DISCUSSION PAPER

Adapting to Climate Change

Issues for South Asia

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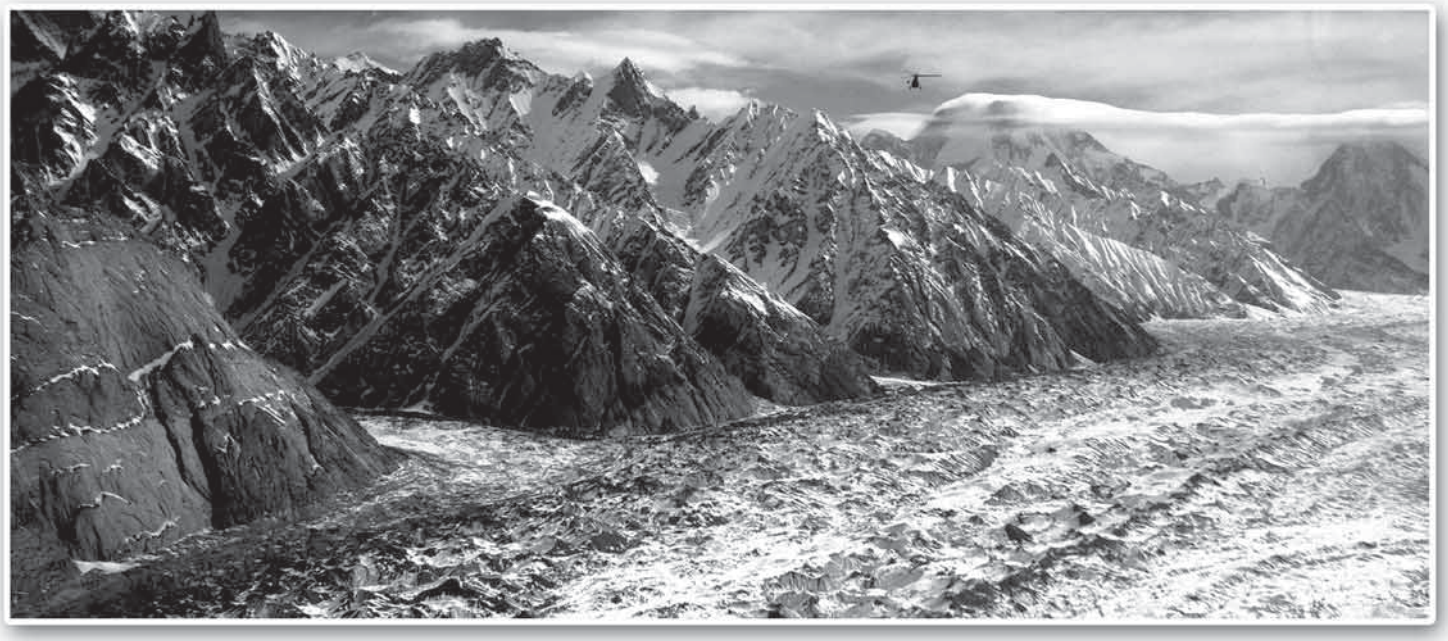

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Acronyms and abbreviations

ADB	Asian Development Bank
CBA	Community-based adaptation
CBOs	Community-based organizations
CCS	Carbon-capture and storage
CDM	Clean Development Mechanism
CO_2	Carbon dioxide
COP	Conference of Parties
CSIRO	Commonwealth Scientific and Industrial Research Organization
DNAs	Designated National Authorities
EU	European Union
GCM	General circulation model
GDP	Gross domestic product
GHG	Greenhouse gas
ICIMOD	International Centre for Integrated Mountain Development
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
LAPA	Local Adaptation Programmes of Action
LDCs	Least-developed countries
NAPA	National Adaptation Programmes of Action
NCAR	National Center for Atmospheric Research
NGOs	Non-governmental organizations
REDD	Reduced Emissions from Deforestation and Forest Degradation
SAARC	South Asian Association for Regional Cooperation
SMRC	SAARC Meteorological Research Centre
SRES	Special Report on Emissions Scenarios
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
WDI	World Development Indicator
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wildlife Fund

Contents

Executive summary

As demonstrated by abnormal rainfall patterns and rising temperatures, climate change is happening. South Asia is especially vulnerable to climate change as it faces the development challenges of addressing high levels of poverty and population density. Furthermore, the region is prone to natural disasters. Compounding these risks is the high rate of urbanization. By 2020, South Asia is expected to host five of the world's 11 megacities.

Among other things, climate change will have a severe impact on the region's agriculture and food security. The Himalayan glaciers serve as the reservoir of freshwater for South Asia, but rapid melting of these glaciers could affect the livelihood of 1.5 billion people who rely on snow-fed rivers. Retreating glaciers, combined with increased precipitation and run-off, will increase the risk of flood in the low-lying areas and the chances of glacial lake outburst floods in Bhutan and Nepal. The resulting sea level rise and changes in salinity profile will affect large tracts of agriculture land and delicate fisheries in the coastal waters of the Maldives and Bangladesh. Even more concerning is the long-term depletion of the glaciers. All these are going to severely impact South Asia's agriculture thereby making food insecurity an even graver concern.

Agriculture employs 60 percent of South Asia's labour force and is the basis of livelihood for most of the region's poor population. Therefore, growth of the agriculture sector is closely linked with poverty alleviation. Removal of the social forces that create unequal exposure to the risks of climate change is imperative when addressing the vulnerability of the poor.

Climate change is expected to worsen the existing strains on the agriculture sector in South Asia by altering the conditions critical for crop growth, such as moisture and temperature. According to several country-level studies, temperature rise is expected to lessen yields of high earning crops such as wheat and rice in South Asia, where they are cultivated close to their upper temperature threshold. Moreover, warming temperatures will force farmers in Nepal and Bhutan to shift the cultivating zone to cooler elevations where the steep slopes are unsuitable for agriculture. An additional concern is the spread of pathogen and weakening of host plant resistance due to heat stress. Excessive use of pesticides and other farming inputs will possibly have a negative impact on food production and consumers' health.

The uncertainty of the future scenario of climate change makes it difficult to predict the exact percentage change in crop yield. The basic method of assessing the impact of climate change on food production has not changed significantly over the years, but incorporation of new parameters have increased the resolution of models. According to the findings of several studies, in general, South Asia as well as sub-Saharan Africa will be the most affected by climate change due to their geographical position as well as socio-economic conditions, but some localities may fare better than the others.

Heat stress and rapid melting of glaciers due to temperature rise will be the main factors behind reduction in crop yield. Estimations for the far future are less reliable, but crop yields are expected to decline with time if proper measures are not taken.

Effects of climate change on crop yield will naturally induce changes in agriculture production and prices. According to a study by the International Food Policy Research Institute (IFPRI), even without climate change, world prices of important crops such as rice, wheat and maize will increase due to population and income growth as well as competing demand for biofuels. But climate change will cause further price hikes. Although livestock will not be directly affected by climate change, decreasing availability of pastures and higher feed costs will pass on to the price of meat. Lower yields and higher food prices will in turn affect food consumption and human diet in the future. Under climate change, consumption of meat and cereals will fall by 2050. Estimates by IFPRI suggest that consumption of meat and cereals, and hence per capita calorie intake, in South Asia will be far below that of most developing countries.

In view of such effects of climate change on South Asia, it is important for countries in the region to undertake various adaptation measures. Being a large and diverse subcontinent, South Asia has a wealth of knowledge and experience on coping with climate variability and extreme weather events. Some adaptation projects undertaken in some countries of the region reveal common successful practices being employed on the field.

Building on or even reviving traditional practices are a highly popular tactic in adaptation projects in South Asia. Even infrastructural adjustments such as large-scale irrigation, coastal defenses and warning systems have long been established in the region. The culture of co-operatives and resource sharing has proven to be an effective adaptation strategy. Another proven strategy has been building local ownership by empowering the community with knowledge, skills, resources and authority through community-based adaptation (CBA). In this approach, local knowledge is harnessed and authority is transferred to the community, thus ensuring that programmes are continued in the long run. Similarly, community-based organizations have built good relationships with local governments and key institutions, whose cooperation is critical in implementing CBA projects.

Efforts have also been undertaken at the national and regional levels. At the national level South Asian least-developed countries have prepared their National Adaptation Programmes of Action (NAPAs). Nepal has even developed a Local Adaptation Programme of Action (LAPA) as a bottom-up approach. Pakistan has approved the first draft of its national climate change policy but it is not yet publicly available. Bangladesh and the Maldives have demonstrated leadership by establishing budgetary allocations to finance adaptation and mitigation efforts. In addition, the Asian Development Bank, the World Bank and the International Finance Corporation are assisting Bangladesh and Nepal to prepare a Strategic Programme for Climate Resilience based on their respective NAPAs under the Climate Resilience of the Climate Investment Funds.

At the regional level, the South Asian Association for Regional Cooperation (SAARC) adopted the SAARC Plan of Action on Environment in 1997. After the devastating Indian Ocean tsunami in late 2004, SAARC took the first step in addressing climate change by adopting the Dhaka Declaration on Climate Change and SAARC Action Plan on Climate Change in 2008. The Declaration suggested the development of clean development mechanism (CDM) projects, expansion of natural carbon sinks and cooperation among member states. The Action Plan identified seven areas to address climate change, including adapta-

tion, technology transfer, investment and capacity building for negotiation. The latest and most significant step taken by SAARC was making climate change the theme of the 16th SAARC Summit in Thimphu, in which members agreed to form separate inter-governmental initiatives on disaster risk reduction, the mountains, monsoon systems and oceans. SAARC has made progress in forming a framework to address climate change by establishing regular high-level meetings, a network of institutions to build knowledge, and bringing out important documents outlining common priorities.

However, SAARC has also been criticized for its sluggish and inadequate response to climate change, with much of its actions supposedly limited to conferences, rhetoric and studies. The organization has reached out to several regional and international actors but its ability to tap into global opportunities has been inadequate. The main reasons are weak capacity and lack of awareness among key stakeholders, including politicians. The stark contrast between the progress made by India and the rest of the SAARC member countries illustrates the lack of unity in the region. India requires large concessions on emissions to fuel its economic growth, and has resisted international pressures to curb emissions. On the other hand, the least-developed member countries, that are most vulnerable to climate change, have been demanding an international treaty irrespective of the share of responsibilities. Lack of cooperation also stems from political and economic issues in the region such as the long-standing disputes over water resources between India and its neighbours.

In spite of SAARC's slow implementation, it has shown noteworthy leadership by bringing together heads of state to work on adaptation and by taking the initiative to complement international efforts, which have also progressed at a laggard pace. Conflict resolution, transboundary river management, financing adaptation projects and defending the common interests of South Asia at global negotiations are some of the important tasks that SAARC should take up in coming years.

The most severe threats of climate change, such as droughts, floods and cyclones, transcend national boundaries. Thus, multilateral cooperation is critical to tackling the shared threat of climate change. For South Asia, two major issues in relation to multilateral cooperation on climate change include finance and technology transfer. It is estimated that achieving climate goals by 2020 will require a total global investment of roughly US$5 trillion. But pledges, let alone disbursements, to date, fall far short of what is needed. Several multilateral funds under the United Nations Framework Convention on Climate Change, the World Bank, the Global Environment Facility and other international organizations target projects related to climate change, but these funds are generally voluntary and have limited resources. Moreover, the proportion of actual disbursements of funds in comparison to approved amount has been very small in the case of South Asian countries.

Regarding technology transfer, multilateral efforts towards the development of low carbon technology have been extensive. Technologies such as carbon-capture and storage hold immense potential in reducing emissions, but implementing these expensive technologies at a large scale will require multilateral cooperation and dedication. To help South Asian countries adopt such technologies, developed countries have a bigger role to play in transferring them to the region.

Chapter 1

Introduction

The earth is experiencing climate variability at unprecedented levels in recent years as demonstrated by the abnormal rainfall patterns and rising temperatures. Scientists and experts agree that this is largely due to massive greenhouse gas (GHG) emissions for which rapid industrialization and human activities have played major roles. While some countries have already started experiencing the negative effects of climate change, it is certain that those that have remained untouched so far are also going to be adversely affected, although the extent of the impacts might vary.

South Asia is especially vulnerable to climate change as it faces the development challenges of addressing high levels of poverty and population density. Furthermore, the region is prone to natural disasters. Between 1980 and 2012, natural and climatological disasters were responsible for damages worth around US$95 billion and death of 492 million people in the region.[1] With climate change, these disasters are likely to increase in frequency and intensity, and add pressure to the high demand on natural resources needed to sustain growth.

Compounding these risks is the high rate of urbanization in the region. By 2020, South Asia is expected to host five of the world's 11 megacities, namely Mumbai, Delhi, Dhaka, Karachi and Kolkata (World Bank 2009). The poor living in the crowded slums of these cities have very little protection or fall-back options in the face of natural disasters.

The impact of climate change on South Asia's agriculture production and productivity threatens the livelihoods of the majority of its populations, which are dependent on agriculture. It also makes ensuring food security even more challenging. The issue of climate change adaptation is thus intimately linked to the physical existence as well as food security concerns. It is also closely linked with the health and livelihoods of people, especially in developing and least-developed countries. But ironically, discussions on climate change at the global level tend to focus more on mitigation. This is reflected, for example, in the bias of global climate finance schemes towards mitigation.

The issue of climate change adaptation is intimately linked to food security and livelihood issues in developing and least-developed countries.

Given the severity of the impacts of climate change to South Asia, and the inadequacy of resources to adapt to such impacts, it is useful to understand how South Asian countries can deal with the negative impacts of climate change which is apprehended to be manifested in various forms.

This paper identifies the impacts of climate change on South Asia, particularly in the context of food security. However, for a broader understanding, impacts of climate change on various other sectors are also discussed. The paper is organized as follows:

Chapter 2 provides an overview of the impacts of climate change on South Asia. Chapter 3 discusses issues related to the agriculture sector in the region while

Chapter 4 delves into food security issues. Chapter 5 provides information on climate change adaptation programmes in South Asia, including the role of multilateral cooperation and regional cooperation for climate adaptation. Chapter 6 concludes the paper and provides some recommendations.

Chapter 2

Impacts of climate change on South Asia: An overview

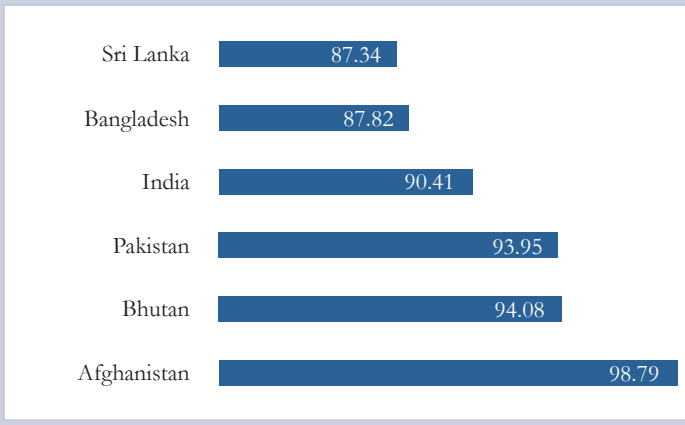
2.1 Water

The Himalayan glaciers are vital resource for South Asia because they act as reservoirs of freshwater for the region. Rapid melting of these glaciers due to rising temperatures because of climate change could affect the livelihood of 1.5 billion people who live on the floodplains of snow-fed rivers (World Bank 2009). Retreating glaciers in the Himalayas, combined with increased precipitation and run-off over the Ganges, Brahmaputra and Meghna river basins, will increase risk of floods for the next two to three decades, especially in the low-lying coastal and delta regions of the Indian Ocean. Moreover, the melting season of the glaciers will coincide with the summer monsoon and thereby intensify the monsoon rains and chances of flood disasters like the Glacial Lake Outburst Floods in Nepal and Bhutan.[2] Flooding as well as thermal expansion of the ocean waters will induce sea level rise and changes in the sediment balance, and salinity profile of coastal areas, affecting large areas of fertile land across the region as well as the delicate fisheries in the coastal waters of the Maldives and Bangladesh.

Even more concerning is the depletion of the glaciers and reduction in freshwater availability for agriculture. The Himalayan glaciers are the source of nine of the largest rivers in Asia. Of these, the Ganges, Brahmaputra and Indus river basins feed over half a billion people (IPCC 2007). However, records suggest that the Gangotri glacier, the source of the Ganges River, is retreating more quickly in recent years, though its link to global warming is not yet certain. Similarly, by 2050, the annual run-off in the Brahmaputra and Indus basins are projected to decline by 14 and 27 percent, respectively (IPCC 2001).

At the country level, Afghanistan is particularly vulnerable because a large proportion of its freshwater supply is used for agriculture (Figure 2.1), but water flow in the country could decline by 20 to 40 percent (World Bank 2009). Water scarcity will adversely affect irrigation as well as hydropower systems. In Pakistan, a 6 percent decrease in rainfall will increase net irrigation requirement for wheat by 29 percent (Kelkar and Bhadwal 2007). Decreasing water supply combined with the intrusion of seawater into coastal areas has significant implications

Figure 2.1 Annual freshwater withdrawals, agriculture (% of total freshwater withdrawal), 2009



Source: World Development Indicator (WDI) database, The World Bank.

for downstream communities and cross-boundary water sharing arrangements.

2.2 Health

An increase in the frequency and duration of heat waves and humid conditions is likely to increase the risk of mortality and morbidity, especially among the aged and urban poor populations in tropical Asia (Hales *et al.* 2003). According to some studies, a large number of heat-related deaths among vulnerable groups such as the poor, elderly and labourers (rickshaw pullers and farmers) are already evident (Lal 2003). Similarly, high temperature can worsen the polluted urban air quality and lead to the spread of heat- and smog-induced illnesses such as cardiovascular and respiratory diseases (Cruz *et al.* 2007; Patz *et al.* 2000).

An increase in the frequency and duration of heat waves and humid conditions is likely to increase the risk of mortality and morbidity in tropical Asia

An indirect health impact of temperature rise and flooding is the spread of epidemics like malaria and dengue (Hales *et al.* 2002). Illnesses and deaths due to diarrhea and malnutrition, which are already acute in the region, will increase with frequent droughts and flooding. Flooding can contaminate surface waters and give rise to water-borne diseases such as diarrhea, cholera, dysentery and typhoid. The stagnant waters after the flood provide breeding grounds for mosquitoes, increasing the risk of malaria. The risk of these conditions is expected to be the largest in South Asia by 2030 (McMichael *et al.* 2004), though in some areas such as the southern states of India, the transmission season will be narrower by 2080 (Mitra *et al.* 2004).

The pathogens that host infectious diseases like malaria may develop resistance to pesticides under climate change conditions (Singh *et al.* 2004). Increased temperature and moisture directly influence the breeding of malaria protozoa and can intensify invasiveness of other infectious vectors as well (Tong and Ying 2000). For example, a higher temperature range of 24°C–27°C is optimal for the infection rate of *schistosomiasis*. Warming of surface waters along the coast of South Asia can also nurture phytoplankton blooms, which are ideal breeding grounds for infectious bacteria like cholera (Pascual *et al.* 2002).

2.3 Settlements and infrastructure

According to conservative estimates, sea level rise of about 40 centimetres by the end of the 21st century can raise the number of people at risk of floods annually from 13 million to 94 million. Almost 60 percent of this risk pertains to populations in the coastal areas of South Asia (Wassmann *et al.* 2004). In fact, India, Pakistan and Bangladesh rank among the top seven populous countries of the world, and majority of Asia's population growth is projected to come from South Asia over the next 50 years (UNDESA-PD 2002). In India, one-metre sea-level rise can inundate 5,763 square kilometres of land (TERI 1996). Bangladesh, comprised of extensive deltaic plains and subject to the complex dynamics of the Bay of Bengal and monsoon rains, is especially vulnerable to these floods (Singh 2001; Ericson *et al.* 2005). Wind and floods caused by higher sea level and more extreme storms will incur substantial damage on coastal cities. Table 2.1 shows the economic costs of natural disasters in the region since 1980. Moreover, human activity is accelerating the destruction of natural defenses to floods—for example, land subsidence due to mining and groundwater extraction, and conversion of coastal mangroves for aquaculture (Woodroffe *et al.* 2006). South Asia and its megacities also have lower protection than other developed parts of Asia.

Climate change will amplify existing stresses, including poor air and water quality, in urban cities. According to sample surveys conducted by the World Health Organization (WHO), air quality, indicated by annual mean concentration of fine particulate matter, is worse in South Asia, especially Pakistan, than in Latin America, though it is better than in the Middle East. The heat generated by urban activities combined with low for-

Table 2.1 Impact of natural disasters in South Asian countries

Estimated cost (US$ '000)									
	AFG	BGD	BTN	IND	MDV	NPL	PAK	LKA	TOTAL
Drought	142,050	0	0	2,041,122	0	0	2,47,000	0	2,430,172
Seismic activity	29,060	500,000	0	5,102,300	470,100	305,000	5,226,500	1,316,500	12,949,460
Epidemic	0	0	0	0	0	0	0	0	-
Extreme temperature	10	0	0	544000	0	123	0	0	544,133
Flood	344,000	11,228,800	0	34,094,629	6,000	1,036,429	13,798,378	962,864	61,471,100
Mass movement	0	0	0	54500	0	0	18000	0	72,500
Storm	5,000	5,343,700	0	10,406,904	30,000	3,600	1,710,936	0	17,500,140
Wildfire	0	0	3,500	2,000	0	6,200	0	0	11,700
Total	520,120	17,072,500	3,500	52,245,455	506,100	1,351,352	21,000,814	2,279,364	94,979,205
Deaths									
Drought	37	0	0	320	0	0	143	0	500
Seismic activity	9,186	36	12	49,843	102	816	74,280	35,399	169,674
Epidemic	3,845	9,799	41	15,424	4	3,551	246	693	33,603
Extreme temperature	1,889	2,368	0	11,651	0	168	1,211	0	17,287
Flood	3,362	12,437	222	40,589	0	5,367	9,586	1,043	72,606
Mass movement	956	0	0	2,817	0	1,216	579	65	5,633
Storm	362	167,217	29	23,379	0	97	1,469	36	192,589
Wildfire	0	0	0	6	0	88	0	0	94
Total	19,637	191,857	304	144,029	106	11,303	87,514	37,236	491,986

Note: AFG–Afghanistan; BGD–Bangladesh; BTN–Bhutan; IND–India; MDV–Maldives; NPL–Nepal; PAK–Pakistan; LKA–Sri Lanka.

Source: EM-DAT: The International Disaster Database.

est cover makes cities more vulnerable to temperature rise (Kalnay and Cai 2003; Patz *et al.* 2005). Rapid industrialization in South Asia is also exerting pressure on natural resources, notably land—a depleting resource in the region. Vast tracts of land are being transformed into agriculture land to feed and support the rapidly expanding cities (Zeqiang *et al.* 2001). The remaining natural flood plains are already disappearing as a result of unregulated land use and changing stream flows due to climate and human-related factors. At the same time, populations in uplands exert pressure on endangered forests by encroaching into forest zones for cultivation, grazing, wood collection, and so on.

Industrialization will lead to intense water and energy use. South Asia is expected to consume one-fifth of the world's total energy by the end of the 21st century (Parikh and Bhattacharya 2004) and climate change is likely to influence energy use and other urban activities. The stress on natural resources can lead to instability and conflict, often followed by displacement of people and changes in migration patterns (Barnett 2003).

2.4 Biodiversity

South Asia's geographical expanse includes ecosystems that support a rich variety of flora and fauna. Some of them include the Sundarbans—the largest contiguous mangrove in the world—in Bangladesh, the magnificent coral reefs and atolls in the Maldives, the snowy deserts in the upper Himalayas and Kashmir, the Western and Eastern Ghats of India and Sri Lanka, and the virgin forests of Bhutan. However, the growing demand for natural resources is imposing an enormous pressure on these delicate ecosystems.

The grasslands of the Indian subcontinent—the shola region of South India, the Himalayan pastures, the semi-arid grasslands of Western and Central India, and the scrublands of the Deccan Plateau—are especially vulnerable to climate change because they survive at a minimum level of water intake. These grasslands are home to diverse avian species and some of the world's fastest animals, including the now extinct Asiatic Cheetah. Ecologists estimate that more than 43 percent of the Indian subconti-

Table 2.2 Threats of climate change on ecosystems in South Asia

Ecosystems	Threats
Coastal (mangroves, mudflats, estuaries)	Inundation, salination, storms, species loss
Coral reefs	Bleaching, acidification, loss of ecological and protective services, reduction in species diversity
Inland wetlands	Desiccation, drainage and diversion, degradation and service loss
Forests	Loss of forest cover and species, altered composition and structure, enhanced evapo-transpiration
Mountain (temperate, sub-temperate, temperate)	Altitudinal shifts in vegetation disrupting species types
Mountain (subalpine, alpine)	Loss of vegetation cover
Glaciers	Loss of coverage
Desert	Expansion
Rangelands and grasslands	Regime shift, degradation due to overgrazing and increased incidence of fire
Freshwater (rivers, lakes)	Desiccation, increased salinity at coast, degradation due to increased demand
Species diversity (floral and faunal)	Loss of diversity and habitat, changes in species composition and food web

Source: South Asia Climate Change Strategy (2009).

nent is in the process of changing from grassland to desert (GoM 2008). Desertification, along with loss of grassland coverage and grass yield, is projected to accelerate with temperature rise associated with climate change (Lu and Lu 2003). Also, grassland productivity is expected to decline by as much as 40–90 percent for an increase in temperature of 2°C–3°C, combined with reduced precipitation in the semi-arid and arid regions of Asia (IPCC 2007).

Rate of forest degradation is the highest in Asia. According to the United Nations (UN), Pakistan is the most heavily deforested country in Asia. The forests in Pakistan, which were destroyed after the floods of 2010, are very susceptible to the negative effects of climate change (Siddiqui *et al.* 1999). Small-scale fuel wood collection, industrial logging for exports of timber, and conversion of forests into estate crop plantation and mining are responsible for decreasing forest cover. In addition, the increase in concentration of atmospheric carbon dioxide (CO_2) may hinder the growth of South Asia's plant life. General circulation model (GCM) projections indicated that 133 to 2,835 plants and 10 to 213 vertebrates in Indo-Burma could become extinct in a climate with doubled CO_2 levels (Malcolm *et al.* 2006).

The subcontinent's coastline is home to a vibrant marine life. Consistency in water temperature, salinity levels, ocean current patterns and the food chain are vital for the survival of fish, but climate change and subsequent sea level rise have the potential to disrupt these critical balances and the coastal economies that depend on them (Cruz *et al.* 2007). Increased frequency of El Niño events could destroy fish larvae and contribute to a decline in fishery production in South Asia's coastal waters. Fisheries at higher altitudes of the ocean may be adversely affected by the lower concentration of dissolved oxygen due to warming of surface waters. Disruption in the timing and extent of precipitation in the plains could also influence the migration patterns of fish species from the river to the flood plains for breeding (FAO 2003).

2.5 Tourism

The natural beauty of South Asia has given way to a booming tourism industry in the region. These rare eco-tourist destinations will be affected by climate change. The coral reefs support a huge tourism industry, providing income as well as food and medicine for coastal communities. The coral reefs of South Asia are found in the Arabian Sea, the Indian Ocean, the Lakshadweep islands, and the Maldives, where the tourism sector accounted for 30 percent of the country's gross domestic product (GDP) in 2010 (World Bank 2010).

In recent years, warming of ocean waters, caused in part by El Niño, have damaged South Asia's reefs. Corals are very sensitive to temperature change. Even a single degree rise in temperature can result in coral "bleaching", that is, the death of the algae that give corals their brilliant colors. Arthur (2000) found that the intense El Niño event of 1997–1998, which warmed water by more than 3°C, induced widespread bleaching and bleaching-related mortality of the coral reefs in the Indian Ocean. Bleached coral comprised as much as 82 percent and 89 percent of the coral cover in the Lakshadweep islands and the Gulf of Mannar, respectively. Thus, temperature rise poses a significant threat to corals. In addition, the increasing concentration of CO_2 can hinder the capacity of reefs to calcify (Kleypas *et al.* 1999; Wilkinson 2002), and sea level rise can lead to storminess and destruction of coral reefs (Knowlton 2001; Wang 2005). Studies project up to 88 percent loss of reefs in Asia in the next 30 years under the "business-as-usual" scenario of the Intergovernmental Panel on Climate Change (IPCC) (Sheppard 2003; Wilkinson 2004). Frequent and intense weather events will have an adverse impact on other aquatic ecosystems as well, including the estuarine flora (IPCC 2007).

The rate of forest degradation is the highest in Asia, and Pakistan as the most heavily deforested country in the continent.

Chapter 3

Agriculture in South Asia

3.1 Introduction

The agriculture sector sustains a large portion of South Asia's poor population and hence its growth is closely linked to poverty alleviation. More than 75 percent of the region's poor population is concentrated in rural areas, most of who depend on agriculture for their livelihoods. The Green Revolution of the 1970s and 1980s reduced rural poverty significantly because higher food grain productivity raised incomes of poor farmers as well. A cross-country study spanning the period 1981–2003 found that the growth of GDP in the agriculture sector is far more effective in reducing poverty than GDP growth in the non-agriculture sector (Ligon and Sadoulet 2008; World Bank 2007).

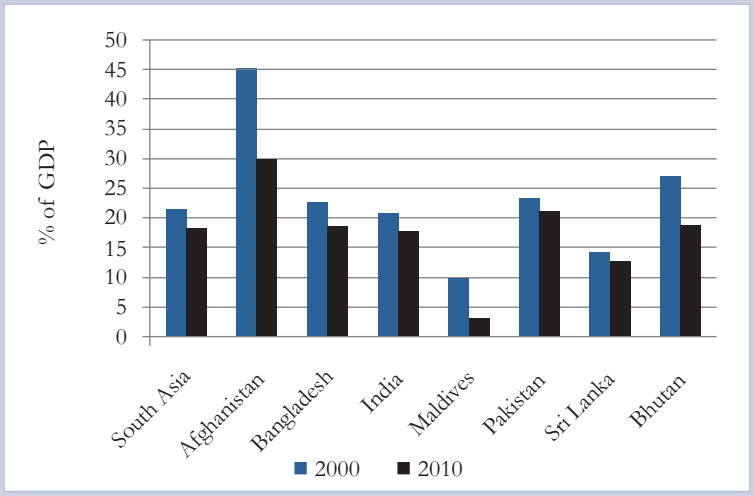
Presently, per capita growth in agriculture productivity in South Asia is less than 2 percent, which is comparatively lower than in other regions such as East Asia and the Pacific (3.1 percent) and Latin America (2.8 percent) (World Bank 2009). Despite employing 60 percent of the region's labour force, value addition of agriculture to the region's GDP has reduced to 18 percent in 2010 (Figure 3.1, next page). Some of the factors constraining growth include declining quality of inputs such as seeds, fertilizers, and pesticides; reduced water availability; lack of access to credit for farmers; and obsolete technologies and farming practices. For example, inefficient use of inputs, intensive cropping systems and a narrower genetic material base were responsible for reducing rice yield in Asia from 2.8 percent in the 1980s to 1.1 percent in the 1990s (IPCC 2001).

Governments in South Asia subsidize agriculture inputs in varying degrees. While this is necessary to incentivize farmers and help keep prices of agriculture products low, in some countries such as India and Sri Lanka, subsidies have also acted as disincentives for farmers to adopt more productive and efficient farming practices. They have also inadvertently supported over-extraction of groundwater, uncontrolled fertilization, and intrusion of saltwater into irrigated lands. For example, zero or negligible tariffs on farm power and no additional costs for extracting extra water in some states of India have led to liberal usage of water (Aggarwal 2004). Moreover, it has been found that over-regulation of agro-based businesses discourage private investments in rural areas. Excessive government regulation and subsidies can also reduce a community's ability to respond to climate change because they delay the economic effects (Antle *et al.* 2010). Incorporating benefits of climate adaptation in the programme design could achieve the dual goals of environmental protection in the current climate and adaptation in the future climate.

In some cases, agriculture subsidies have inadvertently supported over-extraction of groundwater, uncontrolled fertilization, and intrusion of saltwater into irrigated lands.

The burgeoning urban population is pushing the demand for intensive food production, which can lead to loss of soil fertility and depletion of water supply. The expansion of tubewell irrigation schemes to meet the need of rapidly industrializing communities has increased salinity levels in the Gangetic plains and

Figure 3.1 Value addition of agriculture



Source: WDI database, The World Bank.

has depleted groundwater. In Bangladesh, over-extraction of water has exposed the people to high concentration of arsenic in groundwater used for irrigation, especially for boro rice cultivation (Khan *et al.* 2010; Panaullah *et al.* 2009; Islam *et al.* 2005). Forests and grasslands near the cities are being converted into agriculture lands, and intensive agriculture practices are being deployed for higher yields. Moreover, demand for high-value products such as vegetables and meat by the growing middle class in the cities, as well as requirements by international buyers for minimum sanitary standards, are adding pressure to the strained agriculture sector in South Asia.

Most South Asian countries are net importers of food and agriculture products. As shown in Table 3.1, between 2000 and 2010, the share of food import in the country's GDP rose for all countries, except the Maldives and Sri Lanka. This is primarily because of the liberalization policies they adopted in the 1980s, which forced them open their economies to often-subsidized imports from rich countries (Valdes and Foster 2012).

3.2 Impacts of climate change on agriculture in South Asia

One of the greatest threats to South Asia's agriculture is water scarcity. A large share of total fresh water is used for agriculture in South Asia, but many of India's major river basins are likely to face water deficit by 2050 as a result of climate change (Garg and Hassan 2007). Besides water scarcity, land and soil degradation due to climate variability are also detrimental to agriculture. An added concern is the highly unequal access to productive assets such as land and water due to the nature of landholdings in the subcontinent. Removal of the social forces that create unequal exposure to the risks of climate change is just as important as protection from natural hazards

Table 3.1 Share of food import in GDP

	Food Import (US$ million)		2000		2010	
	2000	2010	GDP nom*	Food bill/ GDP (%)	GDP nom*	Food bill/ GDP (%)
Afghanistan	417	666			16,631	4.0
Bangladesh	1,109	5,351	47,125	2.4	105,402	5.1
Bhutan	22	110	428	5.1	1,397	7.9
India	3,157	12,432	474,692	0.7	1,537,966	0.8
Maldives	77	162	624	12.4	1,433	11.3
Nepal	175	575	5,494	3.2	15,108	3.8
Pakistan	1,520	4,871	73,952	2.1	164,792	3.0
Sri Lanka	819	1,839	16,331	5.0	48,241	3.8
South Asia	7,297	26,006	622,811	1.2	1,890,970	1.4

**GDP from WDI database, in US$ million*
Source: FAO database.

when addressing the vulnerability of the poor (Hewitt 1997). Scientists have developed several methods to estimate the exact implications of climate change on agriculture, particularly crop growth.

Studies suggest that in Asia, the heat stress due to climate change will reduce crop yields in the lower latitude areas, such as South Asia, while it will raise yields in the cooler mid- to high-latitude areas (Lou and Lin 1999). The thermal stress will affect critical life stages of the crop and shorten its growing period as well as restrict the supply of water and soil moisture available for plants (Rounsevell *et al.* 1999). Consequently, temperature rise is expected to lessen yields of important crops such as wheat and rice in parts of South Asia where they are cultivated close to their upper temperature threshold. Cereal production is expected to decline at least by 4–10 percent by the end of the 21st century. Non-irrigated wheat and rice will be especially hard hit since a temperature increase of 2.5°C or more may incur loss in net farm revenue between 9–25 percent (Lal 2007).

From a country-level perspective, a 1°C rise in temperature is predicted to reduce wheat yields by 6–9 percent in the humid and arid areas of Pakistan, and even a 0.3°C decadal rise could damage cash crops like cotton, mango and sugarcane (Sultana and Ali 2006; MoE 2003). Similarly, rise in temperature by 0.5°C is predicted to reduce rice yield in Sri Lanka by 6 percent (MENR 2000). In Bangladesh, by 2050, rice and wheat yield might drop by 8 percent and 32 percent, respectively (Faisal and Parveen 2004). Low yield in rice and wheat can affect the economy significantly since they are among the top earning crops in South Asia (Table 3.2).

Temperature rise will pose additional stress on the hot and semi-arid rangelands thereby forcing farmers to shift the cultivating zone to cooler elevations where the steep slopes are unsuitable for agriculture and are susceptible to landslides.

Table 3.2 Most important crops grown in South Asia

Crop	Production value (US$ '000)	Production quantity (metric ton)
Sugar cane	8,162,910	425,196,844
Rice (paddy)	41,671,090	206,210,377
Wheat	16,754,200	120,846,418
Potatoes	4,926,446	43,230,669
Vegetables(fresh)	6,756,402	36,009,709
Other	18,109,551	42,947,629
Total	109,390,731	947,640,740

Source: Knox et al. (2011); FAO STAT (2010).

Regular monsoons are critical for the region's agriculture sector. Approximately three-fifths of the cultivated area in South Asia is rain-fed and monsoons account for more than 70 percent of the region's annual precipitation (World Bank 2009). Rainfall replenishes groundwater and rivers; so changes in precipitation will affect irrigated crops as well.

While it is certain that South Asia will experience temperature rise, there is no agreement on the future rainfall pattern because historically precipitation in the region has been variable. For example, the 2007 IPCC report finds that rainfall intensity has varied even within the same country (India and Pakistan) while no clear trend has been apparent in other countries (Nepal and Bangladesh). Consequently, there is no way to anticipate the future scenario of rainfall and invest accordingly. However, a slight variance in precipitation can have devastating effects on agriculture. The approximate 5 to 8 percent reduction in monsoonal rainfall in India since the 1950s may have contributed to more intense, widespread and longer droughts (Chung and Ramanathan 2006). In 1999 and 2000, droughts caused a sharp decline in the water table and droughts between 2000 and 2002 led to widespread starvation in northeast India as a result of crop failures (Webster *et al.* 1998; Lal 2003). Such incidents are expected to intensify under climate change. About half of the droughts in South Asia are associated

Temperature rise is expected to lessen yields of important crops such as wheat and rice in parts of South Asia where they are cultivated close to their upper temperature threshold.

with the natural El Niño cycle, but scientists predict that warming of the ocean waters will influence this powerful convection (Webster *et al.* 1998).

Conversely, excessive precipitation and sea storms are also likely under climate change. Natural disasters have been very taxing on the agriculture sector in South Asia. During 1962–1988, flooding in Bangladesh damaged about 1.5 million tons of rice, which is the country's staple food, and accounts for nearly 30 percent of the country's average annual food grain import (Paul and Rashid 1993). Again in 1998, floods that lasted 67 days caused a 45 percent reduction in agriculture production and a loss in aman rice production of about 2 to 2.3 million hectares (FAO 1998). The sediment deposited by floods on agriculture lands destroy crops and change runoff regimes, which has a detrimental effect on the availability of water for irrigation, especially in the semi-arid zones in Asia (IPCC 2001; NEC 2000). The loss of land from flooding will push the cultivating zone upwards to unsuitable steep slopes, making mountainous countries like Bhutan especially vulnerable.

The uncertainty of the future scenario of climate change makes it difficult to predict crop yields by any single model.

An additional concern is the spread of pathogen and weakening of host plant resistance due to heat stress. Studies have shown that higher temperatures and longer growing seasons encourage pest growth (Rosenzweig *et al.* 2001; FAO 2004). For example, wheat scab, rice blast, and sheath and culm blight of rice will spread if the climate in Asia becomes warmer and wetter (IPCC 2001). Extreme weather events also give rise to outbreaks and spread of food-borne pathogens such as cholera and mycotoxins. Higher incidence of harmful algal blooms, infection of fish and seafood by pathogens and increased use of pesticides may become sources of food contamination in South Asia. A related health concern may be the increased use of veterinary drugs as rate of livestock disease rises with climate change. Increased use of other farming inputs such as fertilizers will also possibly have a negative impact on food production (FAO 2008).

3.3 Predicting crop yields

The uncertainty of the future scenario of climate change makes it difficult to predict crop yields by any single model. Below is a review of some exercises that have been conducted to estimate such yields.

Model-based studies in the early 1990s estimated crop yields using models and a decision support system. These models predicted the influence of growth factors such as phenotype and management practices on crop yield. Yield predictions were then entered into a world food trade model to estimate aspects of food security—food production, prices and the prevalence of the risk of hunger. The trade model accounts for world population, extent of trade liberalization and regional economic growth rates. The scenarios for these early studies were based on CO_2 simulations generated by three GCMs, including one developed by the United Kingdom Meteorological Office.

After the mid-1990s, higher spatial resolution of GCMs and their improved simulation of atmosphere-ocean interactions substantially raised the accuracy of climate projections. The ability to produce time-dependent scenarios allowed for projections at different time periods, in most cases 2020s, 2050s and 2080s. The future climate conditions were estimated by the Hadley Centre's GCMs known as HadCM2 and HadCM3 and were based on a "business-as-usual" future in economic and social terms.

Modern projections later accounted for the different possible pathways of future socio-economic development, which are delineated in the IPCC's Special Report on Emissions Scenarios (SRES). These differing trajectories of population growth and economic development are expected to distinctly influence future climate conditions and consequently, ag-

riculture's response to these conditions. The projected climate scenarios are derived from HadCM3. The coupling of SRES pathways and advanced estimations of crop yields enables the evaluation of the impact of both socio-economic development and climate change, respectively, on future agriculture productivity, food prices and the extent of the risk of hunger in the world.

Based on broadly the same set of crop yield estimates, recent studies have also used Ricardian models to estimate impacts of climate change on food production. The assumed climate scenarios are the same as in the past, but the economic models take into account land-use changes that would accompany shifts in land values due to alterations in crop productivity and comparative advantage between crops. Consequently, Ricardian models provide a more realistic projection of regional agriculture activity and food supply.

The basic methodology of evaluating the impact of climate change on food supply has not changed significantly over the years. Generally, agronomic models, which simulate the biophysical growth of crops, are coupled with economic models to predict the economic implications of changing crop yields. The higher resolution of models and the incorporation of new variables, such as land value in the Ricardian models, are increasing the accuracy of projections. New integrated modelling systems, where different components (such as climate, water balance, crop production and economic modules) interact with each other, are capturing the complexities of crop production.

The models are applied to various parts of the world through calibration of local historical data. In spite of these advancements, the presence of numerous models and their estimations highlights the uncertainty of the future scenario of climate change and the need for caution. There is evidence that the choice of GCM used is a "strong effect modifier" (Knox *et al.* 2011). Many of the models have been developed in an isolated manner and do not adequately account for real-time adaptation and unforeseen phenomena. Below, three recent studies on the impact of climate change on South Asia's agriculture are discussed in detail for a closer look at the different approaches (Parry 2007).

3.4 Sample studies on the impact of climate change

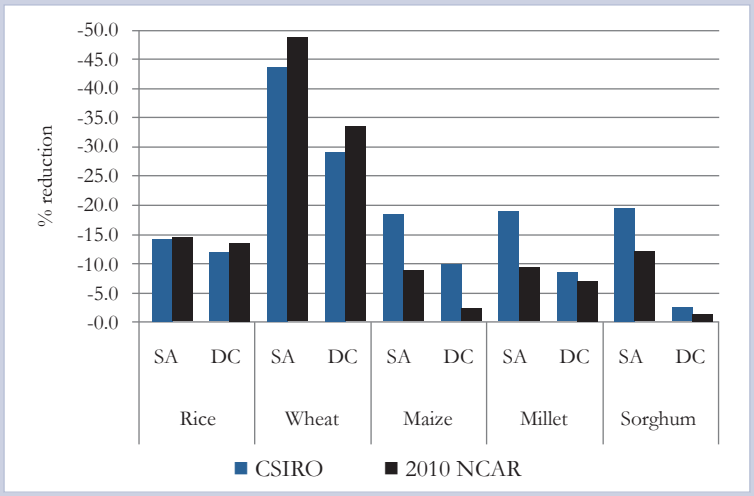
3.4.1 Study by the International Food Policy Research Institute

A study by the International Food Policy Research Institute (IFPRI) attempted to predict the impact of climate change on crop yield all over the world using two climate models and a Decision Support System for Agrotechnology Transfer crop-simulation model (Nelson *et al.* 2009). The two climate models—the National Center for Atmospheric Research (NCAR) model and the Commonwealth Scientific and Industrial Research Organization (CSIRO) model—simulated future climate using SRES's A2 scenario[3]. Few differences exist in the projections made by these two models. For example, the NCAR model estimates higher average maximum temperatures and average precipitation than the CSIRO model. These differing scenarios demonstrate the range of potential climate outcomes using current modelling capabilities.

The basic methodology of evaluating the impact of climate change on food supply has not changed significantly over the years.

The study reports the effects of these two climate-change projections on rain-fed and irrigated crops, with and without CO_2 fertilization.[4] Changes in irrigated yield reflect only the effects of changes in temperature and not precipitation (though precipitation will have some effect on water availability for irrigation). According to the study, South Asia will experience the greatest yield decline. Under both scenarios, in general, yields for all irrigated crops would experience large declines in South Asia compared to other parts of the world. Specifically, wheat and rain-fed maize yields would decline substantially. The primary reason for such declines would be water scar-

Figure 3.2 Reduction in crop production from 2000 to 2050, without CO_2 fertilization



Note: SA–South Asia; DC–Developing countries.
Source: Nelson et al. (2009).

city due to heat stress, competing demands from non-agriculture sectors and increased irrigated area. However, CO_2 fertilization would offset yield reductions to some extent, and in some locations, yields might even increase relative to the baseline year 2000.

Figure 3.2 shows the study's projections on the effects of climate change on crop production in 2050, accounting for changes in yield, crop mix, input use, area and adaptation as farmers respond to price changes. Crop production is determined by IFPRI's supply-and-demand trade model based on crop and input prices, externally determined rates of productivity growth and area expansion, investment in irrigation, and water availability. The negative effects of climate change on crop production are pronounced in South Asia, even exceeding the average losses in developing countries. The models predict a 14 percent decline in rice production, 44–49 percent decline in wheat production and 9–19 percent fall in maize production relative to the no-climate change scenario.

3.4.2 Study by New et al. (2012)

New *et al.* (2012) have used a slightly different approach to investigate the impact of climate change on agriculture in the Indo-Gangetic Plain (IGP), which spans India, Pakistan, Nepal and Bangladesh. Six crops—wheat, maize, sugarcane, potato, onion and rice—were chosen owing to their presence in the four countries and their perceived importance to food security. Based on the climatic requirements for each crop (taken from accounts used for crop cultivation in various South Asian countries), current and future climatically suitable growing areas were estimated. The current (baseline) estimates were interpolated from observed/meteorological data and future estimates were based on GCM ensemble mean values.[5] The GCM projections fell under the category of three periods in the future—2030s, 2050s and 2090s—and three SRES emissions scenarios—B1, A1B and A2[6]. In addition, the study predicted crop production under two watering schemes: i) rain-fed; and ii) irrigated, where all water demands are assumed to be met—similar to the study by Nelson *et al.* (2009).

Due to the general estimated increase in precipitation, suitability for rain-fed agriculture for all the crops will improve in the future. Areas that were previously unsuitable in Western Ganges and lower Indus become suitable for at least one month, and those areas presently suitable become suitable for a longer period. For the rain-fed scenario, suitability of rice cultivation increases by 37 percent, sugarcane by 16–42 percent, wheat by 21–33 percent and potatoes by 12 percent. The authors warn that the ensemble mean rainfall values used in these projections mask significant inter-modal factors.

For irrigated agriculture, where temperature is the only variable, maize, wheat and rice are not affected in terms of areas that are suitable for growth, but temperature increase in the warmer scenarios reduces the number of months in which a crop can be cultivated, especially in the lower Indus valley. Moreover, as temperature rises, the availability of water for irrigation will become an added concern.

3.4.3 A comprehensive literature review

A comprehensive literature review conducted by a project funded by the United Kingdom's Department for International Development focused on the impacts of climate change on five food crops—rice, wheat, maize, sorghum and millet—which account for the bulk of agriculture production in Africa and South Asia (Knox *et al.* 2011). After a systematic search through literature, 1,144 sources were found, which were filtered down to 53 based on relevance. For each crop and region, data were extracted on the projected crop yields for a given future scenario as a percentage of current or baseline yield. Like in previous studies, given the wide range of external factors, including the use of different GCMs, emissions scenarios, crop varieties, husbandry techniques, agro-ecological conditions and scale of study (local vs regional), the results in this case also need to be interpreted with caution.

Studies on crop yield variation in South Asia show a negative trend, especially on winter maize and sorghum. Predictions of rice yield change for Bangladesh, Nepal and Bhutan are negative, while it is positive for Sri Lanka. In the case of India, rice yield estimates vary, partly by area, though predictions generally exhibit negative signs in the 2080s. Some studies considering only temperature rise give positive variations, though reduction is expected with time. In fact, studies have suggested that by the 2080s, rice productivity will decline by 42 percent in India and by 39 percent in Nepal. Wheat production is expected to decline in Bangladesh and Pakistan, though uncertainty is high in the case of the latter, but wheat in the middle and eastern Indo-Gangetic Plain will be worst hit with its yield dropping by 60 percent. Some wheat varieties, such as the cultivar WH542, are expected to benefit from climate change. In some cases, increased rainfall and CO_2 effects are expected to partly offset the heat stress induced by climate change (IPCC 2001). It was also found that C4 crops (maize, sugarcane, sorghum and millet) are likely to be more vulnerable than C3 crops (wheat and rice), possibly due to their different photosynthetic processes. Awareness of such groupings can aid in adapting to climate change.

Depending on the simulation model, the area under study, time period, etc., the two studies and literature review discussed above demonstrate extensive variations in estimating the impacts of climate change on agriculture in South Asia. Therefore, it is difficult to pinpoint the exact percentage change in the yield of each crop, but some general conclusions can be drawn from the findings.

Studies on crop yield variation in South Asia show a negative trend, especially on winter maize and sorghum.

Compared to most other regions, South Asia will be negatively affected. In India, the impact may vary by locality. Estimations become less reliable in the far future, but crop yields are expected to decline with time. The impact of rain is still not conclusive since future rainfall patterns are still not certain, but some estimations indicate that increased precipitation along with CO_2 fertilization may help yields slightly. Rain-fed crops are more vulnerable to changes in precipitation, but irrigated crops will eventually be affected as water grows scarce. Heat stress, evaporation and rapid melting of glaciers due to rise in temperature will be the main factors behind reduction in crop yield. Among the crops, wheat is expected to be the worst-hit and with high certainty according to another study that took a similar probabilistic approach (Lobell *et al.* 2008). Besides subtle changes in climate, frequent natural disasters are likely to damage large quantities of crops.

Chapter 4

Food security in South Asia

Presently, about a fifth of South Asia's population is undernourished. While some countries, such as Bangladesh, have achieved marked progress in reducing the proportion of people suffering from undernourishment, others, such as Pakistan, are lagging behind (Table 4.1). The surge in commodity prices in 2007–2008 exposed the region's vulnerability (Figure 4.1, next page). It is estimated that commodity price rise has incurred an income loss to the region equivalent to about 9.6 percent of GDP between January 2003 and April 2008. Several countries experienced double-digit inflation rates, which exceeded 20 percent in Afghanistan, Pakistan and Sri Lanka (Ahmed 2008). Although inflation rates went down due to the collapse of international commodity prices and the onset of the global financial crisis, they have shown an upward trend since mid-2009. In the second wave, inflation rates have been primarily influenced by food prices, but in contrast to the episode in 2007–2008, non-cereal prices account for a large share of the current food inflation. As demonstrated in Indian household surveys for the last 20 years, growing income in the region has shifted people's demand toward high-protein diets (Joshi *et al.* 2007). Another explanation for a resurge in food prices in mid-2009 is the impact of droughts and some delayed pass-through effects of higher oil prices (World Bank 2011).

4.1 Causes of food inflation and shortage

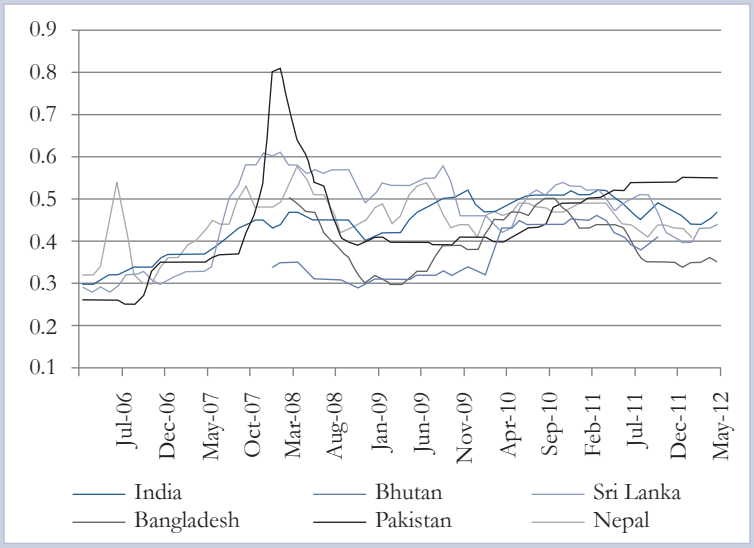
The extent to which international commodity prices get passed on to consumers in South Asia depends on the country's openness to the global market. For example, the Maldivian economy is exceptionally sensitive to international prices because of its high reliance on imports, which constituted 70 percent of the GDP in 2010, almost 40 percent of which comprised of food and fuel prod-

Table 4.1 Undernourishment in South Asia

	Share of population undernourished (%)			Incidence of under-nourishment (millions)			Depth of hunger (kcal/capita/day)		
	1995–97	2006–08	Growth (% p.a.)	1995–97	2006–08	Growth (% p.a.)	1995–97	2006–08	Growth (% p.a.)
South Asia	20	20	1.1	257	317.4	1.9	232	246	0
Bangladesh	41	26	4.1	54.2	41.4	2.4	330	290	0.4
India	17	19	1	167.1	224.6	2.7	220	240	0
Maldives	9	10	1	na	na	na	180	190	0.7
Nepal	20	17	1.5	4.4	4.7	0.6	230	220	0.3
Pakistan	20	25	2	26.8	42.8	4.3	260	280	0
Sri Lanka	25	20	2	4.5	3.9	1.3	260	250	0.2

Source: FAO Statistical Yearbook 2012.

Figure 4.1 Price inflation of rice in South Asia



Note: Data for a single variety of rice for all countries was not available; so the prices are not completely consistent. Prices for Pakistan are of the irri rice; for Bhutan and Sri Lanka, white rice; and for Nepal and Bangladesh, course rice.
Source: FAO GIEWS.

ucts. The degree of pass-through effects also depends on the commodity. In the case of Bangladesh, the pass-through of rice prices is very limited while that of wheat, whose imports account for 80 percent of domestic consumption, is substantial (World Bank 2011).

Response of the region's food prices to higher energy costs has been varied as well. Energy prices translate into the costs of key inputs such as fertilizers, transport, electricity and diesel, but the insulation of some economies in the form of subsidies and price caps has kept these costs artificially low. These economies include India, and to some extent Bangladesh and Nepal. In India, prices of diesel, kerosene and liquefied petroleum gas are regulated, and some farmers even receive free electricity. Likewise, diesel in Bangladesh and Sri Lanka is heavily subsidized to protect farmers. Only Pakistan has a rational adjustment mechanism for determining prices of diesel and gasoline. On the other hand, the Maldives and Afghanistan cannot afford such policies, and consequently their inflation rates have soared along with international commodity prices. Inflation spreads among South Asian countries as well. For example, prices in Bhutan and Nepal are strongly correlated with price changes in India due to their extensive trade with the largest neighboring country (World Bank 2011).

Domestic supply shocks, many of which are triggered by abnormal weather events—possible outcomes of climate change—have also contributed to food price inflation in South Asia.

In addition to global prices, domestic supply shocks have also contributed to food price inflation in some South Asian countries. These domestic shocks have significant implications in the context of climate change because many of them are triggered by abnormal weather events—possible outcomes of climate change. Flooding in late 2010 devastated crops in Pakistan and led to a jump in food inflation from 12.8 percent in July 2010 to 21.2 percent in September 2010. The damage to wheat crops, the main staple and produce in the country, was especially detrimental for the country's economy. Likewise, inflation has inched up in India after mid-2009 as a result of droughts and untimely rains, and vegetable prices have surged in Sri Lanka after destructive floods in early January 2011.

Regarding food shortages, restrictive trade policies adopted by member countries, and export restrictions and bans—such as those imposed by India and China on rice, and by Pakistan on wheat—have aggravated food shortages in the region. In general, trade policies for agriculture are more restrictive in South Asia than in other regions (Ahmed 2008). Other development challenges have also restricted the flow of food in the region. For example, poor infrastructure and security problems, in addition to contention over the interpretation of the Afghanistan-Pakistan Transit Trade Agreement, have impeded food mobility in war-torn Afghanistan.

In the global context, many South Asian countries were able to keep the price of rice low in comparison to global market price because a number of prudent government interventions helped to insulate their economies from the global price surge. In particular, India, after a good wheat and rice harvest in 2007–08,

built up stocks, anticipating a need in the future, and responded to the food situation with swift distribution of the stocks. Moreover, trade restrictions and smart fiscal policies acted as a wedge between international and domestic prices. Restricting exports also averted scarcity at home. But in the case of Afghanistan, which relies on imports of wheat, mainly from Pakistan, wheat prices soared due to high global wheat prices and Pakistan's export ban.

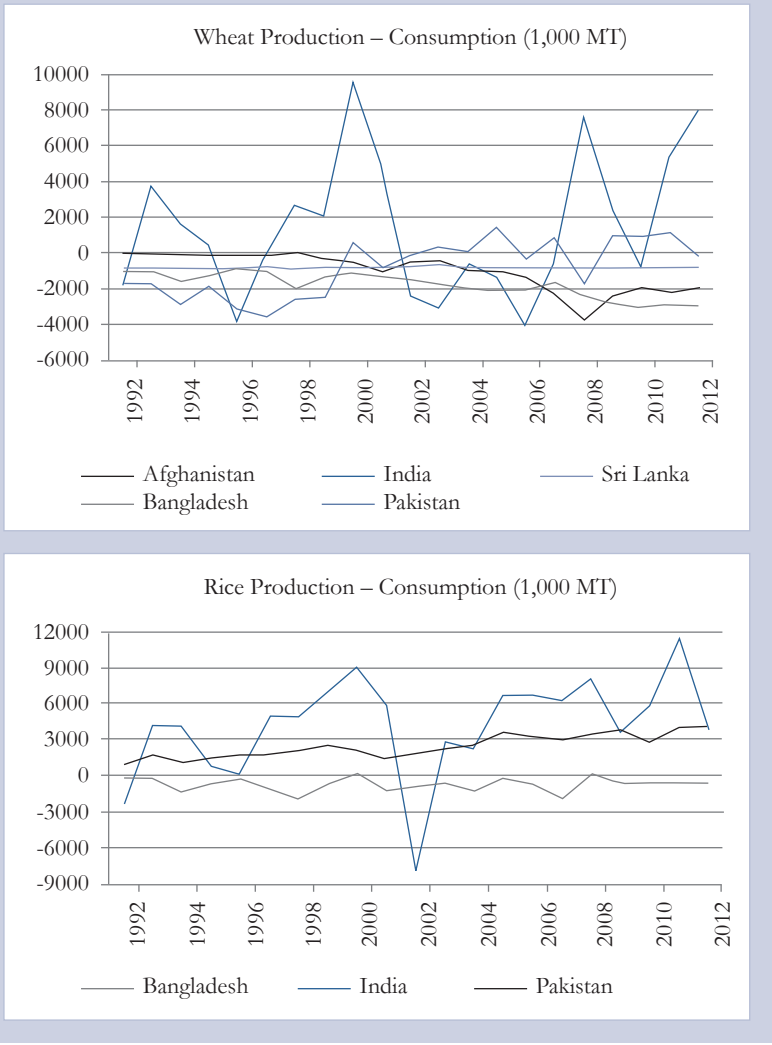
The leading producer of staple items (wheat and rice) in South Asia is India, followed by Pakistan and Bangladesh (Ahmed 2008). In terms of the gap between production and consumption, only Pakistan and India have sustained moderately positive trends in wheat and rice surplus while Afghanistan and Bangladesh exhibit a concerning rise in wheat deficit (Figure 4.2). This is important in the context of climate change, which is estimated to reduce wheat yields significantly.

4.2 Impact of climate change on food security

Contrary to the many experts' assertions and popular belief that climate change is going to severely impact agriculture, and hence food security, there are some who argue that the economic impacts of climate change on world agriculture are expected to be minor because reduced food production in some areas will be compensated by gains in others (Kane *et al.* 1991; Tobey *et al.* 1992; Rosenzweig and Parry 1993). These broad conclusions conceal the localized impact of climate change on the production and distribution of food resources. Studies have projected higher crop yields in developed countries, partly because these countries are concentrated in high, cooler latitudes (Fischer *et al.* 1996; Nelson *et al.* 2009; Rosenzweig and Liverman 1992). According to IPCC predictions, global warming will increase crop yields in East and Southeast Asia, but will reduce yields in drier climates such as Central and South Asia. The extent of disparity will depend on the dominant SRES scenario in the future. For example, GCM results have shown larger differences in crop yields between developing and developed countries under the "warmer" A1 scenario compared to the "cooler" B2 scenario.

Differences are evident even at the district level in India. In one study, adaptive capacity, mapped as a composite of biophysical, socio-economic and technological factors, was juxtaposed against a map of vulnerability to climate change, based on HadRM2 outputs. The map revealed that districts in the Indo-Gangetic plains (except Bihar) had a higher degree of adaptive capacity than interior regions

Figure 4.2 Production and consumption gap



Source: United States Department of Agriculture database.

Table 4.2 Change in per capita consumption in 2050 with climate change and no CO_2 fertilization

		CSIRO	NCAR
Meat	South Asia	-13%	-13%
	Developing countries	-10%	-10%
Cereals	South Asia	-21%	-23%
	Developing countries	-22%	-23%

Source: Nelson et al. (2009).

of the country (O'Brien *et al.* 2004). These wide disparities depend partly on landholding size, education, caste, etc. The uneven impact of climate change, as well as the disparities in adaptive capacity, has great implications for food security, which is already precarious, in South Asia.

Unlike large commercial farms that adopt market-based risk management tools, small farms adopt mixed cropping practices for risk management.

Climate change is also expected to affect household-level food security in varying ways. The dominant farm type in South Asia is the small semi-subsistence or part-commercial family farm, where farms mainly operate for family sustenance and a few cash crops support the purchase of non-farm essential products (FAO 1997). These semi-subsistence farmers, who have few assets and market schemes to resist shocks caused by climate variability, are likely to suffer the most. However, while large, specialized and commercial farms are strong financially and are likely to use market-based risk management tools, small farms have the advantage of a diverse mix of crops and diverse source of income.

At the crux of food insecurity is the issue of food price and nutrition intake. The effects of climate change on crop yield will naturally induce changes in production and prices. Farmers and market participants will adjust by altering crop mix, input use, farming practices, food demand, food consumption, etc. The study by Nelson *et al.* (2009), using a demand-supply trade model, estimated that even without accounting for climate change, world prices of important crops—rice, wheat and maize—will increase by 62 percent, 39 percent and 63 percent, respectively, between 2000 and 2050 due to population and income growth as well as competing demand for biofuels.

Depending on CSIRO vs. NCAR estimations, climate change results in price hikes by 32 percent to 37 percent for rice, 94 percent to 111 percent for wheat and 52 percent to 55 percent for maize. CO_2 fertilization dampens these 2050 estimated prices by 10 percent. Although livestock are not directly affected by climate change, higher feed costs will pass on to the price of meat. Moreover, pasture availability for livestock is expected to lessen in the subcontinent as cool temperate grasslands shift northward with climate change (Sukumar *et al.* 2003). Nelson *et al.* (2009) estimate a 27 percent premium on beef between 2000 and 2050 due to climate change.

Lower yields and higher food prices will, in turn, affect food consumption and human diet in the future. Presently, the growing middle class and higher income groups are consuming more high value foods, such as meat, and less basic foods, such as cereals. However, under climate change, both model simulations indicate that consumption of meat and cereals will fall by 2050 (Table 4.2). The estimates suggest that meat consumption in South Asia will decline even relative to most developing countries. CO_2 fertilization was found to reduce the effects on cereals and meat by 7 percent and 1 percent, respectively.

It is important to note that the effect of CO_2 fertilization is still under study. A study in Japan has found that doubled CO_2 levels could decrease rice yields by up to 40 percent (Nakagawa *et al.* 2003) through the occurrence of heat-induced sterility (Matsui and Omasa 2002). More recent open-air tests of CO_2 fertilization have shown lower yields than the laboratory experiments. Effects of CO_2 fertilization will also vary by crop. C3 crops, which include rice, wheat and legumes, benefit more than C4 crops, which include maize, sorghum and sugarcane (Long *et al.* 2006; Cline 2007; Allen Jr. *et al.* 1996).

Table 4.3 Daily per capita calorie availability

	2000 (kcal/day)	2050 (no climate change) (kcal/day)	NCAR (no CO_2 fertilization) (kcal/day)	CSIRO (CO_2 fertilization) (kcal/day)
South Asia	2,424	2,660	2,226	2,255
Developing countries	2,696	2,886	2,410	2,432

Source: Nelson et al. (2009).

Decline in per capita consumption of cereals and meat translates into a decline in calorie availability. According to the studies, between 2000 and 2050, calorie availability is expected to increase by 9.7 percent in South Asia without climate change. These trends reverse under the climate change scenario with a drop of 7.6 percent compared to 2000 levels. In fact, the per capita calorie values in South Asia are below that of all developing countries on average (Table 4.3). Decline in calorie availability will have severe implications for child malnutrition and there will be an increase in the number of people at risk of hunger.

Chapter 5

Adaptation programmes in South Asian countries

South Asia, being a large and diverse subcontinent, has a wealth of knowledge and experience on coping with climate variability and extreme weather events. For example, in flood prone areas in Bangladesh, farmers have built floating gardens using hyacinth. In a project conducted by Oxfam in Badin, Pakistan, water ponds have been enlarged from 60 square metres to 100 square metres and their linings have been strengthened in order to increase water collection. Also, solar-powered pumps have been installed in each pond to pump water onto the crop fields. This has improved access to water and eased women's workload.

Significant efforts are also underway in different countries to diversify the livelihood options of vulnerable communities. Crop varieties that are resilient to droughts, floods and increasing salinity levels have been/are being developed. In many instances, non-government organizations (NGOs) and other development partners have facilitated collaboration between farmers and scientists to foster innovation in adaptation. Vulnerable groups such as women have also received significant attention, usually in the form of skill training as a way to create employment opportunities. After a review of successful adaptation projects, compiled by Oxfam and others, the following were found to be common practices being employed on the field.

Adaptation projects generally begin with a participatory assessment and analysis of climate risks in the community, and adaptation capacity of the actors involved. Knowledge of the current vulnerability of communities as well as existing development challenges help to build a solid foundation on which to work. Moreover, assessments provide an idea of local systems as well as the complex and interconnected issues in the community, thereby helping to address climate change alongside other development concerns in a "smart" and holistic manner.

Building on or even reviving traditional practices represent a highly popular tactic in adaptation projects. Traditional practices include mixed-cropping, agro-forestry, animal husbandry and surface as well as groundwater irrigation. Even infrastructural adjustments such as large-scale irrigation and coastal defenses and warning systems have long been established in the region. One illustrative example is tidal river management, which has been used for generations in the waterlogged, low-lying areas of southwest Bangladesh. Enclosed embankments trap incoming tides and use the sedimentation to raise land out of the water, thereby reclaiming low-lying lands for agriculture use. This technique requires cooperation between community members and landowners in setting aside land for the reclamation process. For example, Uttaran, a local NGO, assisted communities in raising around 650 hectares of land on the Hari River Basin by 1.5 metre over a one-year period, using tidal river management.

Sharing of resources through co-operatives are common practices in rural com-

Traditional practices such as mixed-cropping, agro-forestry and animal husbandry are useful for climate change adaptation in South Asia.

munities where assets are low and resources are strained. Sharing has proven to be an effective strategy in mitigating the risks of climate change as well. The watershed management project under Nepal's Local Adaptation Programme of Action (LAPA) offers the example of a creative approach.[7] In keeping with LAPA's promotion of local knowledge and institutions, the beneficiaries under the programme have developed a mutually beneficial mechanism between upstream and downstream members of the co-operative. Downstream communities channel some proceeds from the cultivation and sale of fish and other farming products to upstream communities, who use those funds to support natural resource management activities. These activities, beneficial to both communities, include reforestation on degraded lands and construction of check dams to prevent erosion as well as minimum tillage practices and water conservation. One study even found that community managed forests, in this case the Mahananda Wildlife Sanctuary, fare better in times of political conflict (Nagendra 2006).

An effective strategy for climate change adaptation is building local ownership by empowering the community with knowledge, skills, resources and authority.

Another effective strategy was building local ownership by empowering the community with knowledge, skills, resources and authority. This allowed the community to become the driving force behind the initiatives, and ensured that the programmes continued even in the absence of the NGOs. Sustainability forms the underlying argument for community-based adaptation (CBA).

In a project on adaptation and disaster risks, ActionAid laid much emphasis on the collective knowledge of the community and on the ability of local governments to facilitate local change. The project, conducted during 2008–2010 in Sirajganj, Naogaon and Patuakhali in Bangladesh, engaged people in analysing their own problems and subsequently in preparing community action plans. The project demonstrated that community members are well attuned to their local conditions and changes in the weather. Through the project, a variety of options were put on test, including plinth-raising of homesteads, early warning systems, training of para-vets and formation of climate-resilient cluster villages.

Another example of the effectiveness of CBA is the participatory development of agriculture practices in a project implemented by Practical Action in Chitwan district of Nepal. In light of the gaps identified through participatory discussions, the project imparted trainings to farmers on vegetable cultivation, animal husbandry and natural resource management. Improvement in the use of land and water resources, and enhancement in vegetable production as a result of the project gave farmers the confidence in their ability to make decisions and experiment with new farming practices as a step toward finding new ways to cope with climate change.

A project titled "Reducing Vulnerability to Climate Change", funded by the Canadian International Development Agency and implemented by CARE Bangladesh, is credited with coining the term "community-based adaptation". The project, implemented between 2002 and 2005 in six districts in southwest Bangladesh, involved a total of 16 partner NGOs, the local government and local professional, educational and social organizations. Community engagement was critical in achieving the project's desired outcomes, which were improvement in the community's capacity to diversify its livelihood strategies and to develop and implement community-level adaptation strategies.

Social networking is an essential strategy for mobilizing a community. In a project conducted by Practical Action involving 2000 households in Gaibandha district in Bangladesh, 200 youth volunteers from the community were recruited and trained on climate change issues. They raised awareness in the community, prepared disaster preparedness plans and formed two community-based organizations (CBOs). The CBOs built networks and relationships with key institutions, which enabled the community to un-

dertake climate adaptation programmes with political support. Similarly, the Sundarbans Programme initiated in 2005 by the India Office of the World Wildlife Fund (WWF) also engaged volunteers in forming early warning and disaster response teams. Volunteers, especially young people, are an invaluable resource in terms of information dissemination due to their vast networks and links to the local community.

CBOs, as mentioned earlier, have played an instrumental role in facilitating and continuing adaptation initiatives in communities. The Mousumi Climate Adaptation Centre, established as part of the Sundarbans Programme, acts as an early warning station as well as a central point for the exchange of information, data and services. Elected local representatives of the community manage the Centre. Another achievement was the establishment of the Climate Change Impacts and Disaster Management Group as part of the initiative by Practical Action in the Chitwan district of Nepal in 2004–2007. This CBO has coordinated activities implemented by other agencies in the area and built partnerships with the village-level government. The CBO's work with the local government has led to the allocation of 10 percent of the Village Development Committee budget for watershed conservation.

5.1 Role of multilateral cooperation in climate adaptation

The most severe threats of climate change, such as droughts, floods and cyclones, transcend national boundaries. Historically, only a few countries have emitted GHG to a great extent, but the effects have been felt across the globe. Therefore, multilateral cooperation is critical to tackling the shared threat of climate change. This is also because, in the absence of international coordination, some high-emitting countries could free-ride on the efforts of others.

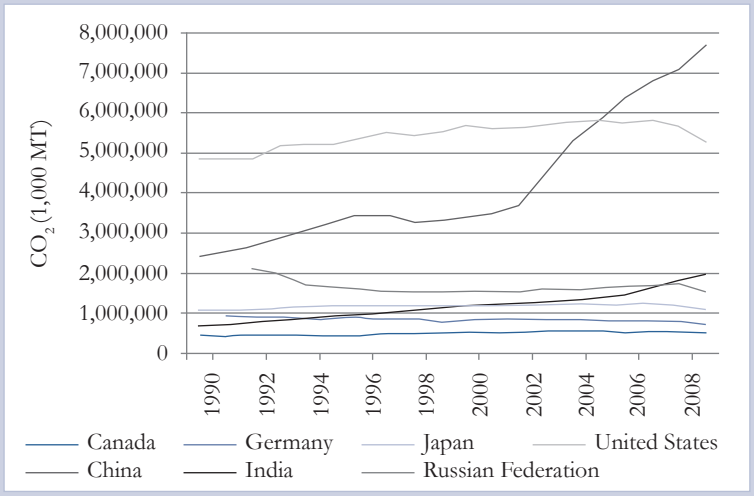
Multilateral efforts to identify climate change impacts began in 1979 with the leadership of the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). UNEP and WMO organized the first World Climate Conference in Toronto to promote research on the subject. In fact, the idea of the IPCC was conceived at this conference, though it came into existence only in 1988. The IPCC's scientific research and periodical assessment reports play a central role in policy-making. Criticism of the organization's objectivity has somewhat weakened its legitimacy and the findings of an independent review even prompted the IPCC to introduce institutional reforms in May 2011. However, the IPCC's findings are generally consistent with those of major scientific authorities such as the United States (US) National Academy of Sciences. Besides the IPCC, there are other international forums, such as the Group on Earth Observations—a group of eighty governments committed to creating a Global Earth Observation System of Systems—that gather and share climate data.

5.1.1 The UNFCCC and the Kyoto Protocol

The second World Climate Conference in 1990 laid down the principles that would guide discourses on climate change. These principles included "common concern for humankind", "common but differentiated responsibilities" and "precautionary principle". The conference also urged large emitters to curb emissions while recognizing that emissions from developing countries are necessary to accommodate growth. The first formal international agreement to address climate change was prepared in the landmark Earth Summit held in Rio de Janeiro in 1992. The objective behind this agreement, known as the United Nations Framework Convention on Climate Change (UNFCCC), was to reduce GHG emissions to "a level that would prevent dangerous anthropogenic interference with the climate system". As a framework convention, the UNFCCC provides a structure for interna-

Multilateral cooperation is critical to tackling the shared threat of climate change also because in its absence, some high-emitting countries could free-ride on the efforts of others.

Figure 5.1 Carbon dioxide emissions by country



Source: Millennium Development Goals Indicators, United Nations.

tional discourse on climate change and does not set any binding limits on GHG emissions.

Since 1995, UNFCCC signatories have held Conference of Parties (COP) to assess progress in dealing with climate change. In the third COP in Japan in 1997, UNFCCC members adopted the Kyoto Protocol, which was the first legally binding commitment by developed countries to reduce GHG emissions to 5.2 percent below 1990 levels by 2012. The Protocol divided countries into two groups: Annex I parties (developed countries) and non-Annex I parties (developing countries). While the Kyoto Protocol was a promising initiative, it was bereft with problems. Decision by the United States, the largest per capita emitter, to disassociate from the treaty in 2001 generated much resentment and induced Canada to withdraw from the accord in December 2011. The Kyoto Protocol also failed to incorporate what the consequences for non-compliance or incentives for compliance would be for emerging big emitters like China and India.

The tension between developing and developed countries stems from disagreements over how to interpret the principle of "common but differentiated responsibilities". In the Major Economies Forum on Energy and Climate at L'Aquila in 2009, G-8 countries agreed to cut their carbon emissions by 80 percent by 2050 on the condition that developing countries would agree to halve their emissions by then. However, the latter only agreed to "peak" their emissions before cutting it down in absolute terms. Emerging economies like India and China insisted on concessions to accommodate their need to maintain or even enhance their growth and fight poverty. The implementation of the Kyoto Protocol stalled for years with only rhetoric and hollow long-term declarations.

Another point of contention is the stipulation for climate monitoring in the Kyoto Protocol. Many countries lack the domestic capacity to monitor their own emissions, and some are wary that reporting emissions would put pressure on them to cap their emissions. China, on the other hand, argues that an international monitoring system is an infringement on national sovereignty.

5.1.2 Recent developments

Progress has been slow in getting countries commit to curb emissions. At COP15 in Copenhagen, parties failed to reach consensus on legally binding emissions cuts, though countries submitted reduction targets and planned measures for 2020 in the Copenhagen Accord. In the subsequent COP in Cancun, the Copenhagen Accord was translated into formal UN decisions, one of which recognized the 2 degrees target for the first time. The Cancun Agreement also set out voluntary reduction pledges and defined a reporting mechanism. A turning point in the latest COP at Durban was the decision that all countries, including emerging and developing, should be legally bound to take action. A newly formed task force will implement a programme of work to initiate more stringent reductions in GHG emissions, and formulate a legal agreement that is to be adopted by 2015 and entered into force by 2020.

In the most recent climate talks that were held in Doha in November 2012, the top priority was to ensure continuity of the Kyoto Protocol, which was to expire by the end of the year. The EU and a handful of other developed countries rescued the Kyoto by agreeing to take on new carbon-cutting targets for 2020, when a new global deal is expected to come into effect. Russia, Japan and New Zealand have decided not to join in the second commitment period while Canada has withdrawn completely, thus leaving only 36 countries accounting for just 15 percent of emissions in the second period. Nevertheless, survival of the Kyoto Protocol is significant in that it continues to bind rich nations to cut down emissions.

In addition, for the first time, countries have recognized the principle of compensating victims for the "loss and damage from climate change" in an international legal document. The pledges will be treated as aid as opposed to legal liability, largely in response to US lobbying. The modalities to implement these pledges will be worked out in later meetings. Representatives from Bangladesh led the case for "loss and damage" based on in-depth studies from across the developing world. National actions, especially in the developing world, have played critical roles in accelerating the response to climate change. Countries such as China, South Africa and Mexico are becoming aware of the development benefits of mitigation such as resource efficiency, energy security and better air quality. These domestic advances will help to create the ground for a comprehensive international agreement by 2020 (Harvey 2012; Vidal 2012; Gummer *et al.* 2012).

Presently, financing of mitigation efforts and transfer of technology are also pressing issues for the developing countries. The G-5 countries (Brazil, India, China, Mexico, South Africa) demanded assistance in these areas from the G-8 countries in a summit in Gleneagles in 2005 and since then these terms have become buzzwords in climate change discourse. Although the Copenhagen Accord was not approved, developed countries pledged to mobilize US$100 billion a year by 2020, establish a Green Climate Fund and organize a Technology Mission for the transfer of technology. In the following COP at Cancun in 2010, developed countries instead agreed to generate US$100 billion in the long run, starting with US$30 billion by 2012. They also agreed to facilitate technology transfer through innovation centers and fund Reduced Emissions from Deforestation and Forest Degradation (REDD) projects (CFR 2012). These concerns, along with a new legal agreement for 2020 are on top of the agenda for the next COP in Warsaw.

5.1.3 Financing emissions reduction

In Durban, the governance structure of the Green Climate Fund was formed but no concrete funding mechanisms were articulated, and as of 2010, disbursed funds for climate change amounted to only US$2.1 billion. While Annex I parties have almost raised the US$30 billion pledged for 2012, reports indicate that much of it is non-additional (CFR 2012). To explore new and additional sources of funding, UN Secretary-General Ban Ki-moon established the High-Level Advisory Group on Climate Change Financing in February 2011. The Group recommended measures such as taxing and removing subsidies of high emissions activities, international development bank loans and carbon markets as a way forward. Accordingly, in January 2012, the European Union (EU) instituted an emissions tax on airlines flying in and out of the region. Considering a recent report by the International Energy Agency, which estimated that achieving climate goals by 2020 will require investment of roughly US$5 trillion, pledges, let alone disbursements to date, fall far short of what is needed. Several multilateral funds under the UNFCCC, the World Bank, the Global Environment Facility and other international organizations target projects related to climate

Survival of the Kyoto Protocol is significant in that it continues to bind rich nations to cut down their emissions.

change, but these funds are generally voluntary and have limited resources. The Annex provides some details of climate finance approved for and received by South Asian countries.

Private investment has been a promising alternative to diplomatic efforts in providing financial support to developing countries. The Kyoto Protocol proposed three market mechanisms to encourage investment in curbing GHG emissions: i) Joint Implementation; ii) International Emissions Trading, and iii) Clean Development Mechanism (CDM). The Joint Implementation mechanism enables industrialized countries to invest in climate-friendly projects in other industrialized countries (mainly former Soviet countries termed as economies in transition). International Emissions Trading creates a market for trading carbon credits where one country that has exceeded target emissions reductions could sell carbon credits to another country. Lastly, CDM allows industrialized countries to invest in climate-friendly projects in poor countries and earn carbon credits in exchange. CDM offers the twin benefits of curbing emissions and facilitating economic development in non-Annex I countries.

CDM operations have been criticized for the high costs of climate-friendly projects and the delayed registry of many pre-approved projects.

Slow progress in carbon markets underscores the need to introduce rules and regulations to this nascent system. CDM operations have also been criticized for the high costs of climate-friendly projects and the delayed registry of many pre-approved projects. Moreover, critics argue that companies from developed countries are earning large quantities of carbon credits in exchange for low-impact projects in poorer countries, thus widening the global inequity in emissions. Challenges related to pricing of carbon have also deterred investors. From a broad perspective, CDM has not prompted fundamental shifts in development patterns; deeper challenges in the development aid model are partly to blame. Environmental activists reject the capital market system altogether, arguing that it is too risky and unstable an approach to resolve a threat like climate change. Emissions trading is most developed in the EU, where the value of the market approached an estimated US$120 billion in 2010. Regulations such as the mandatory cap-and-trade system in the EU emissions trading scheme have facilitated considerable reductions in emissions.

5.1.4 Transfer of technology

Multilateral efforts towards the development of low carbon technology have been extensive. Carbon-capture and storage (CCS) focuses on securing and storing CO_2 emissions before they are released into the atmosphere. Multilateral cooperation is particularly important in implementing CCS on a large scale because it is expensive and offers few economic benefits. The Carbon Sequestration Leadership Forum supports joint efforts to develop cost-effective carbon sequestration technology. FutureGen, a global initiative led by the US Department of Energy, consolidates funds and expertise to help build near-zero emissions plants around the world.

Another attractive option is to replace fossil fuels, which are responsible for much of the carbon emissions with clean and renewable sources of energy such as nuclear, solar and wind. The diminishing supply of fossil fuels has prompted a high demand for renewable and nuclear energy among the large emitters like India, China and the US, and some other developing countries. The International Atomic Energy Agency is promoting nuclear technologies in several countries. They assist with energy planning and developing relevant infrastructure, such as drafting nuclear legislation and establishing safety frameworks. The International Renewable Energy Agency, founded in January 2009, is the first international forum for promoting the use of renewable energy. In addition, UNEP has launched several initiatives, including the Global Bioenergy Partnership and the Solar and Wind Energy Resource Assessment. Although renewable and alternative

sources account for a small portion of the world's energy, investment in these areas is increasing and more countries are mainstreaming mitigation into their national policies.

Besides developing new technology, harnessing natural carbon sinks in the ecosystem is an effective strategy to mitigate climate change. Approximately one-fifth of global emissions come from land use, including deforestation. CDM has facilitated reforestation projects in exchange for carbon credits, though it does not encourage preservation of existing forests. REDD programmes, funded by Norway, Denmark and Spain, as well as the World Bank Forest Carbon Partnership Facility, are examples of multilateral initiatives to promote better forestry management. The possibility of using oceans as a natural carbon sink is also being explored.

5.2 Regional cooperation on adaptation in South Asia

5.2.1 SAARC's role in addressing climate change

The South Asian Association for Regional Cooperation (SAARC) is the official platform for regional cooperation in South Asia. The bloc was founded by Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka in 1985, and Afghanistan joined in 2007. The principle objective of SAARC, as written in its Charter, is to promote the socio-economic welfare of member states. The organization is comprised of the Summit at the apex, supported by the Council of Ministers acting as the decision-making wing and the Standing Committee serving as the executive wing. A network of sector-based Technical Committees provides the base of the organization pyramid.

Suman Sharma, an expert based in the University of Delhi, has written extensively on SAARC's engagement in environment-related issues. According to Sharma, the movement to mitigate climate change began with concerns over the region's dependence on environmental resources and susceptibility to natural disasters, which motivated SAARC to commission a study on the subject at its third summit in 1987. The unprecedented floods, cyclones and earthquakes in 1988 reinforced the need for this study as a basis for an action plan by member states. SAARC also decided to undertake a study on the impact of GHGs on the region at its fourth summit.

The first study assessed the situation in each country and recommended a variety of preventive and remedial measures in regards to natural disasters and environmental degradation. Recommendations included the establishment of sectoral cooperative programmes, network of environmental NGOs, a fund for the environment and a regional relief and assistance programme. The study on GHGs urged members to share technology and knowledge on climate change. The two studies culminated in the adoption of the SAARC Plan of Action on Environment in 1997, which spurred several initiatives in the region. Meanwhile, SAARC closely followed the events taking place at the COPs, particularly the question over the Kyoto Protocol. SAARC members welcomed the Protocol in their 10th SAARC Summit declaration in 1998. They urged Annex I countries to ratify the Kyoto Protocol and to take swift action in implementing commitments laid out in the treaty. They also demanded an equitable distribution of entitlements for emissions as proposed in the Kyoto Protocol.

Besides developing new technology, harnessing natural carbon sinks in the ecosystem is an effective strategy to mitigate climate change.

Following a series of studies and assessments, SAARC's implementing capacity began to take shape. A technical committee dedicated to environment and forestry was entrusted with the task of coordinating and monitoring the implementation of the SAARC Plan of Action on Environment. The devastating Indian Ocean tsunami in late 2004 heightened regional concerns about climate change and prompted SAARC leaders to convene in Male and agree to form a Comprehensive Framework

on Disaster Management in line with the Hyogo Framework of Action. The SAARC environment ministers took the first step in addressing climate change by adopting the Dhaka Declaration on Climate Change and SAARC Action Plan on Climate Change in 2008. The Declaration suggested the development of CDM projects and related Designated National Authorities (DNAs), expansion of natural carbon sinks and cooperation among member states. The SAARC Action Plan on Climate Change identified seven areas to address climate change, including adaptation, technology transfer, investment and capacity building for negotiation.

The latest and the most significant step taken by SAARC was the organization of the 16th Summit in Thimphu, Bhutan in April 2010, with climate change as the theme. The member states adopted the Thimphu Statement on Climate Change which outlines a number of important initiatives at the national and regional levels. Distinct features of the Thimphu Statement were the launching of a regional afforestation campaign, as well as separate inter-governmental initiatives focusing on disaster risk reduction, the mountains, monsoon systems and oceans. In a move to expedite SAARC activities, it called for a review of the slow implementation of the Dhaka Declaration and SAARC Action Plan and the formation of an Inter-governmental Expert Group to guide and monitor implementation of SAARC initiatives (Sharma 2011).

As per the UNFCCC directives, many South Asian countries have prepared their National Adaptation Programmes of Action.

5.2.2 Other regional efforts in climate change adaptation

Regional cooperation on climate change relies on the efforts of each state to mainstream climate change in their national policies. As per UNFCCC directives, many South Asian least-developed countries (LDCs) have prepared NAPAs. Bangladesh, considered to be one of the most active countries in addressing climate change, developed a NAPA in 2005 (updated in 2009) and a National Climate Change Strategy and Action Plan in 2008. By 2010, Bhutan, the Maldives, Afghanistan and Nepal released their NAPAs as well. Nepal even developed a LAPA as a bottom-up approach. Pakistan approved the first draft of a national climate change policy but it is not yet publicly available. Sri Lanka has developed a National Climate Change Adaptation Strategy for 2011–2016. The Asian Development Bank (ADB), the World Bank and the International Finance Corporation are assisting the Bangladeshi and Nepalese governments prepare a Strategic Programme for Climate Resilience based on their respective NAPAs under the Pilot Programme for Climate Resilience of the Climate Investment Funds. Bangladesh and the Maldives have also demonstrated an innovative effort to mainstream climate change into national priorities by establishing budgetary allocations to finance adaptation and mitigation efforts.

Besides SAARC, civil society organizations and NGOs are contributing enormously to regional efforts in South Asia. The World Bank and ADB have been deeply involved since resilience is closely linked to their development mission. The ADB has formulated Climate Change Implementation Plans for all developing countries. It is also supporting agriculture research centres and exploring CDM opportunities in the subcontinent. Another commendable initiative has been taken by the International Centre for Integrated Mountain Development (ICIMOD)—a regional intergovernmental knowledge centre serving countries of the Himalayas, i.e., China and all the SAARC countries except the islands. ICIMOD assists communities to understand and adapt to changes in the fragile mountain ecosystem. It also supports trans-boundary programmes, and addresses upstream-downstream issues, which are highly sensitive subjects in the subcontinent. The Asian Disaster Preparedness Centre prepares vulnerable people against disasters through skills development and awareness building. Environmental concerns of groups such as the WWF are also supporting adap-

tation efforts. WWF's Living Himalayas Initiative in Bhutan, India and Nepal is working to ensure that the Eastern Himalayas are conserved and managed properly to sustain the livelihood of local people.

5.2.3 *Assessment of SAARC and regional cooperation on climate change*

SAARC has made some progress in forming the framework to address climate change. Regular meetings of SAARC Environment Ministers and related technical committees are a good start to facilitate discussions on the subject. Establishment of different centres, such as the SAARC Coastal Zone Management Centre in the Maldives, the SAARC Forestry Centre in Bhutan, the SAARC Disaster Management Centre in India and the SAARC Meteorological Research Centre (SMRC) in Bangladesh, provide a network of SAARC institutions to build specialized knowledge. The STORM programme implemented by the SMRC was one of SAARC's most successful endeavors. Under STORM, a network of weather stations was set up across four countries to monitor severe thunderstorms like the Nor'wester (*Kal Baisakhi*). In addition, the SAARC Plan of Action on Environment (1997), the Dhaka Declaration and SAARC Action Plan on Climate Change (2008), and the Comprehensive Framework on Disaster Management (2006–2015) present the common priorities of member states. Likewise, the common positions taken at COP15 and COP16 to the UNFCCC demonstrate SAARC's emerging unified voice. SAARC has made gains in forming an institutional framework, though it has not yielded significant results.

SAARC has been criticized for its sluggish and inadequate response to climate change, with much of its actions supposedly limited to conferences, rhetoric and studies. Although the environment ministers meet annually, the release of SAARC's first study on environmental degradation, the Plan of Action on Environment in 1997, and the Action Plan on Climate Change, are each about a whole decade apart. Moreover, experts argue that commitments like the Dhaka Declaration and recommendations from studies such as the one on GHG emissions have not been matched by action. In fact, the deadline for the Action Plan on Climate Change has been extended from 2011 to 2014. It has also been posited that the different centres mentioned above have produced very little output (Dorji 2011). It is expected that these centres will become more functional now since specific tasks have been delegated to them in the Thimphu Statement and a group of experts will monitor their activities. Support from other experienced international organizations can help to enhance these SAARC institutions.

SAARC has reached out to several regional and international actors, but its ability to tap global opportunities has been weak. SAARC has signed Memoranda of Understanding with the South Asia Cooperative Environment Programme in 2004 UNEP in 2007 and the United Nations International Strategy on Disaster Reduction in 2008. As late as 2010, SAARC acquired observer status with the UNFCCC. Yet, despite these steps toward cooperation and South Asia's tremendous potential for carbon credit projects in the areas of renewable energy and waste management, most SAARC countries have not taken advantage of Kyoto policy measures such as CDM and REDD+, which can bring large financial flows from Annex I countries. The main reasons are a basic failure in institutional setup (especially of the DNAs), poor understanding at the political level, lack of awareness among key stakeholders and inadequate technical human resources. Poor incentives for the private sector have also stalled adaptation efforts. India, an exceptional case, enjoys the second highest share of global CDM projects after China and hosts 96.3 percent of the CDM projects in South Asia as of April 2012. In 2005 alone, the country earned more than 15 billion Indian Rupees just by selling carbon credits

SAARC has reached out to several regional and international actors to garner support against climate change, but its ability to tap global opportunities has been weak.

to developed countries. In India, Pakistan, Nepal and Bhutan, REDD+ development has been stronger than that of CDM (Iqbal and Tabish 2012).

The stark contrast between the progress made by India and the rest of the subcontinent illustrates the lack of unity in the region. For the most part, adaptation efforts in South Asia have been fragmented and uncoordinated, mainly due to differing interests and groupings within the region. For example, India, Pakistan and Sri Lanka are developing countries and the rest are LDCs. India, the most rapidly developing country, requires large concessions on emissions to fuel its economic growth, and has resisted international pressure to curb its emissions. On the other hand, the LDCs, which are most vulnerable to climate change, have been demanding an international treaty irrespective of the share of responsibilities.

Adaptation efforts in South Asia have been fragmented and uncoordinated, mainly due to differing interests and groupings within the region.

Lack of cooperation also stems from political and economic issues in the region such as the long-standing row between nuclear rivals India and Pakistan. Their dispute over water resources and unwillingness to share water-related data has made it difficult to address the perennial issue of flood forecasting. Officials from Bangladesh have reported that India only shares water flow rates near the Indo-Bangladesh border areas, which does not give them enough lead time to take precautionary measures. Similarly, India's plan to divert water through the Farakka and Mahakali Barrage has raised the ire of Bangladesh and Nepal. Matters can worsen when waterflows from the Himalayas will lessen as glaciers recede. While its neighbours and proponents of a binding international treaty are frustrated by India's bilateralism and reluctance to cut down emissions, which are affecting the entire subcontinent's monsoon system, it must also be noted that India must meet enormous domestic needs. In spite of having to support a large poor population and the largest economy in the region, India is a relatively low intensity emitter. In terms of emissions per unit of GDP (kg of oil equivalent) and taking into account purchasing power parity, India falls in the same category as Germany and other energy-efficient economies (World Bank 2009). The challenge of multilateral cooperation to national sovereignty and statehood has been a long-standing debate (Beyerlin *et al.* 2006).

In spite of SAARC's slow implementation, it has shown noteworthy leadership by bringing together heads of state to work on adaptation and by taking the initiative to complement international efforts, which have also progressed at a laggard pace. Exchange of data, transboundary river management, financing adaptation projects and defending the common interests of South Asia at global climate negotiations are some of the challenges that SAARC should face in the coming years. Moreover, member states will have to simultaneously resolve internal matters that are hindering regional cooperation.

Chapter 6

Conclusion and recommendations

In order to minimise the potential damage to agriculture due to climate change, and ensure food security in South Asia, different adaptation strategies may be suggested. These strategies are implementable in the short and long run by people in rural areas even with no or less formal education.

Access to information and technology

Field level information from South Asian countries indicates that farmers have historically been adjusting their production practices autonomously. This is due to the fact that though farmers are not aware of the science behind climate change, they have a wealth of knowledge as regards changes in weather patterns and trends based on their experiences (Nishat 2005). However, these farmers have to be supported with technical and financial resources so that they can utilize their knowledge more efficiently and accurately in order to sustain production (Smit and Skinner 2002). In this respect, agriculture extension services provided by the government may be useful for farmers to know the overall scope of adaptation to climate change. Extension services can include information on the adjustment of timing of farm operations, management of livestock and change in tillage practices (Kalisch *et al.* 2012).

Price incentives

Small farmers should be encouraged to adopt technology to modernize farm operations by making technology available at affordable prices. It is important to make farmers aware of new technologies on the availability of water and nutrient management alternatives so that they can avoid risks.

Education and training

Those who are not able to adapt to the impacts of climate change and may lose or have already lost agriculture land should be given training to look for income opportunities elsewhere in other sectors so that they can face their livelihood challenges by diversifying income opportunities.

Agriculture research

There is a need for practical research that could support the growth of the agriculture sector. For example, innovation of drought and heat tolerant or water resistant production varieties can help ensure food security. There should also be research for using a different production system that may be more suitable to the changed climatic conditions. Innovations on new varieties should be coupled with market research in order to understand the demand for such changed varieties. Research for innovation and market assessment pre-supposes more dedicated resources from the public sector.

Agriculture insurance

Traditional risk management strategies that include diversification of agriculture activities or development of climate-specific varieties may not be adequate to

Farmers in South Asia need to be supported with technical and financial resources so that they can utilize their knowledge more efficiently and accurately in order to sustain production.

cover the risks faced by farmers. Even social safety net programmes devised by the government are not sufficient to make up the losses due to climate variability and protect them from falling into extreme poverty. Therefore, agriculture insurance can be more useful to recover the loss that could be incurred due to extreme weather events. Insurance could also enhance farmers' willingness to adapt, to make use of innovations and invest in new technologies (Kalisch *et al.* 2012).

In South Asia, India provides comprehensive insurance to farmers to cover yield losses due to non-preventable risks such as natural fires and lightning, storms, cyclones, typhoons, floods, droughts or pests and diseases (GoI 2010). There is also a weather-based crop insurance scheme initiated by the Indian Ministry of Agriculture, and implemented by various insurance agencies across India.

Vulnerable communities should be empowered to take actions based on their own decisions as they have the first hand knowledge on coping strategies.

Community-based adaptation

Vulnerable communities should be empowered to take actions based on their own decisions as they have the first hand knowledge on coping strategies. However, as they are the poorest and the most vulnerable, their adaptive capacity may be inadequate given the predicted severity of the impact of climate change. Though CBA is an emerging idea, basic principles of the concept include: i) non-discrimination, equality and the special needs of marginalized social group; ii) active, free and meaningful participation; iii) empowerment; and iv) accountability (Ehrhart 2011). Mainstreaming of CBA strategies is important for the coordination of such activities by policy makers across various regions of a country.

Water management

As climate change is a cross-cutting issue, policies to adapt to the impacts of climate change also require policies in related sectors. Water management is such an area which has implications for adaptation to climate change. Efficient water management is vital for sustainable agriculture production as climate change threatens to make water management difficult. In some regions there will be prolonged droughts while in others there will be untimely and heavy rainfall which will risk agriculture production. There is thus a need for awareness regarding water management and conservation. There is also a need to establish property rights through proper pricing of water to ensure a sustainable use of water. In order to face dire situations, there should be systems to collect and store rain water. Financial support by the government is needed to arrange for water storage facilities in villages for small farmers.

Adaptation for mitigation

Agriculture is not only affected by climate change, it also contributes to GHG emissions. The use of fertilizer emits nitrous oxide, paddy cultivation generates methane, and livestock produces methane and ammonia. Eighteen percent of global GHG emissions in the form of CO_2 are caused by land use change, tropical deforestation and forest degradation (Stern 2006). Therefore, reduction of GHG emissions due to agriculture activities requires a substitute for fossil fuel energy through production of different forms of biomass. Massive reforestation and afforestation can also reduce the emissions level substantially.

Institutional strengthening

The conclusion that may be drawn from the above discussion is that the importance of supportive public policy is undeniable for enhancing the adaptive capacity of agriculture activities. However, in order to implement public policies, existing institutions have to be reformed in respective countries of South Asia, with changes in decision making structures to ensure more accountability and transparency. Implementation of policies such as efficient water allocation; promotion of research; and changes in subsidies, taxes and pricing structures; require stronger commitments from policy makers.

Endnotes

[1] http://www.emdat.be/advanced-search

[2] See http://www.rrcap.ait.asia/issues/glof/

[3] For details about the scenarios see "IPCC Special Report: Emissions Scenarios", available at http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf

[4] CO_2 fertilization refers to the enrichment of plant growth under higher atmospheric concentrations of CO_2, as expected in the future.

[5] The GCM ensemble mean values are derived from the mean and spread of 13 climate models to minimize the biases inherent in the structurally different models.

[6] This subset (B1, A1B and A2) consists of a "low", "medium" and "high" intensive scenario among the marker scenarios and this choice is constrained by computer resources for calculation.

[7] LAPA is an operational plan that identifies the adaptation priorities of vulnerable households and communities and complements national initiatives such as the National Adaptation Programmes of Action (NAPA).

Annex

Climate financing in South Asian countries (US$ million)

Afghanistan					
Focus	**Source**	**Approved Year**	**Approved amount**	**Disbursed amount**	**Project**
Adaptation	Least Developed Countries Fund	2004	0.2	0.2	Enabling activities for the preparation of National Adaptation Programme of Action
Adaptation	Least Developed Countries Fund	2011	4.9	4.9	Building adaptive capacity and resilience to climate change
Mitigation (general)	Japan's Fast Start Finance	NA	6.09	0	Introduction of clean energy through solar electricity generation system
Multiple foci	MDG Achievement Fund	NA	5	5	Strengthened approach for the integration of sustainable environmental management into the Afghanistan National Development Strategy/Poverty Reduction Strategy Paper
Total			16.19	10.1	
Bangladesh					
Adaptation	Least Developed Countries Fund	2003	0.2	0.2	Preparation of National Adaptation Programme of Action
Adaptation	Least Developed Countries Fund	2008	3.3	3.3	Community-based adaptation to climate change through coastal afforestation
Adaptation	Pilot Programme for Climate Resilience	2011	0.53	0	Climate change capacity building and knowledge management (preparation grant)
Adaptation	Pilot Programme for Climate Resilience	2011	0.71	0.19	Coastal climate resilient water supply, sanitation and infrastructure improvement (preparation grant)
Adaptation	Pilot Programme for Climate Resilience	2011	0.11	0	Coastal embankments improvement and afforestation (preparation grant)
Adaptation	Pilot Programme for Climate Resilience	2011	0.038	0	Feasibility study for a pilot programme on climate resilient housing in the coastal region (preparation grant)

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Focus	Source	Approved Year	Approved amount	Disbursed amount	Project
Adaptation	Least Developed Countries Fund	2011	5.65	0	Integrating community-based adaptation into afforestation and reforestation programmes
Adaptation	Pilot Programme for Climate Resilience	2011	0.17	0	Promoting climate resilient agriculture and food security (preparation grant)
Adaptation	Pilot Programme for Climate Resilience	2012	30.11	0	Coastal climate resilient infrastructure project
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	3	3	Improving kiln efficiency in the brick-making industry
Mitigation (general)	GEF Trust Fund (GEF 5)	2011	4.08	0	Development of sustainable renewable energy power generation
Mitigation (general)	Japan's Fast Start Finance	NA	19.21	0	Bheramara combined cycle power plant development project
Multiple foci	Global Climate Change Alliance	2009	11.56	11.56	Contribute to the Bangladesh Climate Change Resilience Fund to improve 10 million lives through climate change adaptation, mitigation and disaster risk reduction measures
Multiple foci	GEF Trust Fund (GEF 5)	2012	4.63	4.63	Greater Dhaka sustainable urban transport corridor project
Total			83.298	22.88	
Bhutan					
Adaptation	Least Developed Countries Fund	2004	0.2	0.2	Preparation of National Adaptation Programme of Action
Adaptation	Least Developed Countries Fund	2008	3.45	3.45	Reducing climate change-induced risks and vulnerabilities from glacial lake outbursts in the Punakha-Wangdi and Chamkhar valleys
Adaptation	Global Climate Change Alliance	2011	5.72	0	Climate change adaptation in the renewable natural resources sector
Adaptation	Least Developed Countries Fund	2012	11.49	0	Addressing the risk of climate-induced disasters through enhanced national and local capacity for effective actions
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	1.7	1.7	Promoting sustainable rural biomass energy
Mitigation (general)	Japan's Fast Start Finance	NA	0.02	0	National solid waste management programme
Total			22.58	5.35	
India					
Adaptation	International Climate Initiative	2008	0.201	0	Disaster prevention and adaptation to climate change in remote Himalayan villages
Adaptation	International Climate Initiative	2008	0.266	0	Increasing resilience to climate impacts of vulnerable communities and critical ecosystems in the eastern Himalayas of India

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Focus	Source	Approved Year	Approved amount	Disbursed amount	Project
Adaptation	Special Climate Change Fund	2011	1.82	0	Climate resilient coastal protection and management
Adaptation	Special Climate Change Fund	2012	8	0	Sustainable livelihoods and adaptation to climate change
Adaptation	GEF Trust Fund (GEF 4)—Strategic Priority on Adaptation	NA	0.22	0.22	Integrated land and ecosystem management to combat land degradation and deforestation in Madhya Pradesh
Adaptation	GEF Trust Fund (GEF 4)—Strategic Priority on Adaptation	NA	1	1	Reversing environmental degradation and rural poverty through adaptation to climate change in drought stricken areas in southern India: A hydrological unit pilot project approach
Adaptation	GEF Trust Fund (GEF 4)—Strategic Priority on Adaptation	NA	0.35	0.35	Sustainable land, water and biodiversity conservation and management for improved livelihoods in Uttarakhand watershed sector
Adaptation	GEF Trust Fund (GEF 4)—Strategic Priority on Adaptation	NA	0.25	0.25	Sustainable participatory management of natural resources to promote ecosystem health and resilience in the Thar Desert ecosystem
Adaptation	GEF Trust Fund (GEF 4)— Strategic Priority on Adaptation	NA	2.96	2.96	Sustainable rural livelihood security through Innovations in land and ecosystem management
Mitigation (general)	International Climate Initiative	2008	1.838	0	Climate protection and distributed energy supply—Indo-German Energy Forum
Mitigation (general)	International Climate Initiative	2008	3.89	0	Climate-neutral energy supply for rural areas
Mitigation (general)	International Climate Initiative	2008	3	0	Converting a production facility to the manufacture of climate-friendly air-conditioning equipment
Mitigation (general)	International Climate Initiative	2008	1.023	0	Eco-industrial parks in Andhra Pradesh
Mitigation (general)	International Climate Initiative	2008	0.214	0	Energy campaign for the hotel and restaurant industry
Mitigation (general)	International Climate Initiative	2008	1.5	0	Trigeneration in Tamil Nadu House, New Delhi
Mitigation (general)	International Climate Initiative	2009	7.35	0	ComSolar: Marketing solar energy in urban regions and industrial zones
Mitigation (general)	International Climate Initiative	2009	2.49	0	Excellence Enhancement Centre
Mitigation (general)	International Climate Initiative	2009	3.049	0	Producing energy from waste and sewage
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	0.25	0.25	Achieving reduction in GHG emissions through advanced energy efficiency technology in electric motors

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Focus	Source	Approved Year	Approved amount	Disbursed amount	Project
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	6.3	6.3	Chiller energy efficiency project (under the Programmatic Framework for Energy Efficiency)
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	45.4	45.4	Coal fired generation rehabilitation project
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	0.95	0.95	Energy conservation in small sector tea processing units in South India
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	0.7	0.7	Energy efficiency improvements in the Indian brick industry
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	11.3	11.3	Financing energy efficiency at micro, small and medium enterprises
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	5.2	5.2	Energy efficiency improvements in commercial buildings (under the Programmatic Framework for Energy Efficiency)
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	5.2	5.2	Improving energy efficiency in the Indian Railway System (under the Programmatic Framework for Energy Efficiency)
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	0	0	Programmatic Framework Project for Energy Efficiency in India
Mitigation (general)	Global Energy Efficiency and Renewable Energy Fund	2010	0.129999	0	IndiaCo
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	0.8	0.8	Low carbon campaign for Commonwealth Games 2010
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	4.4	4.4	Market development and promotion of solar concentrators-based process heat applications
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	7.17	7.17	Promoting energy efficiency and renewable energy in selected micro SME clusters in India (under the Programmatic Framework for Energy Efficiency)
Mitigation (general)	International Climate Initiative	2010	2.601	0	Promoting low carbon transport
Mitigation (general)	International Climate Initiative	2010	2.144	0	Solar mapping and monitoring
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	22.5	22.5	Sustainable urban transport project
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	9.2	0	Efficient and sustainable city bus services
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	9	0	Facility for low carbon technology deployment
Mitigation (general)	Clean Technology Fund	2012	100	0	Himachal Pradesh environmentally sustainable development policy loan
Mitigation (general)	Germany's International Climate Initiative	2012	1.32	0	Indo-German Trigen Project

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Focus	Source	Approved Year	Approved amount	Disbursed amount	Project
Mitigation (general)	Clean Technology Fund	2012	50	0	National mission on enhanced energy efficiency—Super efficient equipment programme
Mitigation (general)	Clean Technology Fund	2012	25	0	Partial risk guarantee scheme for new technologies in energy efficiency
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	18	0	Partial risk sharing facility for energy efficiency
Mitigation (general)	Germany's International Climate Initiative	2012	4.15	0	Indo-German Energy Forum
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	4.37	4.37	Promoting business models for increasing penetration and scaling up of solar energy
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	4.46	0	Promoting industrial energy efficiency through energy management standard, system optimization and technology Incubation
Mitigation (general)	Clean Technology Fund	2012	88	0	Rajasthan Solar Park
Mitigation (general)	Japan's Fast Start Finance		0.45	0	Project survey for solar heat power plant
Multiple foci	GEF Trust Fund (GEF 4)	2010	3.5	3.5	Enabling activities for preparing India's second national communication to UNFCCC
Multiple foci	Germany's International Climate Initiative	2012	9.6	0	Participatory management for conserving biodiversity in coastal and marine protected areas
Multiple foci	GEF Trust Fund (GEF 5)	2012	9.01	0	Preparation of third national communication to the UNFCCC and strengthening institutional and analytical capacities on climate change
Total			490.5260	122.82	
Maldives					
Adaptation	Least Developed Countries Fund	2004	0.2	0.2	Preparation of National Adaptation Programme of Action
Adaptation	Least Developed Countries Fund	2009	4.25	4.25	Integrating climate change risks into resilient island planning
Adaptation	Least Developed Countries Fund	2011	1.65	1.65	Increasing climate change resilience of Maldives through adaptation in the tourism sector
Adaptation	Adaptation Fund	2011	8.99	0.43	Increasing climate resilience through an integrated water resource management programme in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo islands
Mitigation (general)	Scaling Up Renewable Energy Programme	2011	0.31	0.17	Investment plan preparation grant
Mitigation (general)	International Climate Initiative	2011	3.87	0	Supporting a climate-neutral strategy for the Maldives

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Focus	Source	Approved Year	Approved amount	Disbursed amount	Project
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	3.88	0	Strengthening low-carbon energy island strategies
Mitigation (general)	Japan's Fast Start Finance		8.7	0	Clean energy promotion in Male
Multiple foci	Global Climate Change Alliance	2008	5.24	5.24	The Global Climate Change Alliance and the Climate Change Trust Fund Programme in the Maldives: Building a climate change sustainable strategy and action plan
Total			37.09	11.94	
Nepal					
Adaptation	Global Climate Change Alliance	2010	11.7	11.7	Building climate resilience in Nepal
Adaptation	Pilot Programme for Climate Resilience	2011	1.39	0.18	Building climate resilience of watersheds in mountain eco-regions (project preparation grant)
Adaptation	Pilot Programme for Climate Resilience	2011	9.1	0	Building climate resilient communities through private sector participation (project preparation grant)
Adaptation	Pilot Programme for Climate Resilience	2011	31.47	0	Building resilience to climate-related hazards (project preparation grant)
Adaptation	Least Developed Countries Fund	2011	6.3	0	Community-based flood and glacial lake outburst risk reduction
Adaptation	Pilot Programme for Climate Resilience	2011	0.25	0	Enhancing climate resilience of endangered species (project preparation grant)
Adaptation	International Climate Initiative	2011	0.259999	0	Improving the resilience of vulnerable population groups to climate change
Adaptation	Pilot Programme for Climate Resilience	2011	7.2	0	Mainstreaming climate change risk management in development
Adaptation	Pilot Programme for Climate Resilience	2011	0.504	0	Mainstreaming climate risk management in development (project preparation grant)
Adaptation	Least Developed Countries Fund	2011	0.2	0.2	Preparation of National Adaptation Programme of Action
Adaptation	Pilot Programme for Climate Resilience	2011	0.23	0.21	Design of national strategic programmes for climate resilience (phase 1 funding)
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	2.82	2.82	Kathmandu sustainable urban transport project
Mitigation (general)	Scaling Up Renewable Energy Programme	2011	0.38	0.26	Investment plan preparation and implementation grant
Mitigation (general)	Scaling Up Renewable Energy Programme	2011	0.37	0	Scaling up access to electricity in rural Nepal

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Focus	Source	Approved Year	Approved amount	Disbursed amount	Project
Mitigation (general)	Scaling Up Renewable Energy Programme	2011	0.37	0	Scaling up hydropower promotion
Mitigation (general)	Scaling Up Renewable Energy Programme	2011	0.2	0	Sustainable household energy solutions
Mitigation (general)	Scaling Up Renewable Energy Programme	2012	0.33	0	Extended biogas programme
Mitigation (general)	Scaling Up Renewable Energy Programme	2012	1.16	0	Mini and micro initiatives: Off grid electricity (project preparation grant)
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	3	0	Renewable energy for rural livelihood
Mitigation (REDD)	UK's International Climate Fund	2011	4.03	0	Nepal multi-stakeholder forestry programme
Mitigation (REDD)	Forest Carbon Partnership Facility - Readiness Fund	2011	3.6	0.7	Readiness preparation grant
Mitigation (REDD)	Japan's Fast Start Finance	NA	5.22	0	Forest preservation programme
Multiple foci	UK's International Climate Fund	2011	1.61	0	Nepal climate change support programme
Total			91.69400	16.07	
Pakistan					
Adaptation	Adaptation Fund	2010	3.9	2.64	Reducing risks and vulnerabilities from glacier lake outbursts floods in northern Pakistan
Adaptation	Japan's Fast Start Finance	NA	31.69	0	Project for the improvement of water supply system in Abbottabad
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	4.85	4.85	Pakistan sustainable transport project
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	0.95	0.95	Productive use of renewable energy in Chitral District
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	1.82	1.82	Promoting sustainable energy production and use from biomass
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	0.98	0.98	Promotion of energy efficient cooking, heating and housing technologies
Mitigation (general)	GEF Trust Fund (GEF 5)	2012	3.55	0	Sustainable energy initiative for industries
Total			47.74	11.24	
Sri Lanka					
Adaptation	Special Climate Change Fund	2011	3.12	0	Strengthening the resilience of post-conflict recovery and development to climate change risks in Sri Lanka
Adaptation	Japan's Fast Start Finance	NA	0.37	0	Disaster management capacity enhancement project adaptable to climate change

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Focus	Source	Approved Year	Approved amount	Disbursed amount	Project
Adaptation	GEF Trust Fund (GEF 4)— Strategic Priority on Adaptation	2.1	2.1	Participatory coastal zone restoration and sustainable management in the eastern province of post-tsunami Sri Lanka	
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	2	2	Promoting sustainable biomass energy production and modern bio-energy technologies
Mitigation (general)	GEF Trust Fund (GEF 4)	2010	2.36	2.36	Bamboo processing for Sri Lanka
Mitigation (general)	GEF Trust Fund (GEF 4)	2011	3.6	3.6	Portfolio approach to distributed generation opportunity (Phase 1)
Mitigation (REDD)	UN-REDD	2012	4	0	UN-REDD Sri Lanka
Total			17.55	10.06	

Source: Climate Funds Update, 2003–2012 (September).

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South Asia Watch on Trade, Economics and Environment (SAWTEE) is a regional network that operates through its secretariat in Kathmandu and member institutions from five South Asian countries, namely Bangladesh, India, Nepal, Pakistan and Sri Lanka. The overall objective of SAWTEE is to build the capacity of concerned stakeholders in South Asia in the context of liberalization and globalization.

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