South Asia should be primarily sought as a secondary benefit from programs whose central aim to address the development needs of the region. Mitigation is primarily the responsibility of those countries who contribute the highest per-capita emissions of green-house gases. Consequently mitigation efforts should focus on assisting South Asian nations "leapfrog" old technologies and embed new low carbon infrastructure into their economies. For example, Australian aid to the energy sector should only fund projects that improve energy efficiency, improve demand management and/or increase the proportion of renewable energy.

- Australian aid should have an increased focus on tackling deforestation and enabling reforestation in South Asia and this should become a stronger priority (preferably as part of a multilateral effort) for aid to the region.

- A stronger priority should be given to governance issues associated with the adaptation and mitigation of climate change impacts.

- Education should remain a priority for assistance for the region and should build on the initiatives outlined in the United Nations Decade on Education for Sustainability.

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Introduction

In many developing countries today the issue of climate change is overshadowed by a number of immediate development priorities...includ[ing] poverty eradication, food and water security, health, natural resource management, energy acess, transportation needs, and local air and water pollution. (Halsnæs & Verhagen 2007, 666)

This report examines the impacts that currently observed trends in changing climate will have on the development of South Asian nations. The evidence presented shows that of the raft of environmental issues that threaten to derail development strategies in the South Asia region, climate change is perhaps the most pervasive problem, since it threatens all areas of the region, from the Himalayas to coastal zones, even threatening the very existence of nations such as the Maldives (UNEP 2002, 29).

Climate change poses a serious threat to development in South Asia, particularly in those areas where environmental, social and economic systems are already compromised. Biodiversity, agriculture, water supplies and coastal ecosystems are all likely to be negatively effected. Most of the world's poor reside in South Asia, where the majority of them reside in rural areas (Cruz et al 2007, 494). Impoverished populations lacking sound infrastructure, economic strength and adaptive capability will be highly susceptible to any disruption associated with climate change (Alam and Murray 2005, 3). However political tensions, economic hardships and risk of disease and injury to which these many of these people are exposed in the present often overpower the projected impacts of climate change 50 or 100 years into the future.

The report in particular focuses on the South Asian countries of Pakistan, Bangladesh and Nepal. It shows that each of these countries have particular needs when addressing the challenges that climate change poses. The report outlines what other development partners (including other donors, whole of government, significant NGOs) and national organizations are doing bilaterally and regionally.

The report concludes with the recommendation that while Australian development assistance to region will need to take the reality of climate change much more fully into consideration, it must do so while addressing the social, economic and political causes of imminent environmental degradation and lop-sided development. It is likely that climate change will impinge on sustainable development of most developing countries of Asia as it compounds the multiple pressures on natural resources and the environment associated with rapid urbanisation, industrialization and economic development (Cruz et al 2007, 471).

The report outlines a number of recommendations on areas of focus for a new Australian environment program in South Asia with a focus on mainstreaming sustainable development policies and the inclusion of adaptation and climate-proofing in development strategies of the South Asia region so as to reduce pressure on natural resources and improve management of environmental risks.

Structure of the Report

The report starts with a brief summary of the latest global climate change predictions and the likely impacts on the South Asia region. In the second section the report looks at the counties of Pakistan, Bangladesh and Nepal in more detail and examines the particular impacts climate change is likely to have on their development. In the third section the report outlines the priorities for tackling climate change in these three

countries, targeting adaptation, disaster risk mitigation as the key areas. Due to the low per capita emission of these countries the focus is primarily on adaptation but it also looks at opportunities for mitigation and reductions in greenhouse gas emissions through greater efficiency and better governance.

The fourth section describes the international cooperation efforts which address climate change through mitigation or assist countries to adapt. It describes the main multi-lateral programs and briefly describes how some bilateral partners of South Asia mainstream adaptation to climate change across their Official Development Assistance programmes.

The fifth section briefly describes the nexus in Australian Development Assistance to South Asia and Climate Change. A concluding section suggests how Australian development assistance to the South Asia region can best assist Bangladesh, Pakistan and Nepal to meet the enormous challenges of climate change.

Climate Change – Predictions for the South Asia Region

In late 2007 the Intergovernmental Panel on Climate Change released its *Fourth Assessment Report.* It stated that "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC 2007, 5). The IPCC's overall projections included increases in sea level rise, increases in precipitation in high latitudes and decreases in sub-tropical latitudes, continuing the current pattern of drying in some regions. Increases in temperature are likely to be above the global average throughout sub-Saharan Africa, eastern Asia and South Asia. In many water-scarce regions, climate change is expected to further reduce water availability through increased frequency of droughts, increased evaporation and changes in patterns of rainfall and runoff (UNDP 2007, 90).

This section briefly outlines some of the major implications of climate change in the South Asia region which in its entirety includes Afghanistan, Pakistan, Bhutan, Nepal, India, Bangladesh, Sri Lanka and the Maldives. It will look at key impacts including temperature, rainfall, coastal zones, freshwater availability, agriculture, human health, and ecosystem health. A section of the report presents case studies on three countries in which these impacts will be examined in more detail.

Temperature

Throughout the last century there was already significant warming in the South Asia region. For example, coastal Pakistan warmed by 0.6–1.0°C over the 20th century (CSIRO 2006, 16). During 2005, Bangladesh, India and Pakistan experienced temperatures 5–6°C above the regional average, in consequence of which there were 400 reported deaths in India alone, though unreported deaths would multiply this figure many times over (UNDP 2007, 108).

The Fourth Assessment Report of the IPCC suggests South Asia will be 3.3°C warmer in the period 2080 to 2099 than it was between 1980 to 1999 (Christensen et al. 2007, 881), and that it will experience fewer very cold days (Christensen et al. 2007, 879). Median warming is likely to be greater in winter, ie December to February (3.6°C) than from July to August (2.7°C).

Rainfall

While the projected changes in rainfall vary significantly across the region it is likely that summer precipitation will increase in South Asia. Precipitation in winter, i.e. December, January and February (DJF), will decrease (Cruz et al 2007, 478). It is estimated that by 2030 winter (DJF) rainfall will be 10% less in southern Asia, extending from Pakistan across India, Southeast Asia, and southeast China. Then by 2070 southern India and Southeast Asia rainfall will be approximately 20-30% less at the time of the northeast winter monsoon. Most models agree that there will be reductions in rainfall in Arid and Semi-Arid Asia and South and Southeast Asia from December through May; (CSIRO 2006, 23-24). Thus the intensity of rainfall events will increase, particularly over northern Pakistan, northwest and northeast India, Bangladesh and Myanmar as the number of rainy days decreases (Christensen et al., 2007, 884).

As a result, the expansion of areas under severe water stress will be one of the most pressing environmental problems in South Asia in the foreseeable future, particularly as the number of people living under severe water stress is likely to increase substantially in absolute terms (Cruz et a,l 2007, p484), while the probability of seasonal flooding will increase.

The temperature and precipitation changes for South Asia reported in the Fourth Assessment Report of the IPCC are summarised in Table 1 below (Cruz et al. 2007, 475):

Table 1: Observed changes in temperature and precipitation for Nepal, Bangladesh, Pakistan and Sri Lanka

Country	Temperature change	Precipitation change
Nepal	0.09°C p.a. in Himalayas 0.04°C in Terai More in winter	None observed in records from 1948-1994
Bangladesh	Increased about 1°C in May and 0.5°C Nov from 1985-1998. Temperatures will increase about 1°C in the hot dry summer (May) and 0.5°C going into Winter (November).	Decadal rain anomalies above long term averages since 1960s
Pakistan	Since early 1900s increased 0.6-1°C in coastal areas	In hyper-arid plains and coastal belt 10-15% decrease In northern areas increased summer and winter precipitation over last 40 yr.
Sri Lanka	0.016% increase per year from 1961 – 1990 over whole country 2 degrees increase per year in central highlands	Increasing trend in Feb and decreasing trend in June

Coastal Zones

Even under the most conservative scenario, sea level will be about 40 cm higher than today by the end of 21st century and this is projected to increase the annual number of people in coastal populations who experience flooding from 13 million to 94 million. Almost 60% of these people will live in South Asia, along coasts from Pakistan, around India, Sri Lanka and Bangladesh to Burma. This is especially the case for Bangladesh where high numbers of poor people living in low lying coastal and riparian areas are extremely vulnerable to rising sea levels. An extrapolation from 1986 data to 2100 suggests that a sea level rise of 1.5m would affect 13 million people, with additional impact from short term effects of storm surges (Castro Ortiz, 1994). Tol (2002) estimated approximately 2.3 million migrants will be displaced from South and Southeast Asia as a result of 1 metre of sea-level rise. (CSIRO 2006, 49). If sea levels rise as projected in the most extreme scenario proposed by the International Panel for

Climate Change in their Third Assessment Report, the Maldives will be completely submerged by 2100 (Hay, Suarez, Wong, Briguglio, & Ragoonaden, 2001).

Projected sea-level rise is very likely to result in significant losses of coastal ecosystems and will have substantial impacts on people along the coasts of South Asia will likely be at risk from flooding. Sea-water intrusion is likely to increase the habitat of brackish water fisheries but coastal inundation is likely to seriously affect the aquaculture industry and infrastructure particularly in heavily-populated mega-deltas (Cruz et al 2007, 471).

Fresh Water

Expansion of areas under severe water stress will be one of the most pressing environmental problems in South in the foreseeable future as the number of people living under severe water stress is likely to increase substantially in absolute terms. (Cruz et al. 2007, 484) Climate change will be superimposed on wider pressures on water systems. Many river basins and other water sources are already being unsustainably 'mined'. Today, around 1.4 billion people live in 'closed' river basins where water use exceeds discharge levels. Symptoms include rapidly falling groundwater levels in South Asia and mounting conflicts over access to water. Dangerous climate change will intensify this water stress (UNDP 2007, 95).

The result is that freshwater availability in South Asia, is likely to decrease due to climate change, along with population growth and rising demand that could adversely affect more than a billion people in Asia by the 2050s (Cruz et al. 2007, 471). Take the following examples: the flow of the Indus, which receives nearly 90 percent of its water from upper mountain catchments, could decline by as much as 70 percent by 2080; The Ganges could lose two-thirds of its July–September flow, causing water shortages for over 500 million people and one-third of India's irrigated land area; Projections for the Brahmaputra point to reduced flows of between 14 and 20 percent by 2050 (UNDP 2007, 96)

Fresh water supplies in South Asia are also likely to be affected by saline intrusion in coastal areas. Drainage capacity will be reduced while water logging increases. There will be associated losses in agricultural productivity and an increased incidence of certain water borne diseases. Disruptions to tidal and seasonal patterns of river flows will increase riverbank erosion, often in areas where urban slums are crowded. The intensity of natural events such as flooding and cyclones is expected to increase (Alam and Murray, 2005, 9).

Agriculture

Climate change will affect agricultural productivity directly through changes in average and minimum temperatures, precipitation and evapotranspiration. Most studies indicate agricultural production in South Asia will be harmed under conditions of warming of less than 2°C (for example Peng et al., 2004). Warming of 2–4°C will cause yields of cereal and rice production in South Asia to decline 4 to 10% (CSIRO 2006, 43).

Agricultural production is likely to suffer most in those areas dominated by rain-fed production, on which two in every three rural people are still dependent (UNDP 2007, 99, 178). The drop in yields of non-irrigated wheat and rice will be significant for a temperature increase greater than 2.5°C, incurring a loss in farm-level net revenue of between 9% and 25% (Lal, 2007).

Although increases in summer rainfall alone may benefit crop production and commercial forestry in South Asia, crop stress from rising temperatures may offset such benefits, particularly for rice. Areas currently experiencing water crisis are likely to experience significant land degradation and loss (CSIRO 2006, 6).

In Bangladesh and Nepal climate change is likely to reduce food security with the result that increasing amounts of food will need to be imported (Alam and Murray, 2005, 11).

Glacial Melting

Glaciers cover about 17% of the Himalayan mountains and their melting feeds perennial rivers such as the Indus, Ganga and Brahmaputra: the lifelines to millions of people in Pakistan, Nepal, Bhutan, India and Bangladesh. Himalayan glaciers are receding so fast they are likely to disappear by 2035 (Cruz et al 2007, 493).

Accelerated glacial melt creates some immediate human development risks, such as avalanches and floods which pose special risks to densely populated mountain regions (UNDP 2007, 96). Several Glacial Lake Out Flow (GLOF) events have occurred in Nepal and the Hindu Kush-Himalayan region where they have trans-boundary impacts (Mool, 2001). However, in the very long run, loss of glaciers will mean loss of water reservoirs for the major river systems of the region.

Human Health

Future climate change is likely to continue to adversely affect human health in Asia. The frequency of occurrence of climate-induced diseases and heat stress in South Asia has already increased with rising temperatures and rainfall variability. Natural habitats of vector-borne and water-borne diseases are likely to expand as environments become warmer and wetter (Cruz et al 2007, 471).

Diarrhoeal diseases and outbreaks of other infectious diseases (e.g., cholera, hepatitis, malaria, dengue fever) may be influenced by climate-related factors in association with non-climatic factors such as poverty, lack of access to safe drinking water and poor sewerage system (Cruz et al 2007, 478). However, endemic morbidity and mortality from diarrhoeal disease is linked primarily to poverty and hygiene behaviour and only compounded by the effect of high temperatures on bacterial proliferation (Checkley et al., 2000).

Predictions of increased intensity of summer rainfall with potential for increased flooding will increase disease risk in the region's rapidly growing urban centres, where disposal of sewage and refuse and provision of potable water are difficult in flood conditions.

Decreasing winter rainfall in the Bengal Basin could increase the use of groundwater, causing increased drawdown of water tables which has been implicated in the mobilising of Arsenic in the groundwater, which already affects up to 76 million people drinking groundwater in the delta.

Climate Related Disasters

The number of reported disasters has increased steadily over the past 50 years, as has the number of affected individuals. For the period 2000–2004, flooding affected the lives of some 40 million in South Asia. (UNDP 2007, 76)

It is expected that climate change will further increase the occurrence of extreme weather events. Even though the linkage between climate change cyclone intensities is not yet explained, modelling studies consistently project increases in cyclone intensity

as global temperatures increase. (CSIRO 2006, 36). An increase of 10 to 20% in tropical cyclone intensities for a rise in sea-surface temperature of 2 to 4°C relative to the current threshold temperature is projected for South Asia (Knutson and Tuleya, 2004).

Ecosystem Health

Increased risk of extinction for many flora and fauna species in Asia is likely as a result of the synergistic effects of climate change and habitat fragmentation and key wetlands and mangroves around Asia are likely to be increasingly threatened (Cruz et al 2007, 471)

Recent risk analysis of coral reefs suggests that between 24% and 30% of the reefs in Asia are likely to be lost during the next 10 years and 30 years, respectively (Cruz et al 2007, 471). Over 34% of the vast and diverse coral reefs of Asia that are of immense ecological and economic importance to this region particularly in South, South-East and East Asia are reported to have been lost in 1998, largely due to coral bleaching induced by the 1997/98 El Niño event. The destructive effects of climate change compound the human induced damages on the corals in this region. A substantial portion of the vast mangroves in South Asia have also been reportedly lost during the last 50 years of the 20th century, largely due to human activities (Zafar, 2005). However reduction of freshwater flows and salt-water intrusion in the Indus delta and Bangladesh has already resulted in severe destruction of mangroves (IUCN, 2003a).

As the above summary outlines, the impacts of climate change on the South Asian region are largely detrimental from a development and poverty reduction perspective and they pose massive challenges for the region's sustainable development. In the next section this report looks specifically at the impacts of climate change on Bangladesh, Nepal and Pakistan.

Country Studies

Bangladesh

The likely flooding of large parts of Bangladesh has become a central focus for anyone interested in the impacts of climate change. Already the periodic cyclones and floods in Bangladesh bring the vulnerability of this country to extreme weather events to public attention around the world[1]. The plight of the 12.1 million people who are projected to be affected by a 30 to 50cm rise in sea level brings a human perspective to the international debates about global warming.

Geography and Environment of Bangladesh

Bangladesh became an independent country in 1971: bounded on its western, northern and eastern borders by India and sharing a small section of border with Burma in the south-east. The Bay of Bengal lies to its south. Bangladesh and the Indian state of West Bengal share the Bengal Delta - formed from the siltation of the Ganges-Brahmaputra-Meghna (GBM) river system, which is one of the world's largest freshwater outfalls.

More than two thirds of its 130,170 sq.km of land area (United Nations Department of Economic and Social Affairs 2006, 59) is less than 5m above mean sea level (Agrawala, Ota, Ahmed, Smith, & van Aalst 2003, 14). The hilly areas of Sylhet (north-east) and the Chittagong Hill Tracts (south-east) are the only areas elevated above 30m above m.s.l. (Agrawala et al. 2003, 9).

Population and Economy

The population of Bangladesh in 2005 was estimated at 142 million, of whom 35.5% were under the age of 15 (United Nations Department of Economic and Social Affairs 2006, 58). The population is growing by 1.9% per annum. In the 30 years to 2005 the proportion of the population classified as urban has risen from 10 to 25%, ie from 7.3 million to 35.2 million people.

Less than half of all adults in Bangladesh are functionally literate: 30% of females and 49% of males (United Nations Department of Economic and Social Affairs, 2006). However, enrolment in primary school is 87.7% in secondary school 46.5% (United Nations Department of Economic and Social Affairs 2006, 58).

Current climate of Bangladesh

Located in the sub-tropical region, Bangladesh has a "humid, warm and tropical" climate (Agrawala et al. 2003, 11) with over 80% of annual rainfall coming with the south-west monsoons during June-August. Very little precipitation is received from November to March. The highest rainfall of 4,500mm occurs in the northwest, and precipitation gradually declines to 1500mm in a gradient to the west (Choudhury, 2005). Winter temperatures as low as 5°C, allow a range of crops such as potatoes and wheat to be grown.

Bangladesh is particularly vulnerable to cyclones formed by differential heating of the atmosphere by the Central Asian land mass and cooling by the Indian Ocean water mass. Low pressure cells are funnelled up into the Bay of Bengal where the shallow waters cause formation of extreme tidal surges. On landfall the wall of surging seawater can move unhindered up the vast expanses of relatively open water in the delta

and across the low lying land. Twenty major cyclones occurred between 1876 and 1991 (Agrawala et al. 2003, 14). The human and economic loss in cyclones is exacerbated by the density of population living less than 5m above mean sea level and a lack of any form of shelter capable of providing refuge to other than a tiny proportion of the affected population.

Increased interception of trans-border river flows have also results in the emergency release of flood waters from dams impacting downstream populations who have no communication with the water managers (Donald, 2001).

Flood control, mitigation and disaster management have a long history in Bangladesh, but have been subject to increased debate since the major flood of 1988 (Khalequzzaman, 1994), in particular over the extent to which structures and mechanical controls should be constructed (Khalequzzaman, 1994).

Bangladesh energy use and emissions profile

Over 65% of energy consumed in Bangladesh is produced from biomass fuel, most of which is burned for cooking and heating (TERNA Wind Energy Programme 2007, 10). However, a reported increase in forest cover of 1.33% in the decade 1999 to 2000 (UNEP 2004, 36) supports observations that the biomass is largely derived from agriculture and non-timber forest/woodlot products. The next major source of energy is natural gas, which contributed 66% of energy derived from fossil fuels. It follows then that Bangladesh's net emissions of CO2 come from combustion of natural gas and oil.

Electricity generation in Bangladesh is mostly (95%) derived from thermal energy conversion using steam turbines powered by natural gas (85.5% of all fuel used for electricity generation). By mid-2006 there was about 5.3 GW of installed electricity generating capacity (TERNA Wind Energy Programme 2007, 1). This capacity is only able to supply 32% of the population and they are not guaranteed power 24 hours a day (TERNA Wind Energy Programme 2007, 3). Load shedding is common and increasing (World Bank 2007, 28). The Bangladesh Rural Electrification Board (REB) aims to reach 84% of the rural population by 2020. Currently only 19% or rural households are electrified, the remainder mainly use kerosene for lighting (TERNA Wind Energy Programme 2007, 12).

Although the Bangladesh Council of Scientific and Industrial Research has been promoting biogas since the mid 1980s, its use is not widespread. GTZ's TERNA survey (2007, 11) suggests 25,000 units had been installed by 2004, but the problem is to keep household systems operating.

Bangladesh had over 50,000 photovoltaic systems in use by 2004, and their use in small affordable units for lighting and television/radios is promoted by Grameen Shakti (energy) one of the Grameen non-profit micro-finance organisations (TERNA Wind Energy Programme 2007, 11).

The UN estimated CO2 emissions to be 29.25 million metric tons in 2000, which equates to 0.2 tonne per capita per annum (United Nations Department of Economic and Social Affairs 2006, 59).

Climate change in Bangladesh

Temperature

Between 1985 and 1998 temperatures in Bangladesh increased about 1°C in the hot dry pre-monsoon season (May) and 0.5°C going into winter (November) (Cruz et al. 2007,

475). Analysis of results from 11 Climate Models suggests that by 2050 temperature in winter will increase more (1.6°C) than in the monsoon season (1.1°C in June-August) (Agrawala et al. 2003, 13).

Rainfall

Rainfall is likely to increase by 6.8% in the wet monsoon season (June-August) but decrease 1.7% in the dry winter months (December to February). These twin trends are predicted to continue at a similar rate through to 2100 (Agrawala et al. 2003, 13).

Rising sea level

Cruz et al (2007, 484) point out that in spite of general predictions that sea levels will rise 2 to 3 mm per annum on a global scale, the relative sea level rise along a given coast depends on "thermal expansion, tectonic movement [and] ground subsidence" in addition to the global trend. Processes of siltation, subsidence and tectonic activities are likely to continue in Bangladesh.

A CSIRO estimate that a 30 to 50cm rise in sea level would result in a loss of 15,568 sq km of land, thereby affecting 12.1 million people (CSIRO 2006, 68). Others estimate a rise in mean sea level of 30-100cm by 2100 (Agrawala et al. 2003, 15). A one metre rise in sea level would inundate around 30,000 sq. km or 14% of the landmass (CSIRO 2006, 32).

In addition to direct inundation by the sea there will be increased erosion resulting in receding shores and enhanced "back water effect" in the estuaries of the main rivers particularly as a result of high tides, storm surges or cyclones (Ali 1999, 114). This reduces the gradient of the discharging rivers and increases flooding upstream.

Erosion is likely to be a direct result of sea level rise, however coastal erosion and accretion, just like river bank erosion and char accretion, have occurred for centuries, being the causal processes by which the delta formed and has been continuously reshaped. Simplistic generalisations like "Erosion, coastal land subsidence, siltation of river estuaries, reduced sedimentation, water-logging and saltwater intrusion will all increase as a result [of "sea level rise...due to global warming"] (New Economics Foundation 2007, 19) need to be seen in the historical context of these processes. In the period 1976 to 1990 the Bangladesh "coast and the Meghna delta were relatively stable" even though accretion and erosion were both occurring (Hoque 2006, 56). Dove and Khan (1995, 450) point out that char lands used to be cultivated on a seasonal basis, but increasing levels of landlessness or land poverty have resulted in the increasing formal settlement since the 1950s. This results in increasing numbers of people affected by the erosion of chars and islands.

While Bangladesh with its vulnerability to flood and tidal surges is often regarded as a source of "climate refugees" (Goering, 2007), Ali (1999, 115) argued almost a decade ago that "retreat is not possible", but the affected population would need to find ways adapt. However people from Bangladesh have tried to migrate to neighbouring states and further for many decades, and this will probably increase.

Even without rising sea levels inundation is already a major issue. About 18% of the surface area of Bangladesh (145,000 sq. km) (Chowdhury & Ward 2003, 335) is inundated each year as a matter of course and up to two-thirds of the country can be covered in floods (Agrawala et al. 2003, 16). The agricultural systems of Bangladesh have relied on the annual inundation and siltation processes and adaptation to flooding is deeply embedded in Bangladeshi life and culture (Dove & Khan, 1995). Although

the average annual rainfall is around 2,278mm (Agrawala et al. 2003, 13), intense and sophisticated agricultural systems have developed to make the most of all available land, so variations in the timing of onset, peak and retreat of the floods can have devastating consequences.

Impacts of Climate Change in Bangladesh

Human Health

Health in Bangladesh is related to socio-economic factors which influence access to adequate nutrition, safe drinking water and sanitation and primary health care.

Zooplankton in the estuaries of the Ganga and Brahmaputra rivers act as a reservoir for cholera pathogens and an increased sea surface in the Bay of Bengal has been implicated in the increased incidence of cholera (McMichael & Githeko 2001, 472-473).

Cyclone and storm surges cause drowning deaths in Bangladesh (Confalonieri et al. 2007, 398), so increased intensity of such events projected by climate change models has potential to increase loss of life due to drowning. When displaced by cyclone and floods people are exposed to increased risk of diarrhoeal disease and respiratory infection, and deprivation and economic consequences of a disaster manifest in malnutrition of children (McMichael & Githeko 2001, 459).

Agriculture

Increasing temperature of 2-4°C for Bangladesh may decrease wheat and rice yields but an increase of 4°C could reduce rice production by 30 percent and wheat production by 50-percent. (CSIRO 2006, 43). Increased winter temperatures may also decrease yields and possibly preclude cultivation of some of the winter vegetables which have cold temperature thresholds.

As a consequence of changes in distribution of rainfall, water will be an increasingly limiting factor in agricultural production and in the drier areas in the west and north, domestic water needs will be more difficult to meet in winter and the pre-monsoon hot summer. In 2001 52% of all cropland in Bangladesh was already irrigated (United Nations Department of Economic and Social Affairs, 2006), mainly by extracting groundwater.

Nepal

Geography and Environment of Nepal

Nepal is a small landlocked country, sandwiched between the India in the south, west and east and China to the north. The geography and environment of Nepal is very diverse and although Nepal occupies only 0.03 % of the total land surface of the earth, it has nearly 4.3 % and 8.5 % of mammalian and bird species of the world's total respectively (MPE Nepal 2004, 11).

Population and Economy

The 2001 census reports the population of Nepal was 23.15 million and expected to grow to 28.58 million by 2011 (CBS Nepal 2001). Population growth and decreasing land productivity has triggered migration within Nepal, mainly to the Terai where almost 48% of the population now lives (OECD 2003, 37).

The economy of Nepal is heavily dependent on agriculture (contributing 40% of GDP in 2000) and tourism (contributing 15% of exports in 2000) – both of which rely on natural resources and climate patterns and hence are vulnerable to climate change (Agrawala et al. 2003, 11). Agriculture provides a livelihood for over 80 % of the population, and about 80 % of the total population depends on the forests for daily fuel wood supply (MPE Nepal 2004, 9).

Rice, wheat and maize are the most dominant cereal crops and the rice-wheat cropping system is by far the most important and dominant cropping system. Different cropping patterns, adapted to altitude, are in use in Nepal. In the high Himalayas only 2% of the land is suitable for cultivation, with further area suitable for pasture or grazing lands. Short duration crops like potato, buckwheat, barley and mustard are grown mostly in summer. The middle mountains rice/wheat rotations are cultivated in the irrigated lands and maize/millet or maize/soybean in the rain fed lands. In the lower lying areas rice/wheat is the most dominant cropping pattern. (MPE Nepal 2004, 75)

Despite a tourism industry centred on its world-renowned natural beauty, Nepal is one of the poorest countries in the world, with 82.5% of the population living below the international poverty line of $2 per day (World Bank 2003). The UNDP's *Nepal Human Development Report 2004* (UNDP 2004) reports that Nepal's Human Poverty Index was 39.6, higher than that of other South Asian countries, except Bangladesh and Pakistan (UNDP 2004, 18). The Human Development Index in Nepal's urban areas outstrips that of the rural hinterlands where the majority of the population lives. Rural poverty (42.0) surpasses urban poverty (25.2) and it is also higher in the mountains.

Current climate of Nepal

Nepal has great climate diversity, from sub tropical Terai to arctic mountains. Nepal lies mostly within the monsoon region so the variations in climate are the result of elevation. Nepal receives a major portion of its rainfall during summer monsoon from June to September, and the annual run off from total drained areas is estimated to be 202 billion m^3 (MPE Nepal 2004, 11). The monsoon rains move from southeast to northwest, resulting in higher rainfall in the eastern areas. Whilst the total amount of rain is high, the distribution is varied and localized floods and droughts are not uncommon (Agrawala et al. 2003, 12). During the dry season glacial melt is an important source of fresh water in the streams (WWF Nepal 2005, 3).

About 6,000 rivers and streams including three major basins Sapta Kosi, Karnali and Narayani basin drain the country (MPE Nepal 2004, 11). All the rivers that flow through Nepal finally reach the Ganga in India. It has been estimated that river discharge from Nepal contributes up to 70 percent of water in the Ganga during dry seasons, and a significant change in the flow and quality of the water would affect some 500 million people downstream and the 37 percent of India's irrigated land fed by the Ganga (WWF Nepal 2005, 27).

Nepal energy and emissions profile

Only about 31% of households have access to electricity (UNDP 2004, 40) so 92% of Nepal's primary energy consumption in 1994-95 came from biomass (ARRPEEC 1998, 10). Fuel wood, agricultural residues and animal wastes accounted for 75%, 16% and 9% respectively of the biomass energy consumption in that year, mostly in traditional stoves (92%) (ARRPEEC 1998, 17).

Hydropower contributes over 90% of Nepal's electricity generation (Agrawala et al. 2003, 38) and electricity consumption is expected to grow at 12% per annum between 1996 and 2010 (ARRPEEC 1998, 2). There are coal reserves which would compete with hydro to meet the demand gap.

Nepal's Initial National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change (MPE Nepal 2004) estimated that Nepal's net emissions of CO2 were 9,747 Gg for the base year 1994/95. The total CO2 emission from fossil fuel consumption in the base year was estimated at 1,465 Gg. The biggest contributor to this was the transport sector at 31%, followed by the industrial sector at 27%, the residential sector at 22%, and the commercial sector at 11%. The remaining 9% was contributed by agriculture.

Nepal's emissions minus land use change are ranked 121 in the world. (WRI 2007).

Net emissions of CO2 from the land-use change and forestry sectors were about 8,117 Gg in the base year 1994/95. The total methane emissions in Nepal were estimated at 948 Gg which included emissions from the agriculture sector (enteric fermentation in livestock, rice cultivation and livestock manure management), energy related combustion activities (biomass burning, incomplete combustion of fossil fuel), solid waste disposal and wastewater treatment (MPE Nepal 2004, 35). Since methane has 21 times the Global Warming Potential of CO2, methane had double the impact of all CO2 emissions from Nepal in 1994/95 (MPE Nepal 2004, 17).

Climate Change in Nepal

Temperature

The temperature trend analysis presented in Nepal's *Initial Communication to the Conference of Parties of the UNFCCC* shows an increase of 0 to 0.5° C per decade for 1981-1998, except for small pockets in the eastern region and far western Terai (MPE Nepal 2004, 70). The warming in Nepal is more pronounced at high altitudes in the Middle Mountain and the High Himalaya, while warming is significantly lower or even absent in the Terai and Siwalik regions. Warming is more pronounced in winter than other seasons (Cruz et al. 2007, 475). These trends have implications for the rate of melting of glaciers located in the High Himalaya. Recent studies suggest that "warming

in the Himalayas has been much greater than the global average of 0.74°C over the last 100 years" (Jianchu, Shrestha, Vaidya, Eriksson & Hewitt 2007, 4).

Rainfall

The impacts of climate change on rainfall in Nepal are mixed. Most of the Terai belt and western Nepal will see a negative trend in rainfall in future (a maximum decrease of <300 mm per decade). Rainfall will increase in the hills and mountains of west Nepal and northern belt of eastern Nepal with a maximum increase of 1100 mm per decade, and a maximum negative trend will be observed in the eastern and central part of Nepal with the magnitude < 700 mm per decade. The mountains and mid hills in the west will be hotter and wetter, while the mountains and mid hills in the central and eastern regions will be hotter and slightly drier. Variable changes to the summer monsoon are likely to result in higher rainfall in the summer months and a drying in the winter months (CSIRO 2006, 16). The result of these trends in combination is an overall increased variability in stream flow (Agrawala et al. 2003, 32) across the country.

Glacial retreat

The temperature increases already observed in the high Himalayas will continue, ensuring glacial retreat will also continue. Glaciers in the Himalaya are receding faster than in any other part of the world (Cruz et al. 2007, 493). At the present rate of warming, they are likely to disappear by 2035 and perhaps sooner (WWF 2005, 35).

Glacial retreat and the resulting formation and increase in volume in glacial lakes has been recorded and monitored. WWF Nepal report that the Khumbu Glacier, on the climbing route to the summit of Mt Everest, has retreated over 5 km since 1953 when it was first climbed (WWF Nepal 2005, 2).

During a glacier retreat, there is a high probability of formation of new lakes, as well as merging and expansion of existing ones at the toe of a valley glacier. In the Dudh Koshi sub-basin of Nepal the total number of lakes has decreased by 37% but their total merged area has increased by 21% (Bajracharya, Mool, & Shrestha, 2007). As the area of these lakes continues to increase from melting glaciers, their downstream areas are at increased risk of Glacial Lake Outburst Floods (GLOF).

As well as increased risk of GLOF, the retreating snowline has further implications for river flow with an increase likely during the hotter monsoon times and decreased flow during cooler low-flow winter season (MPE Nepal 2004, 96) further contributing to the variability in stream flow predicted from rainfall changes. It is suggested that the accelerated melting of glaciers will cause an initial increase in river flows the next few decades, followed by a reduction in water availability as the ice available diminishes (WINROCK 2007; Cruz et al. 2007, 471).

Impacts of Climate Change in Nepal

Human impacts from disasters – floods, landslides and GLOF

In the Himalayan region, the frequency of the occurrence of GLOF events has increased in the second half of the 20th century. Accelerated retreat of glaciers in recent times has led to an enlargement of several glacial lakes as discussed above. The retreating glaciers leave behind large voids. Ponds of melted glacier water (glacial lakes) occupy the depression vacated by glacier ice, which then increases the risk of causing GLOFs (WWF Nepal 2005, 3). Out of 2323 glacial lakes reported in Nepal, 20 were found potentially dangerous (Bajracharya et al. 2007, 23, 25).

Large areas of Nepal are already prone to flooding and landslides due to the topography and rainfall patterns of Nepal. The accelerated melting of glaciers and changes to river levels will lead to a higher incidence of flooding[2] and landslides, until the predicted decrease as glacial melting subsides (Cruz et al. 2007, 471).

Human Health

As temperatures increase, the frequency, severity, and duration of extreme heat events is likely to increase (CSIRO 2006, 36). In areas of Nepal this will be of concern in areas where high temperatures already exist, such as the Terai region although it has been predicted that the temperature increases in the Terai will not be high. For Nepal the increase in temperatures at high altitudes will likely reduce the human health risks from cold temperatures. In addition as there are warmer temperatures there would be a decreased use of fuel wood for heating, thus reducing the respiratory diseases associated with inadequate ventilation and burning of fuel wood for heating in enclosed spaces (Bajracharya et al. 2007).

Many vector-borne and water-borne infectious diseases are known to be sensitive to changes in climatic conditions. Diarrhoea, Dysentery and Malaria, Kala-azar and Encephalitis are already the top five diseases in Nepal (MPE Nepal 2004, 112) and climate change is likely to have an impact on these.

The predicted temperature increases are likely to result in both an increase in cases of vector borne diseases such as Malaria, Kala-azar and Encephalitis in areas where these diseases are currently found as well as a tendency for them to be found at higher altitudes. (WINROCK 2007) The subtropical and warm temperate regions of Nepal would be particularly vulnerable to malaria and Kala-azar and the subtropical region of Nepal will also be more vulnerable to Japanese encephalitis. (MPE Nepal 2004, 112, WWF Nepal 2005, 28) However there is a degree of uncertainty in this area and effects may not be clear for some time (Agrawala et al. 2003, 18).

In addition to the vector borne disease impact from climate change, the increase in runoff and soil erosion due to increased rainfall will reduce the quality of the water that is available, which is likely to increase the prevalence of water borne diseases such as diarrhoea and dysentery (Jianchu et al. 2007).

Water Resources

Runoff from melting glaciers and snow in the dry season supplies lower altitude communities with water for drinking, irrigated agriculture, hydropower, industrial processes, and of course maintains river and riparian habitat. Agrawala et al. found that Nepal's water resources sector was the most vulnerable to climate change impacts. This is due to two main factors – melting glaciers and the increased variability of runoff from both glacial melting and rainfall patterns (Agrawala et al. 2003, 6). As noted it is suggested that the accelerated melting of glaciers will cause an initial increase in river flows the next few decades, followed by a reduction in water availability as the ice available diminishes (WINROCK 2007, Cruz et al. 2007, 171). This will have particular impact on dry season river flows. By 2000, it was already reported that Kathmandu experiences water stress, and ensuring adequate water resources for all of the country's various uses will become an increasingly urgent issue (Agrawala et al. 2003, 37).

Hydropower

As well as the direct human and agricultural impacts from reduced runoff, Nepal has a system of hydropower generation situated on these river systems that could be affected by changes in runoff (WWF Nepal 2005, 62). Increasing demand for electricity and population growth are leading towards an energy deficit in the country and this presents a challenging picture when seen in association with the potential risks to the industry from increased variability of runoff and increased risk of GLOF. Further climate induced risks hydropower facilities include: flooding, landslides, and sedimentation from more intense precipitation events (particularly during the monsoon) contributing to a potentially serious risk to water and energy supplies in the dry season especially (Agrawala et al. 2003, 43).

Agriculture and Forests

Agriculture and forests are vital to the livelihood of more than two thirds of the population (MPE Nepal 2004, 128) and is highly dependent on the weather - particularly on the rainfall timing and volume. The implications of reduced water availability for agriculture and forests have ramifications for overall land productivity (WWF Nepal 2005, 4). Agriculture provides a livelihood for over 80 % of the population, and about 80 % of the total population depends on the forests for daily fuel wood supply (MPE Nepal 2004, 9). Medicines and other non-timber products provide families in some areas with half their income. (World Bank 1998b)

As a result of warming climate, the unfolding, blossoming, and ripening in the leaves and fruit of wild plants is advancing; and wildlife in the mountains are hibernating, migrating, and breeding earlier than has been their pattern (Jianchu et al. 2007, 6). At the biome level, climate change can be expected to enable or force shifts in forest boundaries by latitude and upward movement of tree lines to higher elevations; changes in species' composition and vegetation types (Jianchu et al. 2007, 8).

In a country where so much of the population is dependent on agriculture and forests for food, fuel and building supplies changes in productivity will have major implications. Overall, climate change is likely to reduce food security in Nepal resulting in the need to import increasing amounts of food (Alam and Murray 2005, 11). Productivity increases have already declined in the last few years when compared to Nepal's population growth (WINROCK 2007).

In high mountain areas the increase in temperatures may extend the growing season, increasing productivity, but such extensions depend on water being available resources. The yaks and yak-cow crossbreeds which provide a major transport service are sensitive to warmer temperatures (MPE Nepal 2004, 78).

Increasing urbanization in the fertile Kathmandu Valley has reduced the availability of agricultural land, , agricultural land in the valley decreased from 62% to 42% between 1984 and 2000 so by 2025 there will be no agricultural fields left (ICIMOD, UNEP and MEST Nepal 2007). This exacerbates flooding due to the hard surfaces shedding rainfall as runoff.

Tourism

Trekking and mountaineering in Nepal is world-renowned and tourism overall brings in 15% of the small nation's export income. Trekking and mountaineering may be negatively affected by a climate-induced reduction in snow and glacial cover and the associated increase in natural hazards that endanger transportation on high-altitude

routes. These routes have been marked out over many years and changing conditions and more unpredictable weather would create more serious risks that may not be well understood by local guides and porters. Tourism could, however, become more profitable overall however as post monsoon dry periods increase and warm winters come to high elevations (Jianchu et al., 2007).

Pakistan

Geography and Environment of Pakistan

Pakistan is a developing country with a land area of over 880,000km^2 (O'Brien 2000). It is bordered by India on the east, China on the northeast, Iran and Afghanistan on the west. Its Arabian Sea coastline is about 990 km long. Pakistan has great diversity of climate, socioeconomic, and environmental regions.

Pakistan is divided into three hydrological units: the Indus basin, which bisects and comprises 70% of the country, the Kharan desert in west Balochistan with its inland drainage and the arid Makran coast along the Arabian Sea in the south (Ministry of Environment Pakistan 2003). The surface-water resources in the country arise from precipitation in the catchment area or the area that drains into the river of the Indus river system and from glacier melt in the upper basin. About 84% of flows occur in the *Kharif* (summer) crop season and only 16% occur in the *Rabi* (winter) season. About 5% of Pakistan's total land area is covered by forest. These forests cover a range of ecosystems from arid woodlands to coastal mangrove and mountain woodlands, but nationally experience 2% annual loss of cover (O'Brien 2000 119).

Socioeconomic Characteristics of Pakistan

The population of Pakistan was 158 million in 2005 (United Nations Department of Economic and Social Affairs, 2006) and expected to rise to 210 million by 2025 (Ministry of Environment Pakistan 2003). Only 44% of adults are literate and only 25.8% of women (United Nations Department of Economic and Social Affairs 2006) giving Pakistan one of the lowest rates of adult female literacy in the world (O'Brien 2000, 111).

The World Bank describes Pakistan as a low income developing country. Its annual economic growth rate from 1991-2000 was 4% (World Resources Institute, 2003).

Agriculture provides employment for 48% of the labour force (Ministry of Environment Pakistan 2003). The industrial sector of Pakistan is dominated by agricultural commodity processing (O'Brien, 2000) and contributes 23.3% of GDP. The services sector makes the largest contribution to GDP: 53.5% in 2005 (United Nations Department of Economic and Social Affairs 2006, 294).

Current Climate of Pakistan

The 11 distinct climatic zones in Pakistan (Khan, 1993) range from very cold in the north to hot arid in the south, with hyper-arid regions to the West (see UNEP 2003, 132). Pakistan receives rainfall in summer from monsoonal depressions (July to September) and in also in winter from low pressure disturbances coming from the west. The northeast mountainous and sub-mountainous areas receive over 1700mm precipitation per annum. In contrast the arid plains of southwest Balochistan receive only 30mm (Ministry of Environment Pakistan 2003; O'Brien 2000). Temperatures may fall to -26° C in the northern mountains and climb to 52° C in the central arid plains (Ministry of Environment Pakistan 2003).

Pakistan energy and emissions profile

Pakistan's per capita energy consumption is 0.36 Tonnes of Oil Equivalents (TOE) per annum, which is the highest in South Asia (Lahiri-Dutt 2006, 6). Most of its energy is obtained from fossil fuels (60.2%), with natural gas providing 36% of total energy. Biomass burning contributes 31% of total energy consumed (Lahiri-Dutt 2006, 328).

Pakistan generates electricity from hydro (27%), nuclear (3%), geothermal, solar and wind sources, but the majority of its electricity comes from natural gas (55%) and oil (15%) (Ahmed 2006).

The energy sector produces 81% of the national CO_2 emissions, compared to 12% from industry and 7% from forestry and land use changes.. Agriculture is the main source of methane emissions (87%) (Ministry of Environment Pakistan 2003; Pakistan Environmental Protection Agency 2005).

Climate Change Impacts in Pakistan

Overall the impacts of climate change are likely to be more incremental in Pakistan than other parts of Asia but will nevertheless have significant impacts on livelihoods. Pakistan is vulnerable to increased variability in the monsoon. Many of the documents about climate change in Pakistan apply global temperature rises and generalised precipitation changes derived for South Asia, so it has been difficult to examine the likely impacts of global climate change on Pakistan.

Temperature

Mean temperatures in coastal areas of Pakistan have increased 0.6 to 1.0°C since the early 1990s. Up in the Karakoram and Hindu Kush Mountains of the Upper Indus Basin, winter mean and maximum temperatures show significant increases while mean and minimum summer temperature show consistent decline (Fowler & Archer 2006).

Precipitation

The increasing temperature in the coastal areas and the hyper-arid plains in the south-west has been accompanied by 10-15% decrease in rainfall. On the other hand, according to some early models, monsoonal rainfall could increase by 60% (Qutub 1994).

In northern Pakistan precipitation has increased in both summer and winter (Cruz et al. 2007, 475) and Karakoram glaciers have been observed to thicken and expand (Fowler & Archer 2006).

Impacts on Human Health

There insufficient data on the likely changes in specific climate zones in Pakistan to predict health impacts. Malaria still is one of the most important diseases in neighbouring countries of India and Bangladesh, so increased temperatures and precipitation could expand vector borne diseases like malaria, dengue etc (Lal et al. 2001, 571), although those areas where rainfall is declining will be at less risk.

Water Resources & Glaciers

Almost 75% of the water flowing in the rivers of Pakistan originates from Hindu Kush and Himalayan glacier ranges. The Hindu Kush-Himalayan region suffered several GLOF events, of which some have trans-boundary impacts (Mool 2001). In contrast to glacial retreat in the eastern Himalayas, Karakoram glaciers have been observed to thicken and expand (Fowler & Archer, 2006). This suggests that glaciers in the western Himalayas are responding differently to global warming and further studies are required. Abbasi (2007) argues that the Siachen and its major tributary glaciers are melting due to direct human activity[3], not climate change.

Coastal Zones

Sea level rise of 1.1mm/yr has been observed by the National Institute of Oceanography (NIO) (Government of Islamic Republic of Pakistan 2003). "Although Pakistan is less vulnerable to sea level rise than some of its South Asia neighbours, the shoreline of its only major coastal city, Karachi, has retreated in recent decades" (Khan 1993).

Increased temperatures will increase demand for extraction of water from the Indus basin but whether the net effect of rainfall and temperature changes will yield more or less water for the Indus delta is not clear (Ministry of Environment Pakistan 2003), although O'Brien (2000, 121-128) suggests modelling indicates flows may increase. Economic and ecological degradation of the delta would be accelerated by reduction in flows (Government of Islamic Republic of Pakistan 2003, 45).

Sea level rise may lead to significant flooding in the low lying regions of the Indus Delta. Karachi, Pakistan's main industrial city will be affected by flooding, saline intrusion of groundwater and raised water tables (Lal et al., 2001; Ministry of Environment and Forests, 2002). Increased salinity has already been observed in the lower regions of the Indus deltaic plain (Ministry of Environment Pakistan 2003).

The frequency of cyclones in the Arabian Sea has increased from 0.86/year for the period 1891 to 1960 to 2.2 cyclones per year for the five years 1992 to 1996 (Raja & Khan 2006).

Agriculture

Agriculture contributes about 24% to the GDP and provides employment to 48.4% of Pakistan's labour force (EAW 2003). Crops like wheat, cotton, mango and sugarcane are likely to be severely adversely affected by increased temperatures (Ministry of Environment Pakistan 2003; Qutub 1994). Increases in temperature would increase the demand for water. Changes in productivity will also result from altered water availability and there may be shifts in spatial boundaries of crops with particular temperature (eg chilling) requirements, most notably horticultural crops which would need to move to higher latitudes or altitudes. Wheat yields could decline 6–9 percent with a 1°C increase in temperature (UNDP 2007 94).

Forests

Pakistan has about 4.2 million ha of forests (Shahbaz, Ali, & Suleri 2007, 441) which cover less than 5% of the total land area (Qutub 1994; WWF Pakistan 2006). Increased temperature will lead to changes in forest area, productivity and plant and animal species composition.

If temperatures continue to increase, cold and temperate conifer biomes will tend northward, displacing the existing cold conifer/mixed woodland, which may in turn displace the southern and lower edges of the alpine tundra. Similarly, warm conifer/mixed forest will also expand north at the expense of the temperate conifer/mixed forest. This northwards shift of coniferous biomes will increase their size at the cost of the extent of the alpine tundra (Government of Islamic Republic of Pakistan 2003). Some of the hardier species with widest distribution may shift to different biomes. These biomes are determined by temperature rather than precipitation (Ministry of Environment Pakistan 2003).

Deforestation is occurring at the relatively low rate of 7,000 to 9,000ha each year- a 0.2% p.a. decline in forest cover (Ministry of Environment Pakistan 2005; Wani 2003) partly because there is so little forest left to deforest (Dove 2003 30). Most of Pakistan's

forest is in the north, an area is characterised by weak institutions, political uncertainty and large refugee populations (Matthew & Zaidi 2002, 79) seeking to obtain livelihoods from natural resources. Deforestation is mainly caused by cutting of fuel wood, timber cutting, land use change, encroaching, overgrazing of livestock. The consumption of fuel wood is expected to increase with the growth of population by 3% every year in Northern area, threatening complete destruction of Pakistan's woody biomass within 10 to 15 years (Pakistan Environmental Protection Agency 2005). This report therefore recommends that reforestation in Pakistan becomes a priority area of development assistance. This will be expanded on later in the report.

Climate Change mitigation and adaptation: Priorities for development planning at the country level

Although developing countries contribute proportionately less Green-House Gases than developed countries, even Bangladesh, Nepal and Pakistan have opportunities to mitigate the trajectory of their Green-House Gas emissions as their economies and economic welfare of their citizens grows, although adapting to the effects of Climate Change will be challenging enough.

Mitigation activities reduce the amount or release of Green-House Gases in the atmosphere. The many ways that human and natural systems adjust to cope with the effects of climate change are described as adaptation. Anticipatory adaptation strategies prepare in advance for climate change, whereas reactive adaptation strategies are initiated in response to changed climate (Agrawala 2005, 30). The level of development and the pathway by which development is pursued can have a major impact on the adaptive capacity of a country (Agrawala 2005, 31).

It is difficult to get a sense of the priorities for mitigation or adaption in Pakistan or Nepal, and less so for Bangladesh. The official communications to the UNFCCC fail to communicate a sense of scale or priority within the plethora of details they contain. As Nepal's communication notes, "political and socio-economic conditions and circumstances of Nepal time and again prevent the country from fully realizing the government's Climate Change related policy formulations. Its ability to understand fully the situation and the potential impacts and opportunities of abating the Climate Change risk is rather limited" MPE 2004 143). Pakistan's communication notes that its vulnerability is particularly related to its reliance on Agriculture (Ministry of Environment Government of Islamic Republic of Pakistan 2003, 7), and Bangladesh's National Adaptation Programme of Action emphasises reducing vulnerability to natural disasters (Ministry of Environment and Forest 2005, 24). Of these three documents cited, only the Bangladesh National Adaptation Programme of Action claims to have had any broad consultation process as part of its preparation (Ministry of Environment and Forest 2005, 1).

Mitigation priorities for addressing global climate change

Avoiding dangerous climate change requires a transition to a low-carbon economy in developing countries too. However weak institutions and large informal markets for conventional goods and services pose massive challenges for introduction of carbon markets with their dependence on institutional arrangements.

Bangladesh

Energy efficiency is a real priority issue for Bangladesh. Reforms to improve efficiency of electricity generation would reduce greenhouse gas emission, but are very difficult to implement in Bangladesh. Mechanisms such as carbon- taxes or promoting consumer choice of renewable energy supply are hard to conceive in an operating environment where there are already massive subsidies to energy producers through a combination of political interest and corruption (World Bank 2007, 163). Over 20% of electricity delivered is not paid for. Not only is Bangladesh emitting more carbon dioxide than necessary from its electricity generation, but it is using its natural gas reserves at an unsustainable rate (World Bank 2007, 161). Bangladesh needs assistance with investment in sustainable energy generation and distribution options that will both

enable the poorest to access the grid and put in place sustainable infrastructure for the next 20-30 years.

Bangladesh had great success in replacing Dhaka's fleet of three-wheeled, two-stroke vehicles with vehicles operating on Compressed Natural Gas (CNG). The primary purpose of this programme was to reduce air pollution from particulates, but CNG fuel also produces 20% less GHG emissions than two-stroke (United Nations Development Program 2007, 141). This is a good example of the kind of "no-regrets" mitigation strategies required in South Asia. However the appetite of the growing middle class for private cars and electronic equipment also needs to be met by better public transport and emissions and energy efficiency standards.

Nepal

Increased energy demand and population growth are leading towards an energy deficit in Nepal and ways to meet this demand are gaining attention. The OECD has argued that Nepal should maintain its current high share of hydropower rather than shift the balance to fossil fuels (Agrawala et al. 2003, 38). Given the geographical diversity of Nepal, several options must be available depending on the local situation. The continued focus on small scale biogas is key for energy access in Nepal in some areas. Biogas has been successful in Nepal and has the potential to meet one-third of current energy consumption (Agrawala et al. 2003, 38) while making small reductions in methane emission. In other areas small scale solar power is more appropriate - such as in the high Himalayas where there is a very limited amount of plant and animal matter due to the dry and cold conditions. In other areas micro hydro systems would be appropriate.

Nepal's first communication to the UNFCCC estimated that sequestering carbon in forests or agro-forestry on degraded lands would be "several times lower" than substituting renewable energy sources for kerosene and LPG (MPE Nepal 2004, 57). This warrants further investigation so that holistic cost effective strategies which meet multiple objectives can be developed.

The high level of emissions from the transport sector warrants attention. They contributed 23% of CO2 derived from fossil fuel in 1998 (WRI 2007) and have complicating health impacts from the associated particulate pollutants. This is a growth sector given urbanisation and population growth. There have been programs of varying success such as electric or CNG rickshaws and other small electric public transport vehicles within the Kathmandu Valley. Further efforts in this area are needed as well as a focus on commercial vehicles within the valley and across the country.

Pakistan

While Pakistan is not presently a major contributor to climate change, it is on a trajectory of exponential growth in emissions. Development assistance could enable Pakistan to take a lower GHG emissions path to development. In its Initial National Communication to the IPCC, the Pakistan Government listed 21 strategies to improve efficiency in the energy sector which would yield a positive economic benefit while abating greenhouse gas emissions (Ministry of Environment Pakistan 2003). Infrastructure assistance to the energy sector that will reduce the losses in power generation, transmission and distribution (average 25% over the past 20 years) could be

important. Its ageing, mainly diesel vehicle fleet (Khan no date, 2) is also an opportunity for assistance to reduce both CO2 and particulate emissions.

Policy settings are the key to improving efficiency in Pakistan's energy sector: policies that will enable economic incentives for efficiency and which facilitate overcoming infrastructure and technology constraints. For example, tariff concessions on imported used machinery and subsidies on diesel inhibit efficiency (Khan no date, 2). Already there have been benefits from the Fuel Efficiency in Road Transport Sector (FERTS) Project funded by Global Environment Facility (GEF) of the UNDP. Its major thrust is public education and awareness to improve fuel efficiency of road transport vehicles, thereby reducing emissions of greenhouse gases (GHGs) and other pollutants.

It is clear that significant climate change mitigation could also be achieved through assistance in increasing reafforestation but this would have to be done carefully in light of predicted lower precipitation in some areas (Ministry of Environment Pakistan 2003). It would also have associated benefits in improving livelihood security for Pakistan poorest.

Adaptation priorities for addressing climate change

Adaptation to Climate Change will need to involve mitigation of the hazards and reducing the vulnerability of human and natural systems to climate change related processes and hazardous events. Adaptation needs to be both anticipatory and reactive, although increasing capacity to react to hazardous events brings together the anticipatory and reactive responses.

Bangladesh

The Bangladesh NAPA (Ministry of Environment and Forest 2005) identified fifteen priority projects, the first listed being reafforestation of a coastal buffer zone in regions vulnerable to storm surges, (est. cost US$23 million). However, reafforestation programs will be futile unless the pressures to convert forest and woodlot to agriculture or aquaculture can be addressed. The international significance and threats to the Sundarban area have been well documented (eg. Agrawala, Ota, Ahmed, Smith, & van Aalst 2003).

The second priority is provision of potable water to communities threatened by increasing salinity of groundwater. This ought to be seen in conjunction with the contemporary crisis in arsenic contamination of groundwater which is the main source of potable water in Bangladesh. Both problems need to be addressed by similar policy, social and technological approaches moving away from the "single simple solution" which tube-wells offered to the devastating diarrhoeal disease epidemics prevalent up until 30 years ago.

Another major part of Bangladesh's adaptation strategy centres on disaster management. Learning from the "super" cyclone of 1991, Bangladesh developed a storm alert system and storm shelter program (Asaduzzaman 1994). The early warning provided for Cyclone Sidr on 16 November 2007 alerted a large number of people to the danger, demonstrating improvements in that aspect of disaster management. The elevated shelters serve as community facilities such as schools when there is no emergency (Choudhury 2005). Provision of shelters is far below that required for the 16 million people living in high risk, cyclone areas (Barisal Correspondent 2007). The

NAPA gives high priority to projects to enhance capacity of communities to manage emergencies as well as construct flood shelters.

Mainstreaming adaptation to climate change into government policies and programs is prioritised by the NAPA. The Government of Bangladesh seeks support to build capacity to do this, especially in the areas of land and water management and infrastructure planning. It also places a priority on mainstreaming disaster management across all sectors.

Educational priorities include integrating climate change issues into secondary and tertiary curricula and "develop[ing] eco-specific adaptive knowledge on adaptation" (Ministry of Environment and Forest 2005 25). In order to reduce vulnerability of poor people dependent on agriculture and fisheries in areas of high risk, adult and vocational education are required for a strategy to increase the livelihood options for people who may need to migrate or live on reduced areas of land above the level of flooding.

Nepal

In anticipation of changes in climate, improved management water resources is a high priority and needs to be approached within a catchment/watershed framework that also addresses problems of erosion. The Government of Nepal has highlighted the need for improved understanding of water resources and hydrology, institutional reform and technological innovations to adapt to the changes in precipitation and ice and snow melt due to climate change (MPE Nepal 2004, 100-101).

Related to this is widespread recognition that reducing the risk of Glacial Lake Outburst Floods (GLOF) and monitoring and warning systems to reduce vulnerability to them is a key priority for Nepal's adaptation strategy (Bajracharya, Mool, & Shrestha 2007). In this area Nepal faces hazards which are unique in comparison to Pakistan and Bangladesh. As information and understanding of the nature of GLOF risk develops, there will be opportunities to design infrastructure to minimise the risk of outburst floods from glacial lakes. Thus there is a need to develop both software and hardware to mitigate the risk of GLOF within the capacity of the Nepalese communities and Government (MPE Nepal 2004, 104-105).

Similar to most countries, Nepal also needs to adapt its agricultural systems to the movement of climatic zones up the mountains and altered rainfall patterns. One challenge will be to protect indigenous montain vegetation against migration of agriculture upslope. In addition to modification of farming systems, changes to practices and cultivars are routinely listed as part of adaptation strategies (MPE Nepal 2004, 89).

Pakistan

Like Nepal, Pakistan has not yet published a National Adaptation Plan, so the priorities have to be derived from other sources.

Since "Pakistan does not have adequate monitoring systems for the prediction of likelihood of occurrence of extreme events or the assessment of possible changes in weather patterns" (Ministry of Environment Government of Islamic Republic of Pakistan 2003), the development of meteorological and climate monitoring systems should have high priority. Mechanisms to share data at a regional level would reduce the burden on Pakistan. The coupling of this data with bio-economic modelling could assist farmers and pastoralists to make strategic decisions in growing seasons (Ministry of Environment Government of Islamic Republic of Pakistan 2003, 56).

Climate change is likely to exacerbate Pakistan's water deficit and water storage will be key to addressing more severe dry seasons. Institutions and infrastructure for water allocation and distribution in the aging and extensive irrigation and urban reticulation systems need to be examined (Ministry of Environment Government of Islamic Republic of Pakistan 2003, 76) inter alia to increase irrigation efficiency above the 36% reported in 2003 (Ministry of Environment Government of Islamic Republic of Pakistan 2003, 79)

Pakistan's priorities for adaptation in the agriculture sector include developing integrated Agricultural Production and Resource Management (APARM) systems using spatial databases and modelling for Decision Support Systems which guide policy makers, research and extension institutions and farmers. Agronomic and livestock practices, cultivars and farming/land management systems also need to be adapted to changing climate, and APARM systems contribute to this process (Ministry of Environment Government of Islamic Republic of Pakistan 2003, 78).

Since one third of Pakistan's land area is rangeland, the needs and impacts of pastoralists need to be a part of the national adaptation strategy.

International development organisations and cooperation with South Asia to address climate change

The international signatories to the UNFCCC committed to support climate change mitigation efforts in developing countries such as those in South Asia. While developing countries themselves need to bear the brunt of financing energy policy reform, the incremental costs of reforms in finance, technology and capacity building can be met by developed countries through the UNFCCC (UNDP 2007, 153)

Multilateral Funding for mitigation and adaptation

The major multilateral organisations partnering with countries of South Asia include the World Bank, Asian Development Bank and United Nations agencies such as the UNEP and UNDP.

The Global Environment Fund (GEF) is an international fund constituted by 178 member countries, established to provide the financial mechanism for four international conventions, one of which is the United Nations Framework Convention on Climate Change (UNFCC). In relation to the UNFCCC, the GEF funds projects in the areas of:

- Renewable energy
- Energy efficiency
- Sustainable transportation
- Adaptation
- New low-Greenhouse Gas Technologies
- Activities enabling countries to meet their obligations under the UNFCCC process including preparation of National Communications (Global Environment Facility 2007)

Its funds come mostly from voluntary contributions to the GEF Trust Funds (UNDP 2007, 154). The GEF has approved 3 projects for Nepal, 4 in Bangladesh (with another in preparation) and 5 for Pakistan (see Appendix 1 for complete list). The UNDP,

UNEP and IBRD are the implementing agencies for these projects on behalf of the GEF.

Mitigation

The Clean Development Mechanism (CDM) is also operated through the GEF and was introduced under the Kyoto Protocol (1997) specifically for developing countries to achieve their sustainable development goals, while at the same time mitigating climate change (Ministry of Environment Pakistan 2005). Developed countries have been asked to support CDM project activities that reduce GHG emissions in the developing countries by purchasing Certified Emission Reduction (CER s) which can be used by developed countries as credits to meet their emission reduction targets under the Kyoto Protocol. CDM projects can be initiated in the areas of energy, waste management, transport and forestry.

CDM projects will continue to be part of a GHG mitigation plan for the region. For example, the first CDM project in Pakistan was only inaugurated in January 2007and is expected to abate one million tones of carbon dioxide equivalents per annum (Ministry of Environment Pakistan 2005). Peterson (2008, 301-302) points out the limitations of CMD to date, showing that many of the renewable energy projects in India use technologies which are local and not obtained from developed countries. For the energy sector as a whole, Foreign Direct Investment in developing countries is seven-fold the amount of funding flowing though CDM or any of the other multilateral funds for technology transfer. Peterson calls for more research to determine whether used capital goods or least emissions technologies comprise the bulk of this FDI in the energy sector (Peterson 2008, 302).

Since the Kyoto Protocol came into effect a 2% levy on CDM credits will be used to fund specific activities when governance issues are resolved (UNDP 2007, 189). Since Australia ratified the Kyoto Protocol in 2007, Australian businesses are now able to access the Clean Development Mechanism.

Smaller enterprisers and land managers in developing counties face barriers to entering the Carbon market, even through the CDM. The MDG Carbon Facility launched by the UNDP is an effort to link carbon financing to sustainable development goals in which UNDP 'bundled' a portfolio of projects whose Carbon Credits will be marketed (UNDP 2007, 155).

Adaptation

Not only is the mitigation potential of South Asian nations limited in contrast to developed counties, they lack capacity to adapt to the effects of global climate change discussed in the first section of this report.

> Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. (UNFCC 2007 Sect 2.1)

To build capacity for "taking the right measures" means to "increase the strength of social, economic and natural systems to cope with both the short tem and long term impacts of climate variability and human induced climate change" (Friends of the Earth, 2006). Adaptation measures may be broadly classified as reactive or anticipatory (UNFCC 2007, 31)

In addition to the major costs which will be borne by communities and national governments for adaptation, two GEF administered UNFCC funds assist adaptation by developing countries: the Least Developed Country Fund (LDCF) and the Special Climate Change Fund (SCCF). These are both funded by donations. Australia contributed $7.5 million to the LDCF (AusAID, 2007) in October 2007 (AusAID pers comm.).

Following the ratification of the Kyoto Protocol in 2004, the Strategic Priority on Adaptation (SPA), was established to support projects that enhance countries' capacity to manage natural resources under changing climate. It is funded through a levy on the Certified Emissions Reductions (CER) credits generated by CDM projects (Friends of the Earth, 2006).

The United Nations Environment Program is also working around national adaptation planning and in the past has done work on adaptation to climate change for agricultural productivity. Other development agencies implementing GEF projects in South Asia include the World Bank, the Asian Development Bank (ADB); the European Bank for Reconstruction and Development (EBRD); the International Fund for Agricultural Development (IFAD); the UN Food and Agriculture Organization (FAO) and the UN Industrial Development Organization (UNIDO).

Bilateral and Non-government funding

It has been difficult to find evidence of direct funding for specific climate mitigation and adaptation projects by the many bilateral donors to the focus countries. For example while the European Union is a major donor to Pakistan, only €150,000 of its €266 million 2007/08 budget was committed to projects with a climate change focus. However, this is a rapidly changing landscape. In 2008 the UK's Department for International Development (DfID) committed 35 million pounds sterling to fund adaptation measures in Bangladesh (DfID, 2008).

Amongst non-government organisations the Climate Action Network - South Asia (CANSA) appears to be playing a key coordination role (see http://www.can-sa.net/cansa/index.htm).

Mainstreaming Adaptation to Climate Change.

For many people in Bangladesh, Pakistan and Nepal the impact of climate change is overshadowed by the immediacy of environmental, economic and socio-political problems with which they struggle on a daily basis (Halsnæs & Verhagen 2007, 666).

At the same time, Klein et al (2007) point out that specific funds to address adaption to climate change will be inadequate for the task of enabling communities and countries at risk to face the impacts of climate change. Consequently in addition to specific programs related to climate change, "the need to mainstream adaptation to climate change into development" programs and planning is increasingly recognised in the international aid and development community (Klein et al. 2007, 1).

The World Bank report *Managing Climate Risk* pointed out "that appropriate hazard risk management, including adaptation to climate change, is not a luxury for development planning but is pure due diligence", closing the gap between investment in development and disaster risk management (World Bank 2006, 8). It identified three main risks to development posed by the changing climate:

- Direct threats to investments (e.g., effect of extreme weather events on infrastructure)
- Underperformance of investments (e.g., irrigation investments that fail to pay off when rainfall decreases)
- Maladaptation - economic development triggers settlement in vulnerable areas or taxes the resilience of natural resource (World Bank 2006, 7)

The Bank claims to make Climate Change a cross-cutting issue that is integrated into all of its projects in the region (World Bank, 2006).

The incorporation of climate risk assessment is contingent on the nature of the programs and projects, especially their effective life time. The following table from Smith et al. (2005) demonstrates time horizons for climate risk assessment for different development activities.

Figure 1: Time horizon for climate risk assessment for selected development activities

Time horizon (years)	Process
0	Election cycles, profit and loss planning Agriculture (whole farm planning
20	Plant breeding Forest lease agreements Pulp plantations Generational succession
	New irrigation projects Coastal/tourism infrastructure
40	Tree Crops National Parks
60	Airport design life
	Large dams Major Urban Infrastructure
80	Intergenerational equity Long – term biodiversity Bridge design life /flood heights
100	

Source: (Smith et al. 2005, 46)

Neo-classical economic paradigms of development, epitomized by "new institutionalism" favour "general capacity building programmes, market development and local enterprise and finance development" to enable adaptation to climate change. On the other hand development theories focussing on human wellbeing focus more on the "rights of all human[s] to have access to specific resources" (Halsnæs & Verhagen 2007, 668). However, the kind of analyses of climate change and mitigation for whole countries described by Halsnaes and Verhagen (2007) are not necessarily required by a donor agency. Rather, donors of Official Development Assistance could screen their project portfolios to ensure the "projects consider climate risks or address vulnerability to climate variability and change" (Klein et al. 2007, 24). AusAID already screens projects in a similar way for Gender equity and Environmental Impact.

Although Klein et al. (2007) report on screening by German (GTZ), Norwegian (Norad), OECD, Swiss (SDC) and the World Bank, only DfID;s Bangladesh Office has a screening methodology (ORCHID) which is used in the process to prioritise new development assistance (Klein et al. 2007, 31).

One of the problems with screening, is that the risk factors, like climate change, are seen as the "responsibility of the environment department in the development agencies". DfID and GTZ are exceptions, with local staff involved in screening (Klein et al. 2007, 32). USAID has sought to broaden involvement of all staff by producing a manual to assist development planners incorporate climate change into development planning(USAID 2007). It should be noted that mainstreaming for climate change is more complex than a screening check-list, and "adaptation needs to become part of the dialogue between development agencies and recipient countries regarding development priorities" (Klein et al. 2007, 40)

Climate Change and disaster management

UNEP (2007) points out that "disasters...are the convergent of hazards and vulnerable conditions" (UNEP 2007, 4) and that "climate change exacerbate[s] or alters existing hydro-meteorological hazards (UNEP 2007, 8). The importance of development planning in addressing vulnerable conditions and tackling hazards has been discussed. Improved disaster management involves reducing risks by reducing vulnerability of communities through risk reduction and improving capacity to respond to disaster (International Strategy for Disaster Reduction 2005, 1).

Within the United Nations system the International Strategy for Disaster Reduction (est. 2000) provides an inter-agency framework to increase cooperation and expand knowledge and commitment to a very broad approach to disaster risk reduction. A broad partnership of governments, UN, international and non-governmental organizations, international financial institutions, academic and research institutes, networks and civil society agreed on the Hyogo Framework for Action 2005-2015, which aims to increase the "integration of disaster risk considerations into development policies, planning and programming", to strengthen institutions which build resilience to hazards and (International Strategy for Disaster Reduction, 2005). While this agenda is broader than adapting to Climate Change, the Hyogo Framework has incorporated the risks anticipated from climate change into its considerations. It notes that lease developed countries and small island developing States have high vulnerability and risk (International Strategy for Disaster Reduction 2005, 5) and that climate variability and

change are hazards that must be addressed in development planning "as well as in post-disaster situations" (International Strategy for Disaster Reduction 2005, 10).

The ISDR established an Asian Partnership on Disaster Reduction in 2003 (International Strategy for Disaster Reduction, no date) It is "expected to serve as a recognized regional mechanism involving the relevant regional actors in implementing jointly disaster risk reduction along the lines of the Hyogo Framework for Action (HFA) [by]... working with governments and in-country partners" (International Strategy for Disaster Reduction, no date). Other important regional initiatives include a *Comprehensive Regional Framework for Action 2006-2015 in South Asia*, and the *South Asian Regional Platform for Disaster Risk Reduction and Management* (AMCDR, 2007).

The SAARC Disaster Management Centre was established in 2006 in Delhi to provide policy advice and facilitate capacity building services such as strategic learning, research, training, system development and exchange of information to improve effectiveness of disaster risk reduction and management in South Asia (SAARC Disaster Management Centre 2007a). A *Comprehensive Framework on Disaster Management* was adopted in April 2007 (SAARC Disaster Management Centre 2007b). However the Director of the National Institute of Disaster Management in India observed that progress on regional cooperation in South Asia is difficult within SAARC (Chakrabarti 2007) where conflicts over territory, migration, refugees and water resources continue to simmer (Gaan 2000, 152ff; Gollagher, Davis, & Pettitt 2006, 206-207).

The World Bank's Global Facility of Disaster Reduction and Recovery was established in 2006 to support the ISDR, enhance investment in risk reduction and transfer and strengthen mobilization of international assistance for disaster recovery (Global Facility for Disaster Reduction and Recovery, no date). The GFDRR is able to access funds from bilateral donors, U.N. agencies, international finance institutions, and private sector partners (Global Facility for Disaster Reduction and Recovery 2007, 32). In 2008 GFDRR is funding activities in Bangladesh, India Maldives, Nepal, Pakistan and Sri Lanka (World Bank 2008).

The International Federation of Red Cross / Red Crescent Societies has recognised that it must address the risks posed by climate change. In 2002 it established a Climate Centre to assist the Federation and member Societies "understand and address the humanitarian consequences of climate change" (Red Cross/Red Crescent Climate Centre 2007).

Australia's Development Cooperation with South Asia and Climate change

Australia is a modest donor to South Asia (AusAID n.d., 1), having only selective partnerships in the sub-region over the 10 years to 2006 (AusAID 2006). Australia gave an estimated $148.8 million of ODA in South Asia. None of this had a particular focus on climate change adaptation or mitigation. The 2008-09 budget has estimated $113.5 million will be spent in the year, $34.5m in Bangladesh and none in Pakistan[4] (Smith & McMullan 2008, 47). Support for climate change related activities is specifically listed as one of the elements of funding committed to regional partnerships with the World Bank and ADB (Smith & McMullan 2008, 48). The increased funding to the region probably arises in part from the recommendations of the White Paper discussed below.

The 2006 White Paper on Australia's overseas aid program signalled increased engagement with South Asia, particularly Pakistan and Bangladesh. The primary focus of Australia's aid program is accelerating economic growth, fostering functioning and effective states, investing in people and promoting regional stability and cooperation. The White Paper recognises that environmental challenges to growth must be addressed "through an environment strategy focusing on climate change and adaptation, water, and strengthening environmental regulatory regimes" (AusAID 2006, xii).

Climate change is directly addressed in an AusAID environment strategy published subsequent to the White Paper: *Aid and the environment- building resilience, sustaining growth* (AusAID 2007).

The climate change objectives are stated as:

- to build knowledge of regional climate systems and support adaptive planning and adaptive measures (focusing primarily on the Pacific)
- to reduce greenhouse gas emissions in significant emitting countries through energy efficiency and clean energy technologies (focusing primarily on Asia), and
- to reduce greenhouse gas emissions through reforestation and avoided deforestation (focusing on countries where deforestation is an issue) (AusAID 2007, 22-27).

While there has been only limited engagement with South Asia, of which little endeavoured to address climate change related issues, Australia's long history of development assistance in the South Asia region, including well regarded projects such as the Nepal Community Forestry project, means that Australia is potentially well placed to be a partner in climate change mitigation and adaptation programmes. A case has been presented in this paper that the needs of South Asian countries in relation to adaptation to Climate Change are similar to those of countries in the Pacific and they should not just be treated as "significant emitting countries" in Development Cooperation policy.

The primary vehicle for addressing climate change and adaptation proposed by the White Paper is "clean energy initiatives in support of the Asia-pacific Partnership on Clean Development and Climate (AP6)" (AusAID 2006, 41). However India is the only member of both SAARC and AP6, limiting the relevance of AP6 mitigation initiatives in South Asia. AP6 may enable Australian foreign policy objectives placing importance on India's growing capacity as a trading partner for manufactures, and as a market for Australian education services, minerals and energy to be aligned with mitigation of climate change, however its relevance under the new Australia government is unclear and in relation to Bangladesh, Nepal and Pakistan, invisible.

Recommendations on areas of focus for the Australian development program in South Asia

> *International cooperation on climate change demands a twin-track approach. The priority is to mitigate the effects that we can control and to support adaptation to those that we cannot. Adaptation is partly about investment in the 'climate-proofing' of basic infrastructure. But it is also about enabling people to manage climate-related risks without suffering reversals in human development* (UNDP 2007, 169).

It is clear from the evidence that climate change is likely to have primarily negative impacts on the development of Bangladesh, Nepal and Pakistan and on the South Asia region as a whole. Major challenges including sea level rise, glacial melt and changing rainfall patterns will put the livelihoods of many of the region's poor at greater risk.

The Australian aid program will need to respond to the challenge of climate change by shifting its resources to enable countries to both adapt to the changes and to also to be able to pursue a low carbon development model.

Although global climate change is inherently a trans-boundary issue, the great diversity of cultures and political systems, and deep historical animosities have resulted in little regional cooperation on environmental management in South Asia (eg. Kango 2001). For example, Abbasi (2007) demonstrates that for many in Pakistan, regional military and political tension is felt more acutely than any threat from climate change scenarios generated through the IPCC.

This section first looks at key adaptation measures to which Australia might contribute and then looks at the issue of mitigation. It argues that the Australian aid program should have an increased focus on assisting the countries of South Asia to adapt to climate change and this should be central to AusAID's country strategies. This section also argues that assistance with disaster preparedness should be central to Australia's development assistance in South Asia.

In addition, it argues that mitigation is also important but should not come at the expense of developmental outcomes in the region. Instead mitigation should be focused on assisting South Asian nations "leapfrog" old technologies and embed new low carbon infrastructure into their economies. It also argues for a stronger focus on reducing deforestation and supporting reforestation in the region.

Adaptation

Human development itself is the most secure foundation for adaptation to climate change. Policies that promote equitable growth and the diversification of livelihoods, expand opportunities in health and education, provide social insurance for vulnerable populations, improve disaster management and support post-emergency recovery all enhance the resilience of poor people facing climate risks. That is why climate change adaptation planning should be seen not as a new branch of public policy but as an integral part of wider strategies for poverty reduction and human development. (UNDP 2007, 172).

Vulnerability to climate change is exacerbated by the presence of other stresses such as minority status, poverty and isolation (Schneider et al. 2007). This report therefore

recommends that adaptation options pursued in the Australian development program should be integrated with other development efforts and be broadly aligned with the targets outlined in the MDGs. This section outlines some broad adaptation options for South Asia with a focus on information, research, infrastructure and disaster management. The particular relevance of each of these to Bangladesh, Nepal and Pakistan will be examined on a country by country basis in the final section.

Information.

Planning for climate change adaptation requires access to timely and reliable information directly useful for monitoring and forecasting climate. If the climate information gap is to be overcome then there needs to be a substantial investment in meteorological infrastructure. Such an investment will be most effective if it can operate across the South Asia region and Australia can play a role in developing such as system as part of a multilateral regional approach. Australia's own forecasting and modelling systems are international best practice and could be used as a model for the region. Australia's capacity to assist in expanding access to climate information should build on the lessons learnt from Australia's previously involvement in the Global Change and Terrestrial Eco-Systems Regional Centre that it funded in South East Asia in the late 1990s.

In addition to meteorological infrastructure there needs to be a strategy for communicating information on climate to the broad population in the South Asia region. Better information on climate monitoring and forecasting South Asia can assist populations to plan and adapt for climate change. Such a system could, for example, give agricultural producers advanced warning of changes in rainfall patterns or temperature which in turn can mean the difference between a successful harvest and crop failure (UNDP 2007, 174). Already farmers with high-speed internet in rural India receive online updates about market prices and weather with substantial benefits (WRI 2005, 111).

Improving human health throughout the South Asia region will also require the improved monitoring of disease outbreaks and trends in addition to programs that currently address health education to raise community awareness of diseases. For example, tracking their incidence and capacity to forecast outbreaks of vector borne diseases like Malaria and Japanese Encephalitis are concerns for the Government of Nepal (MPE 2004, 140).

Research

Throughout South Asia there will be a need to adapt agricultural practices in response to climate change. There will need to be an investment into research on rice and vegetable varieties that can withstand increasing salinity in coastal soils and cope with reduced water. This will include the development of drought, heat and pest resistant cultivars and diversified cropping (Agrawala et al. 2003, 41). However, as in Australia, it is not just a question of new cultivars, but also reassessing where some crops are best suited. In Nepal it could include the development of a yak-cow cross-breeds and minimum tillage practices in rice-wheat production systems (MPE Nepal 2004, 89,92).

Infrastructure

Climate change requires planning for new infrastructure investments to protect populations and property and upgrade existing infrastructure to deal with its impacts. The level of investment required is likely to be beyond the financing capacities of most governments in the region.

Glacier Lake Outburst Floods (GLOF)

As highlighted in the country profiles, Glacier Lake Outburst Floods (GLOF) will be a major challenge in the region. In the mountainous areas of countries such as Nepal and Pakistan there will need to be a focus on managing the likely increase in disasters from glacier melt and other changes as a result of climate change. Such approaches to mitigate the impacts of disasters must be integrated with knowledge of population migration, watershed management, flood management and landscape management.

Disaster management should include the establishment of flood warning systems including GLOF early warning systems such as raised watchtowers to detect impending GLOF events in sufficient time. Examples of early warning systems and mitigation measures are already in place in the Tsho Rolpa and Bhote Koshi valleys of Nepal, and Lunana region of Bhutan (Bajracharya et al. 2007, 97).

Further, early warning systems in other parts of the region will need to be developed in conjunction with an inventory of risks, monitoring and evacuation plans to help communities and the government better prepare for disasters. In addition, labour and material to shore up embankments as well as mapping and inventories for better land use planning for road construction and major infrastructure will need to underlie future reconstruction and rehabilitation (UNDP 2007, 171).

Potential GLOF hazards in the Himalayas will also need to be tackled more directly through the lowering the level of the lake water when required. (Bajracharya et al. 2007, 103). Physical interventions such as pumping, and cutting channels are of course expensive and complex, requiring sound knowledge on the rates of outflow needed to reduce the lakes sufficiency and the longer term impacts.

Managing GLOF events also has the potential to be coupled with investment in micro hydro and to spread the cost of reducing of GLOF hazards while bringing benefits to local communities - improving indoor air quality and reducing pressure on forests. In this way climate change can be seen as an additional benefit or motivator for micro hydropower generation in Nepal and Pakistan (Agrawala et al. 2003, 35).

Incorporating climate risk into infrastructure design may require paying greater attention to the wider landscape or catchment such as avoiding deforestation or implementing increased reforestation programs to reduce risk of flooding or landslide in Mountainous areas (Agrawala et al. 2003, 38) to mitigate the hazard from increasing intensity of rainfall events.

Fresh water access

A key issue across the South Asia region is going to be access to fresh water as climate change results variously in salt water intrusion from sea level rise, rainfall changes and glacial melt – all of which have impacts for fresh water availability and agriculture. As a result, there will need to be an increased focus on the local storage of rainwater through

investing the necessary infrastructure for small scale rainwater harvesting, as well as decentralised and localised capacity to design and build it in accordance with local needs and resources. Small dams and reservoirs and even household storage will reduce local vulnerability to reduced water resources and increased variability[5] of supply (Agrawala et al. 2003, 20).

Salt water intrusion and flood-proofing

Impacts from sea level rise (most acute in Bangladesh but also involve other coastal areas) will require adaptation to increased flooding and salinity. It will require rethinking many development plans including creating coastal buffer zones in regions vulnerable to storm surges. Increased seasonality of precipitation will also require new forms of housing that are better able to withstand fluctuating water levels and measures to place agriculture on higher ground or on 'floating' gardens (Ministry of Environment and Forest 2005, 22-25). Although not entirely the products of climate change, extensive internationally funded programs to assist the *char* (sandbar island) dwellers of Bangladesh provide an example of how housing can be designed and built to cope with seasonal flooding (UNDP 2007, 171)

Disaster Management

In addition to long term and incremental impact of predicted climate change there will also need to be a ramping up of the capacity of South Asian nations to reduce the risk of disasters exacerbated by climate change. This report argues that this should involve the creation of strategies for disaster risk management systems that are clearly linked to the MDGs, including the development of early warning systems, community-based flood defence systems and post-disaster recovery strategies.

The economic case for this is clear: "One recent global study estimates that US$1 invested in pre-disaster risk management activities in developing countries can prevent US$7 in losses" (Jha, Saroj Kumar 2007). The UNDP makes a similar case in relation to disaster risk analysis in Bangladesh which provides a compelling insight into returns on adaptation investments "Using risk analysis methods analogous to those deployed by the insurance industry, researchers assessed the economic asset losses associated with flooding risks today, in 2020 and in 2050, under a range of plausible climate change scenarios. If no adaptation was assumed, the costs associated with more extreme '50-year events' amounted to 7 percent of GDP in 2050. With adaptation they fell to around 2 percent" (UNDP 2007, 176). In other words, investments of official development assistance in disaster risk reduction will deliver higher returns than post-disaster relief.

Such a comprehensive disaster management plan across the region and individual countries in South Asia will require investments that are beyond the financing capacities of most governments acting alone.

In summary, well targeted adaptation assistance is essential in reducing the vulnerability of the poor to climate change and climate related disasters. However, for this adaptation planning assistance to be most effective it needs to be integrated into the existing development assistance program fully as well having a long time horizon. Adaptation need to be, as the 2007 HDR Report argues, at the centre of aid partnerships: "Donors need to mainstream adaptation across their aid programmes, so that the effects of climate change can be addressed in all sectors. By the same token, national governments

need to mainstream adaptation across ministries, with the coordination of planning taking place at a high political level (UNDP 2007, 198). The next section looks at mitigation before making some overall recommendations for the Australian Aid Program and climate change.

Mitigation

The UNDP's 2007 UNDP argues that "inequalities in aggregate and per capita carbon footprints are intimately related to wider inequalities. They mirror the relationship between economic growth, industrial development and access to modern energy services" (UNDP 2007).

While the human race will undoubtedly need to reduce its greenhouse gas emissions the more immediate challenge for many of South Asia's poor is for access to affordable and reliable energy services to generating employment and improve the quality of people's lives (United Nations Development Program 2007, 44-45). Biomass and animal waste provide South Asian countries with anywhere from 87% (Nepal) to 29% (India) of their energy (Lahiri-Dutt 2006, 6), much of that renewable.

It is clear then that any environment and development strategy for the region of necessity includes greater access to energy services for the poor and support broader poverty reduction strategies, but this must be done in a manner that avoids the carbon intensive development patterns of developed countries. Particular challenges are faced in the rapid urbanisation taking place. The large proportion of energy currently obtained from renewable biofuels by rural households is clearly not able to be sustained in urban settings due to supply and air pollution problems.

Technology transfer from developed countries such as Australia to South Asia that could create win–win outcomes for the diffusion of energy services, energy efficiency, human health and global climate change mitigation is required. This will require a substantial investment over and above current investment plans over a number of years to support a rapid transition to low-carbon energy generation. (UNDP 2007, 152).

At present low levels of energy efficiency are holding back South Asia's efforts to increase energy supply and expand access to electricity, while driving up emissions. It has been estimated that South Asia could generate the same amount of power with up to one-third less fuel. Examples from Bangladesh and Pakistan have been described above. The UNDP argues that technology is a central part of the explanation for the low levels of efficiency in India's coal sector: "Over 90 percent of India's coal generation capacity is subcritical, much of it concentrated in small-scale plants. Improving the efficiency of these plants would generate large energy sector benefits for India, along with global climate change mitigation benefits" (2007, 152). In other words, radical changes to South Asia spiralling emissions trajectory are possible but this is going to requires substantive development assistance from developed nations. It will also require improved governance to overcome the interests vested in the current systems.

The United Nations Global Environment Fund has established four funds to assist Least Developed Countries finance adaptation to the consequences of Climate Change. The Least Developed Countries Fund, and the Special Climate Change Fund (which both rely on contributions for funding); the Adaptation Fund, which will fund 'concrete' (actual) adaptation measures and the Strategic Priority on Adaptation. Australia had not contributed to the first two mentioned (Oxfam International 2007, 31) by the Federal Election in November 2007. However, given the Australian Government policy to

engage with multilateral donors in South Asia (AusAID n.d., 9) this would be a way to make a significant contribution.

Efficiency problems are not only related to technology but are also caused by current policy distortions such as energy subsidies to fossil fuel-based power and nuclear energy have created disincentives for substantial investment more sustainable energy sources such as renewable energy. Furthermore, electricity subsidies overwhelmingly benefit higher-income groups (as the primary users) and not the poor (UNDP 2007 153).

It is this report's recommendation that Australian aid to the energy sector should only fund projects that improve energy efficiency, improve demand management and/or increase the proportion of renewable energy. It is likely that this will need to be done, at least in part, through an array of small-scale, decentralized projects. Such an approach builds on Australian aid strengths in remote area technologies and previous aid programs such as the Municipal Solar Infrastructure Project that was implemented in the late 1990s (AusAID 1997, p6)

Halting Deforestation and Assisting Reforestation

The destruction of forests accounts for around 20 percent of the world's greenhouse gas levels[6] (AusAID 2007, 27) and as shown in the country profiles there is clear scope for tackling this issue in the South Asia region. It has benefits not only for slowing carbon release and increasing carbon capture but also for protecting and enhancing the livelihoods of many of the world poorest people who rely on forests for their livelihoods most directly (WRI 2005).

The 2007 Human Development Report gives the example of Kenya's Greenbelt Movement which successfully marketed a programme to reforest two mountain areas as part of an emissions reduction agreement. The project will see women's groups will plant thousands of trees, with revenues coming from a carbon trade for the reduction of 350,000 tonnes of CO2. The aim is to generate wide-ranging social and environmental benefits, including the restoration of eroded soils (UNDP 2007, 155).

Deforestation and reforestation are also areas that Australia has shown recent leadership. In 2007, the Australia government pledged $A200 million dollars to the *Global Initiative on Forests and Climate* which aims to reverse deforestation by fighting illegal logging, planting new trees and providing alternatives to the timber industry. At present the funding is for Southeast Asia, particularly Indonesia, and the authors of this report believe there may be scope for expanding this to the south Asia region.

Australia also has considerable experience in the forestry sector though its aid program. Although the long running *Nepal–Australia Community Forestry Project* ended in 2006, there may be scope for reviving this model for use in other regions in Nepal and in other parts of South Asia as has been done in Cambodia etc. This project is a good example of an Australian development assistance success story in which Australian experience can be applied across the region (Cribb 2006). The National Forestry and Conservation Program trust in PNG is another area where Australia has had experience in this area.

This report asserts that climate change should not be seen in isolation from other key environmental issues such as biodiversity protection. It is important that the increased demand for renewable fuels such as bio-fuels do not undermine the recent work been

done in trying to protect remanent bio-diverse areas including old growth forests and wildlife reserves. For example, the rapid growth of monocultures such as Palm Oil at the cost of bio-diverse forests in South East Asia should be avoided in South Asia and monocultures should be excluded from existing forest areas. This also applies to forestation projects more generally[7].

The recommendation of this report is that there should be an increased focus on tackling deforestation and enabling reforestation in South Asia and that this should become a stronger priority (potentially as part of a multilateral effort) for aid to the region.

Overarching Issues

Governance

> *...adaptation is about far more than infrastructure. The starting point is to build climate change risk assessment into all aspects of policy planning. In turn, risk management requires that strategies for building resilience are embedded in public policies. For countries with limited government capacity this is an immense task. (UNDP 2007, 172)*

Over the past decade Australia development assistance has given an increased priority on governance and the building of institutions. Building on this strength this report recommends an increased focus on institutions for climate change and disaster risk management.

It will be essential to build capacity for environmental governance in South Asia. Governance remains a key challenge throughout the South Asia region. Strengthening institutions capacity in risk assessment, resilience planning, disaster mitigation and response work as well as domestic policy reform is one requirement for unlocking efficiency gains (such as the electricity sector) will be essential if an effective response to climate change is to be found[8].

While it is reasonably clear that adaptation and mitigation in climate change planning has been a fringe activity in most of South Asia, there is substantial good intent to be found among governments in the region, for example, the Government of Bangladesh has acknowledged the potential impact of climate change and produced a National Adaptation Programme of Action that includes the strategic goal of "integrating climate change issues with other policies, programmes, and projects" (Government of Bangladesh 2005, 344).

Nevertheless the countries of the South Asia region have a low capacity to mitigate and adaptation to climate change because of limited financial resources, lack of skills and technologies and high level of poverty. For example, Pakistan has acknowledged that it needs improvement in information sharing, education and training, technical and scientific research to develop a functional adaptation plan[9] (Government of Islamic Republic of Pakistan, 2003).

This report recommends that a stronger priority be given to governance issues associated in the adaptation and mitigation of climate change impacts.

Education

Education should remain a priority for assistance for these three countries which all share literacy rates of just under 50% (UNDP 2007, 231). Wherever possible, environmental literacy should be developed to equip the community and decision-makers to address the needs of sustainability under changing climate and should build on the initiatives outlined in the United Nations Decade on Education for Sustainability.

In varying degrees, institutions in Nepal, Pakistan and Bangladesh are weak, and these countries are all in some degree of political crisis, some even facing questions of legitimacy of national governments. In these circumstances it is difficult for governments to find support for policies which address global meta-narratives like climate change, and to motivate individuals and collectives to pay the costs required for

intangible global "goods" such as biodiversity or the mitigation of "bads" like global warming. Development assistance should be provided to increase the capacity of society to understand the issues and to devise and support institutions and policies which have long term national benefit. Ongoing support for universal primary schooling and strengthening of universal mathematics and science (especially ecology) literacy may do more for long term adaptation and mitigation in South Asia than immediate programs which appear to address the issue more directly.

Priority Areas for Development Programming at a country level

The overwhelming lesson from this review of the information available is that allowance for the best guesses about climate change must be incorporated into any Australian development assistance programmes. Australia's assistance to South Asia is constrained not only by the resources available, but also by the capacity of the partner country to receive assistance, and in varying degrees by domestic and international political constraints. In most cases, adaption to climate change will be assisted indirectly at best because of the pressing immediate needs of the large population of those whose subsistence is still insecure.

Bangladesh

Of the three focus countries, Bangladesh is potentially the most vulnerable. However it has the most highly developed strategies for adaptation to climate change and has very sophisticated partnerships with many Multi-lateral and bi-lateral partners.

Australia's ongoing support for education, especially working though effective partnerships in primary education (Smith & McMullan 2008, 47) is a necessary part of building the country's adaptive capacity. Similarly improving livelihoods of the rural poor, especially where capacity development is fostered through functional education, skills development and strengthening community organisations contributes to resilience in the face of the likely effects of climate change.

This report has highlighted the need in Bangladesh for safe water alternatives to tube-wells in saline and arsenic contaminated areas. This is an area where Australia may be able to contribute more than it does already through the AusAID NGO Cooperation Program. A minor corollary which receives little attention is the need to develop human waste disposal systems which are effective in periods of inundation during the predicted increasing frequency of flooding.

Pakistan

Australia has very limited development assistance commitments to Pakistan, most recently focussing on humanitarian assistance and research to add value in horticulture.

In light of Pakistan's need for meteorological and natural resource information and modelling noted above, this could be an area where Australia may be able to contribute to capacity development in Pakistan.

Nepal

As for Pakistan, development assistance to Nepal is relatively minor ($8.2m in 2008-09) (Smith & McMullan 2008, 48). There may be opportunity to increase assistance if the current political turmoil resolves.

As discussed under mainstreaming climate change above, AusAID should ensure climate change considerations are addressed in the existing programs *Mid and Far West Water Supply and Environmental Sanitation Program.*

Australia should also consider building on its experience in the forestry sector (ie the *Nepal–Australia Community Forestry Project*) and reviving this program for use in other regions in Nepal

In both Nepal and Pakistan it may be possible to assist development of the capacity of civil society organisation to engage in environmental management. It may be best to do so through some regional body.

Recommendations

This report recommends the following:

- AusAID should review its existing programs to see if they are vulnerable to future climate impacts and to see if they are able to flexibly respond to future predictions and uncertainties.

- AusAID should make stronger investment in programs which tackle poverty and disaster preparedness in the short term and which will also be increasingly valuable in addressing climate change into the future. The individuals who constitute South Asia's poor may not see long term climate change without more immediate investment in primary health care, sanitation, potable water and disaster mitigation. Strategies which address poverty and vulnerability with a view to long term sustainability under climate change scenarios potentially offer win/win solutions.

- Substantial new Australian ODA funding (in addition to existing ODA commitments) should be invested in climate change adaptation initiatives in the region.

- Adaptation options pursued in the Australian development program should be integrated with other development efforts and be broadly aligned with the targets outlined in the MDGs.

- Adaptation to climate change should be tackled in a manner that addresses its trans-boundary nature: Regional coordinated strategies are required to cope with the impacts of climate change. As Australia is a small donor to South Asia, the current strategy of working in broad partnership with multi-lateral development agencies where possible is supported.

- Mitigation of climate change in South Asia should be primarily sought as a secondary benefit from programs whose central aim to address the development needs of the region. Mitigation is primarily the responsibility of those countries who contribute the highest per-capita emissions of green-house gases. Consequently mitigation efforts should focus on assisting South Asian nations "leapfrog" old technologies and embed new low carbon infrastructure into their economies. For example, Australian aid to the energy sector should only fund projects that improve energy efficiency, improve demand management and/or increase the proportion of renewable energy.

- Australian aid should have an increased focus on tackling deforestation and enabling reforestation in South Asia and that this should become a stronger priority (preferably as part of a multilateral effort) for aid to the region.
- A stronger priority should be given to governance issues associated with the adaptation and mitigation of climate change impacts.
- Education should remain a priority for assistance for the region and should build on the initiatives outlined in the United Nations Decade on Education for Sustainability.

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Appendix 1: Global Environment Fund Projects addressing climate change in Bangladesh, Nepal and Pakistan (as of 2007)

Approved Bangladesh Projects (All amounts in US$ million)

GEF ID	Country	Project Name	Focal Area	GEF Agency	Project Type	GEF Grant	Cofinancing Total	Project
619	Bangladesh	Prepare its Initial National Communication in Response to its Commitments to UNFCCC	Climate Change	UNEP	Enabling Activity	0.175	0	CEO Approve
1209	Bangladesh	Rural Electrification and Renewable Energy Development	Climate Change	IBRD	Full Size Project	8.54	22.4	Under Imple
2026	Bangladesh	National Adapation Programme of Action	Climate Change	UNDP	Enabling Activity	0.2	0.05	Project Com
1901	Bangladesh	Improving Kiln Efficiency for the Brick Industry	Climate Change	UNDP	Full Size Project	3.348	11.04	Council Appr
Sub totals						**12.263**	**33.49**	**4 Proj**

Projects Under Preparation (All amounts in US$ million)

GEF ID	Country	Project Name	Focal Area	GEF Agency	Project Type	GEF Grant	Cofinancing Total	Project
3287	Bangladesh	Community Based Adaptation to Climate Change through Coastal Afforestation	Climate Change	UNDP	Full Size Project	3.1	6.08	PPG Approve
Sub totals						**3.1**	**6.08**	**1 Pro**

Approved Nepal Projects (All amounts in US$ million)

GEF ID	Country	Project Name	Focal Area	GEF Agency	Project Type	GEF Grant	Cofinancing Total	Project
453	Nepal	Enabling Activities for the Preparation of Initial National Communications Related to the UNFCCC	Climate Change	UNEP	Enabling Activity	0.31	0.07	Project Com
1920	Nepal	Climate Change Enabling Activities Expedited Financing (Additional Financing for Capacity Building in Priority Areas)	Climate Change	UNEP	Enabling Activity	0.1	0	Under Imple
3412	Nepal	National Adaptation Programme of Action to Climate Change	Climate Change	UNDP	Enabling Activity	0.2	0.06	CEO Approve
Sub totals						**0.61**	**0.13**	**3 Proj**

Approved Pakistan Projects (All amounts in US$ million)								
GEF ID	**Country**	**Project Name**	**Focal Area**	**GEF Agency**	**Project Type**	**GEF Grant**	**Cofinancing Total**	**Project**
391	Pakistan	Fuel Efficiency in the Road Transport Sector	Climate Change	UNDP	Full Size Project	7	0	Council Appr
489	Pakistan	Enabling Activities for the Preparation of Initial National Communications Related to the UNFCCC	Climate Change	UNEP	Enabling Activity	0.274	0.05	Project Comp
1260	Pakistan	Sustainable Development of Utility-Scale Wind Power Production (Phase 1)	Climate Change	UNDP	Full Size Project	3.475	0.72	Under Imple
2408	Pakistan	Expedited Financing for Interim Measures for Capacity Building in Priority Areas (Phase II)	Climate Change	UNEP	Enabling Activity	0.1	0	Under Implm
2526	Pakistan	Promotion of Energy Efficient Cooking, Heating and Housing Technologies (PEECH)	Climate Change	UNDP	Medium Size Project	1	1.489	CEO Approve
Sub totals						**11.849**	**2.259**	**5 Proj**
Total for three countries						**15.079**	**8.469**	**13 Pro**
Sub totals						**37.747**	**46.888**	**7 Proj**

Source: (Global Environment Facility, 2007)

Endnotes

[1] On the occasion of the devastating 1991 cyclone the Chairman of Greenpeace wrote the leaders of the Group of Seven nations suggesting that the cyclone "may be linked to" global climate change (Dove & Khan, 1995, p. 455).

[2] The flooding experienced in the low-lying Terai is exacerbated by land use practices upstream in the hill and mountain areas. Construction of settlements, cultivating land on steep slopes, gathering fuel wood, and building other infrastructure have led to severe land degradation in Nepal. From 1979-1998, forested area decreased by one third (Agrawala et al., 2003). Deforestation, both for community and commercial purposes, has contributed to the impacts of up to 12,000 landslides reported per year (Agrawala et al., 2003, p. 37).

[3] In particular he blames military traffic in this highly militarised border area. This indicates relationship between regional security issues and environmental problems in South Asia.

[4] Pakistan is scheduled in the Budget to share in ACIAR projects "for more productive citrus and mango systems through the Australia Pakistan Agriculture Sector Linkages program" (Smith & McMullan, 2008, p. 59). It is to be hoped that the systems under development will be subject to climate change risk assessment and appropriate strategies to manage the risks will be one of the project outputs.

[5] Nepal's submission to the UNFCCC suggests a series of response to climate impacts on water resources that are relevant to much of the South Asia region. These include:

- More efficient management of existing poor water supply infrastructures
- Institutional arrangements to limit water demand
- Strengthening of watershed management programs
- Introduction of improved water management technologies
- Introduction of a drip irrigation scheme
- Introduction of less water intensive crops
- Coordination of water resources development among government and NGOs avoiding duplication
- Encouragement and incentives on water conservation
- Promotion of groundwater recharge technologies (MPE Nepal, 2004, p.102)

[6] Forests are the most visible ecological resource written out of the script for international cooperation on mitigation. But, they are not the only such resource. Carbon is also stored in soil and biomass. The rehabilitation of severely degraded grasslands, and the conversion of degraded croplands to forests and agroforestry systems, can also build carbon storage capacity (Human Development Report, 2007).

[7] The long-running conflict between local Mandi communities and "social forestry" projects introducing rubber plantation into the Modhupur *sal* forest in Bangladesh is another example of the need for rigor in such interventions (Gain, 1998).

[8] According to the Human Development Report "The power sector in India is dominated by large monopolies that control both power supply and distribution. Most state power utilities are in a financially weak condition, with average annual losses running at 40 percent. Uncollected bills, the provision of heavily subsidized electricity to agriculture (where most benefits are captured by high income farmers) and wider inefficiencies all contribute to these losses. The upshot is that utilities lack the financial resources needed to upgrade technology" (Human Development Report, 2007, 152).

[9] Some of the strategies flagged in Pakistan's Initial National Communication to the United Nations Framework Convention include

- Policy reform of the power sector
- Improving the storage, delivery, allocation and use of irrigation through infrastructure renewal, policy reform, watershed management and agricultural innovation.
- Improve equity and efficiency of urban water use.
- Improved weather forecasting and information systems.
- Improved forest management.
- develop capacity to deal with natural disasters and extreme weather events like floods and droughts.
- Institutional strengthening – local and national level