Background Paper

Impacts, vulnerability and adaptation to climate change in Asia

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This paper was commissioned by the secretariat of the United Nations Framework Convention on Climate Change and prepared by Mozaharul Alam, Atiq Rahman, Mariam Rashid, Golam Rabbani, Preety Bhandary, Suruchi Bhadwal, Murali Lal, and Moekti Handajani Soejachmoen. In some parts of the document the secretariat introduced modifications.

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Abbreviations and Acronyms

ACCCA	Advancing Capacity to Support Climate Change Adaptation
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
AIACC	Assessments of Impacts and Adaptation to Climate Change
AOGCM	Atmosphere-Ocean General Circulation Model
APN	Asia-Pacific Network for Global Change Research
BCAS	Bangladesh Centre for Advanced Studies
BFRI	Bangladesh Forestry Research Institute
BIDS	Bangladesh Institute of Development Studies
CBA	Community Based Adaptation
CBO	Community Based Organisation
CDM	Clean Development Mechanism
CDMP	Comprehensive Disaster Management Programme
CER	Certified Emissions Reduction
CFIS	Community-based Flood Information System
CGE	Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention
CGIAR	Consultative Group on International Agricultural Research
CIFOR	Centre for International Forest Research
CLACC	Capacity Strengthening of LDCs for Adaptation to Climate Change
CO_2	Carbon dioxide
COP	Conference of the Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFID	UK Department for International Development
DoE	Department of Environment
DSWD	Department of Social Welfare and Development
EC	European Commission
ENSO	El Niño - Southern Oscillation
GAW	Global Atmosphere Watch
GCM	General Circulation Model
GCOS	Global Climate Observing System
GCOS RWP	GCOS Regional Workshop Programme
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Global Environmental Outlook

GIS	Geographic Information System
GLOF	Glacial Lake Outburst Flood
GSN	GCOS Surface Network
GUAN	GCOS Upper Air Network
HadRM2	Hadley Centre Regional Climate Model
IAI	Inter-American Institute
ICIMOD	International Centre for Integrated Mountain Development
ICSI	International Commission of Snow and Ice
IFRC	International Federation of Red Cross and Red Crescent Societies
IFS	International Foundation for Science
IGES	Institute for Global Environmental Strategies
IOS	GCOS Initial Observing System
IPCC	Intergovernmental Panel on Climate Change
IUCN	World Conservation Union
IWMI	International Water Management Institute
KBS-LANKA	GIS Based Knowledge Base System for Sri Lanka
LEG	LDC Expert Group
LDC	Least Developed Country
LDCF	Least Developed Countries Fund
NAPA	National Adaptation Programme of Action
NC	National Communication
ODA	Official Development Assistance
PSC	Project Steering Committee
RCM	Regional Circulation Model
SCCF	Special Climate Change Fund
SGP	Small Grants Programme
SLR	Sea Level Rise
SMRC	SAARC Meteorological Research Centre
SPA	Strategic Priority on Adaptation
SRES	Special Report on Emissions Scenarios
SSN	SouthSouthNorth
SSNAPP	SouthSouthNorth Adaptation Project Protocol
SST	Sea Surface Temperature
START	global change SysTem for Analysis, Research and Training
SWG	Sectoral Working Group
TAR	Third Assessment Report
TERI	The Energy and Research Institute
TWAS	Third World Academy of Science

UNFCCC	United Nations Framework Convention on Climate Change
UNU	United Nations University
WARPO	Water Resources Planning Organisation
WBCSD	World Business Council for Sustainable Development
WCED	World Commission on Environment and Development
WWF	World Wildlife Fund

I. Introduction

A. Purpose and Scope

1. The Conference of the Parties (COP), by its decision 1/CP.10, requested the secretariat to organize three regional workshops, reflecting regional priorities, and one expert meeting for small island developing States, in order to facilitate information exchange and integrated assessments to assist in identifying specific adaptation needs and concerns.

2. This paper represents background information as input to the Asian Regional Workshop on Adaptation (Beijing, China, 11-13 April 2007) and is prepared by secretariat of the United Nations Framework Convention on Climate Change (UNFCCC).

3. The purpose of the background paper is to provide the context of climate change vulnerability and adaptation in Asia aiming to facilitate discussion during the Workshop. The paper provides an overview of general social and environmental conditions in this region. It outlines the vulnerability of the Asian region to climate change, the current status of adaptation assessments, and the implementation of adaptation options, taking into account sub-regional and national differences. Asia is a challenging region because of its geographical expanse and diversity, political circumstances and varying levels of implementation of adaptation action.

4. The paper is intended to provide a starting point for discussions on the various aspects of impacts, vulnerability and adaptation in the Asia Region.

B. Sources of Information

5. This background paper is prepared based on available secondary data and information, including:

(a) National Communications (NCs) to the UNFCCC, National Adaptation Programmes of Action (NAPAs), materials from previous UNFCCC regional workshops e.g. those undertaken by the Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention (CGE) and the Least Developed Countries Expert Group (LEG), and other relevant UNFCCC documents.

(b) The Intergovernmental Panel on Climate Change Third Assessment Report (IPCC-TAR), as well as more recent publications on climate change (especially from peer-reviewed journals), literature on sustainable development and other relevant topics including outcomes of relevant conferences held in and for the Asia region.

(c) Where available, government strategy papers for the consideration of climate change in planning and development, for example in the improvement and expansion of sectors such as infrastructure, water resources, agriculture, disaster risk reduction and coastal zone management.

(d) Outcomes and reports of completed multilaterally and bilaterally funded projects within the region, for example the Global Climate Observing System Regional Workshop Programme (GCOS RWP), Assessment of Impacts and Adaptation to Climate Change (AIACC), Advancing Capacity to Support Climate Change Adaptation (ACCCA), and other relevant documents.

(e) The Global Environmental Outlook (GEO3, GEO4) report and database on the Asia Region.

(f) Examples of Community Based Adaptation Projects and Activities, including those in the UNFCCC database on local coping strategies as well as those presented in the CBA Workshops held in Dhaka in 2006 and 2007.

II. Context for Adaptation to Climate Change

A. Introduction

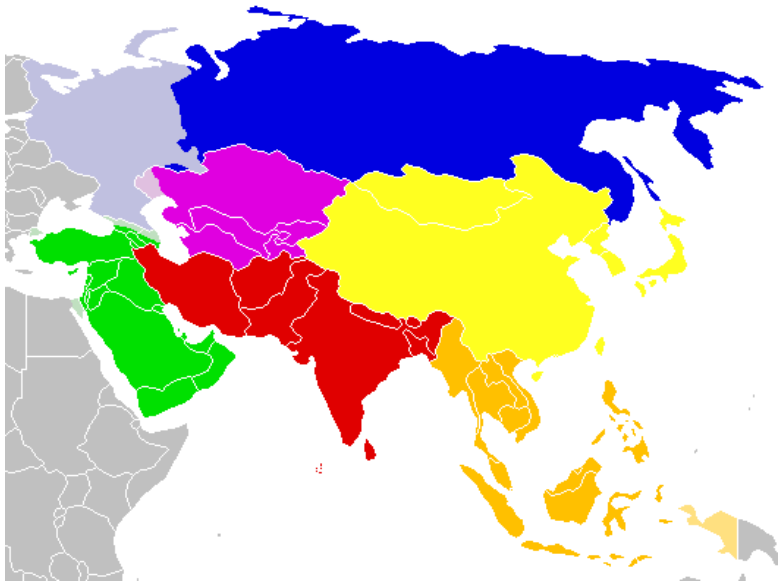

Figure 1. Different UN Sub-region of Asia

6. Asia is the world's largest and most populous continent which covers about 30% of the world land area and contains more than 60% of the current human population. The Asian continent is bounded on the north by the Arctic Ocean, on the east by the Pacific Ocean, and on the south by the Indian Ocean; the western boundary with Europe, runs roughly north-south along the eastern Ural Mountains, the Zhem River, the Caspian Sea, the Kuma-Manych Depression, the Black Sea, the Aegean Sea, the Mediterranean Sea, the Suez Canal, and the Red Sea. The Tibetan Plateau, with an average elevation of more than 4,000 m, is the world's largest plateau and Mount Everest (8,848 m), lying near the southern border of this plateau, is the world's highest peak.

7. Asia comprises more than 4 billion people living in 46 different States (Annex I, Table 1) with a large range of differing cultures, environments, historical ties and government systems. Asia's wealth differs widely within and between States. In terms of nominal GDP, the largest economies in Asia are Japan (4,622.8 billion US$) and China (1931.7 billion US$) (UNDP, 2006). However, in terms of Purchasing Power Parity, the People's Republic of China has the largest economy (7,642.3 billion US$) in Asia and the second largest in the world while Japan (3,737.3 billion US$), India (3,389.7 billion US$) and South Korea (985.6 billion US$) are the world's third, fourth and eleventh largest economies respectively (UNDP 2006).

8. In most nations, central governments have played a key role in economic planning to achieve development goals, and in many instances, have also formulated environmental policies. Progress has been made in overall poverty reduction in many Asian countries. The number of people living on less than US$1 a day dropped by nearly 250 million from 1990 to 2001. Sustained growth in China and the acceleration of India's economy contributed to such progress. Efforts at reducing malnutrition, however, have been less successful. The most severe problems are evident in South Asia, where almost half the children aged 0-5 years are malnourished.

9. Environmental protection is considered to be a fundamental element in achieving several Millenium Development Goals (MDGs) and is also a powerful engine for economic growth and poverty eradication. South Asia has increased access for many to safe sources of drinking water, with India contributing substantially to the overall positive trend. Another positive sign is the significant progress made in improving energy efficiency and providing

access to clean technology and fuels in Eastern Asia and Southern Asia, although energy efficiency continues to decline in Southeast Asia.

10. The region still faces some formidable challenges in its effort to protect valuable natural resources and the environment. Land and ecosystems are being degraded, threatening to undermine food security. In addition, water and air quality are deteriorating while continued increases in consumption and associated waste have contributed to the exponential growth in the region's existing environmental problems. Furthermore, the region is highly subject to natural hazards. Notable examples include the 2004 Indian Ocean Tsunami, the 2005 Pakistan Earthquake, and the 2006 landslides in the Philippines. There is evidence of prominent increases in the intensity and/or frequency of many of the extreme weather events such as heat waves, tropical cyclones, prolonged dry spells, intense rainfall, tornadoes, snow avalanches, thunderstorms, and severe dust storms in the region throughout the1990s and beyond (IPCC-TAR). Impacts of such disasters range from hunger and susceptibility to disease, to loss of income and livelihoods, affecting the survival and human well-being of both present and future generations.

11. The environmental and social problems in Asia are not new; many of them are persistent and some are getting worse. The Brundtland report highlighted the risks twenty years ago, declaring that the loss of ecosystems, for example natural forests and wetlands, the degradation of water and air quality, and ever increasing consumption and associated waste generation have made people and ecosystems more vulnerable. Since 2000, Asia's GDP growth has surpassed that suggested by the Brundtland Commission, but ecosystems and human health continue to deteriorate. The region faces many years of challenges in attempting to preserve the environment while alleviating poverty and improving living standards with limited natural resources.

B. Current Environmental and Socio-economic Vulnerabilities

12. Even though Asia is the largest continent on Earth and spreads over four climatic zones (Annex I, Table 2), it has environmental and socio-economic problems common to the entire region, in sectors such as water, agriculture and land use, ecosystem and biodiversity, and population (Annex I Table 3). The majority of the problems in these sectors are related to management issues and are exacerbated by the associated impacts of climate change.

1. Water Sector: Balancing Water Use and Demand

13. Adequate water supply is one of the major challenges in Asia. The growing demand for water is driven by high population, increasing urbanization and the flourishing of economic and social development. Since Asian economies depend heavily on agriculture and hence on irrigation, this sector continues to be the most demanding on available water resources. Excessive withdrawals from surface waters and underground aquifers, pollution of freshwater resources by the industrial sectors and inefficient use of freshwater are also major causes of water stress. Climate change has the potential to exacerbate water resource stresses in many countries of Asia (IPCC-TAR).

14. The Arid characteristic of Middle Eastern countries makes water scarcity a major problem. Extensive irrigation systems allow for agricultural production in this region, although this can increase salinity in groundwater aquifers. Combined with decrease in precipitation due to climate change, the Middle East faces a daunting task of ensuring fresh water supply for its sustainability. For example, in Iran, agricultural water usage is about 81.4 billion cubic metres, which accounts for 94% of the total consumption. Drinking water accounts for about 5% of the overall consumption and the industrial sector for only 1% of the whole. The required water is primarily extracted from ground water resources, which supply 55% of water used. The rest is sourced from surface water using dams, irrigation and traditional methods (National Communication, Iran, 2003).

15. Parts of Asia suffer from both water abundance as well as water scarcity. Southwest Bangladesh faces extreme water shortages as well as acute moisture stress during the dry months, adversely affecting both the ecology and agricultural production. Also, floods during the monsoon season inundate an average of 20.5% of the country and can flood as much as 70% (Mirza, 2002).

16. The rate of retreat of glaciers in the Himalayan highlands and permafrost thawing in north Asia has rapidly increased in the last decade. The Himalayan glaciers feed seven of Asia's great rivers: Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang He, and ensure a year-round water supply to billions people.

17. Human activities, such as land-use change, water storage, inter-basin transfers, and irrigation and drainage, are modifying the hydrological cycle in many river basins. A change in the onset, continuity and withdrawal patterns of the summer monsoon in recent years has also led to considerable spatial and temporal variations in rainwater availability in parts of the continent (Lal, 2005). Furthermore, watershed quality over the past few years has been threatened by climatic variability and natural disasters. The impact extends to damage of sanitation facilities and contaminated groundwater (UNEP, 2005).

18. There have been some attempts and actions to deal with water in Asia. Major structural, technological, social and policy changes, including effective water-related policies, lifestyle changes and technological transfer, are needed to decrease water withdrawals and hence water stress in most Asian countries. In addition, improvements in water-use efficiency, especially in the irrigation sector, will have immediate positive impacts on water availability under warmer climate.

2. Pressures on Ecosystems

19. Over the last two decades enormous pressures have been put on Asia's ecosystems to support the ever growing demand for natural resources. The most affected ecosystems are coastal and marine, forests and mountainous regions. Coastal ecosystems play an important role in the region. They are the locus of land-ocean interaction. The region has a long coastline and over half of Asia's more than 4 billion inhabitants live on or near the coast and depend directly on coastal resources, such as mangroves and coral reefs, for at least part of their livelihoods (Middleton, 1999).

20. Mangroves are vital to coastal ecosystems and fulfill multiple functions, such as providing forest products and habitat for fish and shellfish; protecting coastal land from erosion; enhancing biodiversity; and protection from inundation, for example the large mangrove forests in Phang Nga, Thailand, significantly mitigated the impact of the 2004 Indian Ocean Tsunami (UNEP, 2005).The destruction and reduction of ecosystem services and functions, in turn reduce their contribution to human well-being. Deforestation has caused the rapid reduction of timber production, especially of the timber only found in natural forests, thus affecting livelihoods (SEPA, 2004).

21. Heavy reliance on marine resources across the region has resulted in the degradation of many coral reefs, particularly those near major population centres. Moreover, the higher sea surface temperatures have led to severe bleaching of the corals in coastal regions of Asia. Approximately 60% of its coral reefs are estimated to be at risk and mining and destructive fishing practices are the greatest threats (UNESCAP, 2005).

3. Sustainable Agricultural Land Uses

22. Land degradation is a serious problem in Asia because of the threat to food security, human livelihoods and overall sustainability of the region. Problems include salinisation due to poor irrigation practices, soil erosion, desertification and overuse of water.

23. Since agriculture is the main land use in Asia, land conservation as a tool of sustainable agriculture has been heavily emphasized. It can promote rural development, as well as increase food security and ecosystem vitality. Immediate responses are reforestation, redefining protected areas and adopting integrated approaches such as Integrated Watershed Management. Good governance is the basic foundation of any land conservation strategy. Besides providing appropriate legal and policy mechanisms for administering land ownership, it can foster the active participation of civil society in land reform efforts and ensure equitable distribution of the benefits from agrarian development.

24. Many farmers in Asia are women. Their contribution, however, tends to go unnoticed. Effective land management and conservation schemes take into consideration the need to recognize and protect the rights of female participants in agricultural areas and the benefits derived from those areas (FAO, 2003).

C. General Climate Change Profile for Asia

1. Different Climatic Zones and their Characteristics

25. The six geographical sub-regions of Asia primarily fall under the four climatic sub regions as categories by IPCC-TAR with it distinctive characteristics (Annex I, Table 2):

Boreal Asia: is located on the north of the continent between 50°N and the Arctic Circle. Boreal forests cover most of this region. Siberia, Russia, is the coldest region of the northern hemisphere in winter. Three Siberian rivers, the Ob, the Yenissey, and the Lena, contribute about 42% of total runoff from all rivers of the Arctic basin. Lake Baikal, in the heart of this region is one of the world's largest and oldest lakes and contains as much as 85% of Russian surface freshwaters.

Arid and semi-arid Asia: extends from 22°N to 50°N and from 30°E to 105°E and includes more than 20 countries of the Middle East and central Asia, many of which are landlocked. Many storms develop locally, and the maximum frequency of cyclones occurs in January and March, although very little precipitation is recorded over most of the region because of the lack of moisture. Grasslands, rangelands, and deserts dominate most of arid and semi-arid Asia.

Temperate Asia: extends from 22°N to 50°N and from 105°E to 150°E and includes eastern China, the Japanese islands, the Korean peninsula and Mongolia. Much of the natural forest in the region has long been destroyed. Broad plains have been cultivated and irrigated, and natural grasslands have been used for animal husbandry for centuries.

Tropical Asia: extends from 10°S to 28°N and from 50°E to 150°E and includes several countries of south Asia, which are influenced predominantly by the monsoons. The region is physiographically diverse and rich in biodiversity. Agriculture is the main industry in several countries. Exploitation of natural resources associated with rapid urbanization, industrialization, and economic development has led to increasing air and water pollution, land degradation, and other environmental problems in countries of this region.

2. Observed changes in Temperature and Rainfall

26. According to the IPCC-TAR there are large variations in observed changes in temperature and rainfall across Asia.

Boreal Asia: There has been an observed average annual mean increase in surface air temperature of about 2.9°C in the past 100 years, which is more pronounced in the winter although summer temperatures in central Siberia have

exhibited decreasing trends. Annual mean precipitation in Russia is decreasing about -4.1 mm/month/100 years, particularly during warm years. However, during the past 10–15 years, precipitation has increased, mostly during the summer-autumn period. Consequently, the levels of major aquifers have risen by 50–100 cm; the growth of groundwater storage has resulted in increasing ground river recharge and considerable low-water runoff.

Arid and semi-arid Asia: In most of the Middle East, mean annual surface temperature has risen by about 1.3°C during 1894–1997; in the arid regions of China, air temperature has increased since the 1970s. In Pakistan, annual mean surface temperature has a consistent rising trend since the beginning of 20th century. Annual mean rainfall is considerably low in most parts of the arid and semi-arid region and temporal variability is quite high.

Temperate Asia: The average annual mean surface temperature in Mongolia has increased by approximately 0.7°C over the past 50 years; consequently, noticeable changes have taken place in the length of the cold and warm seasons. Surface temperature in northeast China has increased in winter but decreased in summer; in southeast China surface temperature has decreased 1–2°C. In Japan, the surface air temperature has shown a warming trend during the past century. The East Asian monsoon greatly influences temporal and spatial variations in rainfall. Annual mean rainfall in Mongolia is 100–400 mm and is confined mainly to summer. Summer rainfall seems to have declined over the period 1970–1990 in Gobi; the number of days with relatively heavy rainfall events has dropped significantly. In China, annual precipitation has been decreasing continuously since 1965. The summer monsoon is reported to be stronger in northern China during globally warmer years although drier conditions have prevailed during globally colder years.

Tropical Asia: Several countries have reported increasing surface temperatures. In Vietnam, annual mean surface temperature has increased approximately 0.32°C over the past three decades and in Sri Lanka a gradually increasing trend is suggested of about 0.30°C per 100 years. The warming trend over India has been reported to be about 0.57°C per 100 years. Hills and mountain ranges cause striking spatial variations in rainfall. In India, long-term time series of summer monsoon rainfall have no discernible trends, but decadal departures are found above and below the long time average alternatively for three consecutive decades. Recent decades have exhibited an increase in extreme rainfall events over northwest India during the summer monsoon and the number of rainy days during the monsoon along the east coast has declined.

3. Extreme Events and Severe Weather Systems

27. Extreme weather events such as heat waves associated with extreme temperatures, extra-tropical and tropical cyclones, prolonged dry spells, intense rainfall, tornadoes, snow avalanches, thunderstorms, and dust storms are known to cause adverse effects in widely separated areas of Asia. There is some evidence of increases in the intensity or frequency of some of these extreme weather events on regional scales throughout the 20th century, although data analyses are relatively poor and not comprehensive (Balling and Idso, 1990; Bouchard, 1990; Agee, 1991; Yu and Neil, 1991; Ostby, 1993; Bardin, 1994; Born, 1996). There are also reports of an increase in thunderstorms over the land regions of tropical Asia (Karl et al., 1995). The frequency and severity of wildfires in grasslands and rangelands in arid and semi-arid Asia have increased in recent decades (IPCC-TAR).

28. Permanent glaciers in mountainous areas have vacated large areas during the past few decades, resulting in increases in glacial runoff and Glacier Lake Outburst Floods (GLOFs) and an increased frequency of events such as floods, mudflows and avalanches affecting human

settlements. However, as mountain glaciers continue to disappear over the next decades, the volume of summer runoff will be reduced as a result of loss of ice resources with serious consequences for downstream agriculture. For example, low- and mid-lying parts of Central Asia are likely to change gradually into more arid, interior deserts, and lower Himalayan Countries will have more intense and frequent drought.

29. In recent years, GLOFs have happened in Nepal, India, Pakistan, Bhutan, and China in the Himalayan region. The most significant GLOF event since detailed recording started occurred in Dig Tsho Lake at Bhote Kosi in Nepal in 1985. It destroyed a hydropower project, numerous foot-bridges, and trekking trails and caused loss of many lives. Millions of hectares of protected areas and many human settlements are located in the downstream of potentially dangerous glacial lakes. GLOF events have widespread impacts on the region's socio-economic systems, hydrology, and ecosystems.

30. Temperate Asia has experienced many droughts in the 20th century. In China, droughts in 1972, 1978, and 1997 have been recorded as the most serious and extensive. In Japan, drought disasters are significantly more frequent during years following ENSO warm events than in normal years. Floods are also a threat, for example a large number of severe floods have occurred in China, predominately over the middle and lower basins of the Yangtze (Changjiang), Huanghe, Huaihe, and Haihe Rivers (Ji et al., 1993) and severe flooding with daily rainfall exceeding 25 cm struck during July and August 1998 in South Korea.

31. In Tropical Asia, droughts, floods and cyclones are the key natural disasters. In India, chronically drought-affected areas cover the western parts of Rajasthan and the Kutch region of Gujarat. Drought conditions have also been reported in Bihar and Orissa States. In Bangladesh, about 2.7 Mha are vulnerable to drought annually (Mirza, 1998). Drought or near-drought conditions also occur in parts of Nepal, Papua New Guinea, and Indonesia, especially during El Niño years. In India, Laos, the Philippines, and Vietnam, drought disasters are more frequent during years following ENSO events. At least half of the severe failures of the Indian summer monsoon since 1871 have occurred during El Niño years (Webster et al., 1998). Floods are also common in this region. For example in Bangladesh the total flood-prone area is 3.1 Mha and in India it is about 40 Mha (Mirza and Ericksen, 1996). In the event of enhanced anomalous warming of the Eastern Equatorial Pacific Ocean, such as that observed during the 1998 El Niño, a higher frequency of intense extreme events across Asia is possible.

D. Future Change in Climate and Extreme Events

32. There is general agreement among global climate models (GCMs) of a significant acceleration of warming in the 21st century in Asia over that observed in the 20th century. Predictions indicate that higher latitudes in Asia will warm more than the global average and will receive disproportionately more precipitation, while mid-continental mid-latitude areas may become drier, depending on the effects of aerosols (IPCC-TAR; Gao et al., 2003).

33. The area-averaged annual mean warming is projected to be about 3°C by the 2050s and about 5°C by the 2080s over the land regions of Asia as a result of future increases in atmospheric concentration of greenhouse gases. The rise in surface air temperature is projected to be most pronounced over North Asia in all seasons. In general, projected warming over all sub-regions of Asia is higher during northern hemispheric winter than during summer for all time periods.

34. An increase in annual precipitation in most of Asia during the 21st century is predicted with the relative increase being largest and most consistent in North and East Asia (Lal, 2003; Kwon et al., 2004; Boo et al., 2005; Japan Meteorological Agency, 2005; Kurihara et al., 2005). There is a predicted decline in summer precipitation over the central parts of arid and semi-arid Asia, leading to expansion of deserts and periodic severe water stress conditions. Increased rainfall intensity, particularly during the summer monsoon, could increase flood-prone areas in East Asia, South Asia and Southeast Asia.

35. While there is no evidence that tropical cyclone frequency may change (Trenberth, 2005), an increase of 10-20% in tropical cyclone intensities (including the near-storm precipitation rates and destructive potential) for a rise in sea surface temperature of 2 to 4^{o}C relative to the current threshold temperature is likewise projected in East Asia, Southeast Asia, and South Asia (Knutson and Tuleya, 2004; Emanuel, 2005). Amplification in storm surge heights could result from the occurrence of stronger winds with increase in sea surface temperatures and low pressures associated with tropical storms resulting in an enhanced risk of coastal disasters along the coastal regions of East, South and Southeast Asian countries. The impacts of increase in cyclone intensities in any location will be determined by any shift in the cyclone tracks (Kelly and Adger, 2000).

36. Global warming has accelerated melting of glaciers, with the vast Himalayan glaciers showing the fastest rate of retreat. Recent studies by the International Commission of Snow and Ice (ICSI) and the DFID, have predicted that Himalayan glaciers might disappear within 40 years time causing water stress to millions in India and China depending on glacier fed rivers. The Chinese Academy of Sciences states that as many as 64 % of China's glaciers will not exist by 2050 if current trends continue.

37. Future changes in sea level rise are predicted to be geographically variable. An additional 0.5m sea level rise is projected for the Arctic during this century (ACIA, 2004). The rising rates of sea level vary considerably from 1.5 to 4.4 mm per annum along the East Asia coast due to regional variation in land surface movement (Mimura et al., 2004). The projected rise of mean high water level is greater than that of mean sea level (Chen, 1991; Zhang et al., 2000). Thus projected relative sea level rise (RSLR), including that due to thermal expansion, tectonic movement, ground subsidence and the trend of rising river water level, is 40-60cm, 50-70 cm and 70-90 cm in the Zhujiang, Changjiang and Huanghe Deltas, respectively by the year 2050 (Li et al., 2004a, b).

E. National Programmes for Adaptation and Climate Change

38. Almost all Asian Counties have submitted their NC to the UNFCCC to comply with their commitments under the Convention, (Annex I, Table 4). Three Asian countries, Bangladesh, Bhutan and Cambodia, have also submitted their National Adaptation Programmes of Action (NAPAs). Other LDCs in Asia are finalizing their NAPAs. The levels of assessment of impacts, vulnerabilities and adaptation to climate change and reporting varies widely by region and countries due to differences in institutional capacity and economic strengths.

39. Some countries have reported that adaptation measures have already been adopted to address climate change related problems. For example, the Law on Water Resources of the People's Republic of China has been promulgated to safeguard and normalize the management of water resources. The Project of South-to-North Water Diversion has been launched in order to increase water supply to Beijing, Tianjin and the Shandong Peninsula. The construction of upgrading projects for water-saving in 226 large irrigated areas and 200 demonstration projects for water-saving irrigation were launched to raise water use efficiency (Initial National Communication on Climate Change, China, 2004).

40. Terracing of slopes, one of the most effective amelioration activities, has been practiced in many mountainous and low mountain regions for a long time, for example Azerbaijan, Nepal, Indonesia and Bhutan. Besides prevention of erosion processes, terracing of slopes enables additional areas to be cultivated and improves land productivity. The NC of Azerbaijan reported that productivity of terraced slopes would increase by 8-10 times once the cultivation of fodder crops is practiced. Increase of terraced slopes' productivity is maintained through the improvement of plant water regime as a result of 2-3 fold decrease of surface drain.

41. Several NCs give an emphasis on "no-regret" adaptation options, particularly for the water and agriculture sectors, in order to meet national development goals and promote sustainable development (National Communication of India, Saudi Arabia, Bangladesh, China etc). For example, China stated that they are promoting sustainable development and utilization

of water resources; reinforcing adaptive capacity of the water resource system; and thus reducing the vulnerability of the water resource system to climate change. Iran suggests a number of methods for conserving water used in agriculture such as improving irrigation efficiency by lining existing earth irrigation canals, using pipes as water conduits and the reuse of drainage water.

42. The government of Saudi Arabia has implemented measures to protect the sustainability of water resources. These measures include execution of a long-term investigation programme to assess the availability of groundwater and surface water resources in different regions and supporting the drilling of thousands of wells, under the supervision of the Ministry of Agriculture, for domestic, agricultural, and industrial purposes.

III. Projected Future Impacts and Vulnerabilities

43. Key biophysical vulnerabilities to climate change, variability and extreme events in Asia vary widely across the region due to differences in physical, social and economic circumstances. It is revealed from the NCs and NAPAs of Asian countries that the key biophysical vulnerability contexts are agriculture and food security, water resources, natural ecosystem, forestry and biodiversity, coastal zone and sea level rise, natural disasters and human health.

A. Agriculture and Food Security

44. In the past few decades, production of rice, corn and wheat has declined in many parts of Asia due to increasing water stress arising partly from increasing temperature, increasing frequency of El Niño and reduction in the number of rainy days (Agarwal et al., 2000; Jin et al., 2001; Fischer et al., 2002; Tao et al., 2003a; Tao et al., 2004). In a study by the International Rice Research Institute, the yield of rice was observed to decrease by 10% for every 1°C rise in growing-season minimum temperature (Peng et al., 2004). A decline in potentially good agricultural land in East Asia and substantial increases in suitable areas and production potentials in currently cultivated land in Central Asia have also been reported (Fischer et al., 2002). Climate change could make it more difficult than it is already to step up agricultural production to meet growing demands in Asian developing countries.

45. Recent studies confirm and extend the findings reported in the IPCC-TAR that temperature and precipitation changes in future decades will modify, and often limit, direct CO_2 effects on plants. For instance, high temperatures during flowering may lower CO_2 effects by reducing grain number, size and quality (Caldwell et al., 2005; Baker, 2004; Thomas et al., 2003). Increased water demand under warming may also reduce CO_2 effects. Rainfed wheat grown at 450 ppm CO_2 showed yield increases up to 0.8°C warming, then declines beyond 1.5°C warming; additional irrigation was needed to counterbalance these negative effects (Xiao et al., 2005).

46. Recent studies suggest that substantial decreases in cereal production potential in Asia could be likely by the end of this century as a consequence of climate change. However, regional differences in the response of wheat, maize and rice yields to projected climate change are likely to be significant (Parry et al., 1999; Rosenzweig et al., 2001).

47. Crop simulation modelling studies based on future climate change scenarios indicate that substantial losses are likely in rainfed wheat in South and Southeast Asia (Fischer et al., 2002). In South Asia, the drop in yields in non-irrigated wheat and rice will be significant for a temperature increase greater than 2.5^{o}C, incurring a loss in farm level net revenue of between 9% and 25% (Kumar and Parekh, 1998). The net cereal production in South Asian countries is projected to decline at least between 4 to 10% by the end of this century under the most conservative climate change scenario (Lal, 2005).

48. Studies reveal that a northward shift of agricultural zones is likely such that the dry steppe zone in the eastern part of Mongolia would push the forest-steppe to the north resulting

in shrinking of the high mountainous and forest-steppe zones and expansion of the steppe and desert steppe (Tserendash et al., 2005). Studies also suggest that, by the middle of this century in northern China, the tri-planting boundary will likely shift by 500 km from Changjiang Valley to Yellow River basin, and double planting regions will move towards the existing single planting areas, while single planting areas will shrink by 23% (Wang, 2002). Suitable land and production potentials for cereals could marginally increase in the Russian Federation and in East Asia (Fischer et al., 2002).

49. More than 28 million ha in South and East Asia require substantial increases in irrigation for sustained productivity (FAO, 2003). Agricultural irrigation demand in arid and semi-arid regions of Asia is estimated to increase by at least 10% for an increase in temperature of 1^{o}C (Liu, 2002; Fischer et al., 2002). The rainfed crops in the plains of north and northeast China could face water-related challenges in coming decades due to increases in water demands and soil-moisture deficit associated with projected decline in precipitation (Tao et al., 2003b).

50. The impact of climate change on Asian fisheries depends on the complicated food chains in the surrounding oceans, which are likely to be disturbed by climate change. Fisheries at higher elevations are likely to be adversely affected by lower availability of oxygen due to a rise in surface air temperatures. In the plains, the timing and amount of precipitation could also affect the migration of fish species from the river to the floodplains for spawning, dispersal, and growth (FAO, 2003). Future changes in ocean currents, sea level, sea water temperature, salinity, wind speed and direction, strength of upwelling, mixing layer thickness and predator response to climate change have the potential to substantially alter fish breeding habitats and food supply for fish and ultimately the abundance of fish populations in Asian waters (IPCC-TAR).

B. Water Resources

51. Water availability, in terms of temporal as well as spatial distribution, is expected to be highly vulnerable to anticipated climate change. Growing populations and the concentration of the population in urban areas will exert increasing pressures on water availability and water quality. As reported in IPCC (1998), surface runoff generally is expected to increase in the high latitudes and near the equator and decrease in the mid-latitudes under anticipated climate change scenarios.

52. Some areas of the Asian continent are expected to experience increases in water availability; other areas will have reduced water resources available. Surface runoff is projected to decrease drastically in arid and semi-arid Asia under climate change scenarios and would significantly affect the volume of water available for irrigation and other purposes. Sensitivity analysis of water resources in Kazakhstan to projected climate change scenarios indicates that surface runoff would be substantially reduced as a result of an increase in surface air temperature of 2°C accompanied by a 5–10% decline in precipitation during summer (Gruza et al., 1997). In temperate Asia, future changes in surface runoff would be highly spatially variable. An increase in surface runoff seems likely in Mongolia and northern China. Studies suggest that, on average, a 3°C increase in temperature coupled with a 10% increase in precipitation will increase river flows by approximately 15% in water abundant areas. An increase in temperature also accelerates snow melting, which increases river flows from January through March but decreases flows from April through June (Hanaki et al., 1998; Inoue and Yokoyama, 1998).

53. The perennial rivers originating in the high Himalayas receive water from snow and glaciers. Snow, ice, and glaciers in the region are approximately equivalent to about 1,400 km^3 of ice. The contribution of snow to the runoff of major rivers in the eastern Himalayas is about 10% (Sharma, 1993) but more than 60% in the western Himalayas (Vohra, 1981). Because the melting season of snow coincides with the summer monsoon season, any intensification of the monsoon is likely to contribute to flood disasters in Himalayan catchments. Such impacts will be observed more in the western Himalayas compared to the eastern Himalayas because of the

higher contribution of snowmelt runoff in the west (Sharma, 1997). An increase in surface runoff during autumn and a decrease in springtime surface runoff are projected in highland regions of south Asia. In addition, the increase in surface temperature will contribute to a rise in the snowline, which, in effect, reduces the capacity of the natural reservoir. This situation will increase the risk of flood in Nepal, Bangladesh, Pakistan, and north India during the wet season (Singh, 1998). No significant changes are projected for annual mean surface runoff in southeast Asia; although an increase during winter and a decrease during summer season is likely.

54. Reduction of annual surface runoff and increase in temperature will reduce total availability of water both in surface and groundwater in the western region of Asia. The impacts will be greater on irrigation for agriculture and water supply for the industrial and domestic sector. In Saudi Arabia, for example, the total water stress is equal to the total quantities of decrease in groundwater recharge and surface runoff.

C. Ecosystems and Biodiversity

55. As a consequence of global warming, the present distribution of species in high-elevation ecosystems is projected to shift to higher elevations, although the rates of vegetation change are expected to be slow and colonization success would be constrained by increased erosion and overland flows in the highly dissected and steep terrains of the Himalayan mountain range (IPCC-TAR).

56. There is growing concern that climate change may accelerate the damage to freshwater ecosystems such as lakes, marshes, and rivers. With a rise in temperature, a decrease in the amount of snowfall in the Lake Biwa catchment in Japan is projected—which might exacerbate the process of eutrophication (Fushimi, 2000a). Deterioration of lake water quality also is suggested in Kasumigaura Lake in eastern Japan (Fujimoto et al., 1995; Fukushima et al., 2000). The response of lakes and streams to climate change will involve complex interactions between the effects of climate on areal inputs, hydrology, catchments and in-lake processes.

57. Climate change is expected to affect the boundaries of forest types and areas, primary productivity, species populations and migration, the occurrence of pests and diseases, and forest regeneration. The increase in GHGs also affects species composition and the structure of ecosystems, which, in turn, affects ecosystem function (Schulze, 1994). The interaction between elevated CO_2 and climate change plays an important role in the overall response of net primary productivity to climate change at elevated CO_2 (Xiao et al., 1998).

58. Climate change will have a profound effect on the future distribution, productivity, and health of forests throughout Asia. Warming is expected to be particularly large at high latitudes and so climate change could have substantial impact on boreal forests (Dixon et al., 1996; IPCC, 1996; Krankina, 1997) such as decreasing permafrost areas, improving growing conditions, decreasing areas of disturbed stands and reducing ecosystem quality. Moreover, forest fire is expected to occur more frequently in boreal Asia as a result of increased mean temperature (Valendik, 1996; Lelyakin et al., 1997). Pest activity also could increase with a rise in temperature, depending on the age composition of the boreal forests (Alfiorov et al., 1998).

59. Studies on projected impacts of climate change suggest that northeast China may become deprived of conifer forests. Broad-leaved forests in east China may shift northward by approximately 3° of latitude. These results are based on a 2°C increase in annual mean temperature and a 20% increase in annual precipitation (Omasa et al., 1996; Tsunekawa et al., 1996).

60. With an increase in temperature of 2–3°C combined with reduced precipitation as projected for the future in the semi-arid and arid regions of Asia, grassland productivity is expected to decrease by as much as 40–90% (Smith et al., 1996). Approximately 70% of pastures are facing degradation, with dramatic decreases in fodder yield over recent decades in some parts of Mongolia (Khuldorj et al., 1998). Climate change is likely to represent an additional stress to rapid social change in many of Asia's rangelands.

D. Coastal Zones

61. There are complex interrelationships and feedbacks between human driving forces and impacts, on the one hand, and climate- and sea level-induced changes and effects on the other (IPCC, 1996). At the interface between ocean and terrestrial resources, coastal ecosystems undergo stress from competing multi-usage demands, while having to retain their functional diversity and resilience in the face of global environmental change (Bower and Turner, 1998). Much infrastructure and economic activity is located in coastal zones, which are vulnerable to sea level rise and more frequent weather events (e.g. cyclones, storm surges). Temperature increases could also adversely affect local flora and fauna of coastal areas, as well as the biological equilibrium of marine life.

62. Global mean sea level is projected to rise between 9 and 88 cm between 1990 and 2100, with a central value of 48 cm, for the full range of SRES scenarios (Church et al., 2001). The projected central value of 48 cm gives an average rate of sea-level rise of 2.2 to 4.4 times the observed rate over the 20th century. Even with drastic reductions in greenhouse gas emissions, sea level will continue to rise for centuries beyond 2100 because of the long response time of the global ocean system.

63. A major uncertainty is how the global mean sea-level rise will manifest itself on a regional scale. All models analysed by the IPCC-TAR show a very uneven spatial distribution of sea-level rise. Some regions show a sea-level rise substantially higher than the global average (in many cases more than twice the average) and others a sea-level fall (Church et al., 2001). However, the patterns produced by the different models are not similar in detail. This lack of similarity means that confidence in projections of regional sea-level changes is low, although it is clear that they are important with respect to impacts of sea-level rise on coastal zones.

E. Human Health

64. Climate change will have a wide range of health impacts all across Asia. Although a reduction in health stresses and wintertime deaths is anticipated as a result of less frequent occurrence of extreme cold temperatures in boreal and temperate Asia, an increase in the frequency and duration of severe heat waves and humid conditions during the summer will increase the risk of mortality and morbidity, principally in older age groups and urban poor populations of temperate and tropical Asia (Epstein et al., 1995). In addition, human health is likely to suffer chronically from heat stress related damages (Bouchama et al., 1991; Ando, 1998).

65. Adverse health impacts result from the build-up of high concentrations of air pollutants such as nitrogen dioxide (NO_2), ozone, and air-borne particulates in large urban areas. Combined exposures to higher temperatures and air pollutants appear to be critical risk factors for health during the summer months (Piver et al., 1999). Global warming will also increase the incidence of some diseases, such as respiratory and cardiovascular diseases, in arid and semi-arid, temperate, and tropical Asia. There is already evidence of widespread damage to human health by urban air quality and enhanced climate variability in Asia. Throughout newly industrialized areas in Asia, such as Chongqing, China and Jakarta, Indonesia, air quality has deteriorated significantly and contributed to widespread heat stress and smog induced cardiovascular and respiratory illnesses in the region (WHO, 2004).

66. Malaria is one of the most important diseases in tropical Asia. With a rise in surface temperature and changes in rainfall patterns, the distribution of vectors such as mosquito species may change (Patz and Martens, 1996; Reiter, 1998) and temperature can directly influence the breeding of malaria protozoa and suitable climate conditions can intensify the invasiveness of mosquito (Tong et al., 2000). Changes in environmental temperature and precipitation could expand vector-borne diseases into temperate and arid Asia. The spread of vector-borne diseases into more northern latitudes may pose a serious threat to human health. Climate change is likely to have principal impacts on epidemics of malaria, dengue, and other vector-borne diseases in Asia (Martens et al., 1999). The epidemic areas of vector-borne diseases in Asia would depend

on many demographic and societal factors, as well as environmental hygiene for vector control, available health infrastructure, and medical facilities. An empirical model projected that the population at risk of dengue fever (the estimated risk of dengue transmission is greater than 50%) will be largest in India and China (Hales et al.., 2002).

67. The global burden of climate change-attributable diarrhoea and malnutrition are already the largest in the world in Southeast Asian countries including Bangladesh, Bhutan, India, Maldives, Myanmar and Nepal in 2000, and the relative risks for these conditions for 2030 is expected to increase (Patz et al., 2005), although in some areas such as southern states in India there will be a reduction in the transmission season by 2080 (Mitra et al., 2004).

68. Warmer sea surface temperatures along coastlines of South and Southeast Asia due to climate change will support higher phytoplankton blooms. These phytoplankton blooms are excellent habitats for the survival and spread of infectious bacterial diseases such as cholera (Pascual et al., 2002). Water-borne diseases including cholera and a suite of diarrhoeal diseases caused by organisms such as giardia, salmonella and cryptosporidium could also become common with the contamination of drinking water quality.

F. Development and Human Dimensions

69. The impacts of climate change on Asia will place additional stress on socioeconomic and physical systems. These pressures may induce change in demographic processes. Demographic trends, including the stability and size of populations, will be influenced directly through the impacts of climate change on human health and indirectly through the impacts of climate change on food security and the viability of natural resource-based economic activity. A further demographic response will come about through the risk of extreme events on human settlements. If the incidence and magnitude of events such as droughts and coastal floods increase, there could be large-scale demographic responses—for example through migration.

70. The annual rate of growth in migration on a global scale has been greatest in developing countries of south and southeast Asia. Migration in itself is not necessarily a signal of vulnerability to present-day extreme events. Motivations for migration are diverse; much rural to urban migration in Asia takes place as a result of increased economic opportunities in megacities (cities with at least 8 million inhabitants). For instance, population growth and land scarcity has encouraged the migration of more than 10 million Bangladesh natives to neighbouring Indian states during the past two decades. This migration has been exacerbated by a series of floods and droughts affecting the livelihoods of landless and poor farmers in this region. Land loss in coastal areas resulting from inundation from sea-level rise as a result of climate change is likely to lead to increased displacement of resident populations. Many South Asian countries increasingly expect the number of internally displaced persons to rise in future.

71. Immigrant labour often benefits both the donor and the host cities/countries (Connell and Conway, 2000). However, perceptions of regional/national identity, language/cultural differences, and fears of unemployment may contribute to increased hostilities between immigrants and nationals in years to come. Climate change will act in parallel with a complex array of social, cultural, and economic motivations for and impacts of migration (Pebley, 1998; Conway et al., 2000; Kates, 2000). Irrespective of resource constraints, developing countries in Asia have to better equip themselves through appropriate public education and awareness programmes with disaster preparedness measures, including infrastructure for effective resettlement of displaced people as a consequence of weather calamities.

IV. Capacity for National Climate Change Studies and the Use of their Results and Climate Data

72. The UNFCCC has recognized the importance of research and systematic observation to reduce uncertainties regarding the effects of climate change and impacts and responses to it, particularly adaptation to climate change. Various decisions of the COP to the UNFCCC have

been aimed at strengthening systematic observations, improving the exchange of climate data, supporting capacity-building, and encouraging the development of national plans. It has also recognized that data at sub-regional and national levels is essential to facilitate vulnerability and impact assessments and to provide ground truth for model outputs. There is a wide variation in national capacity to collect, process, and make available observational data, as well as use data for impacts and vulnerability assessment.

A. Systematic Observation

1. Characteristics of Observation Systems and Quality of Data

73. A wide range of data is being collected and used for developing future climate change scenarios, impacts, and vulnerability assessment in Asia, including atmospheric, oceanic and terrestrial data and information. In most countries, the meteorological or hydro-meteorological department of the government is responsible for collecting, processing and supplying data as well as maintaining infrastructure of the systematic observation system.

74. The number of systematic observation systems, types of equipment, capacity of computers and models, and number of trained and skilled people vary widely across Asia. Variation of economic strength and national priority have resulted in limited access to modern observational technologies and computerized systems for many developing and least developed countries. The models that were used to predict climate change variations, extreme events and its associated impacts were designed for the developed countries and need accurate baseline data to run efficiently. A major problem is the lack of reliable and accurate data, discrepancies in data and non-systematic data collection, especially for rainfall and temperature. Failure of equipment is a very common concern and time series data is often incomplete.

75. Some highly developed economies in Asia such as Japan and South Korea have invested both financially and technologically in climate change research and climate observation systems. Oil exporting countries like Saudi Arabia and rapidly developing economies like China have also realized the importance of climate change on development and the economy. They have invested in state of the art observation systems and technological knowledge. China has developed its own climate models and has used those, with the IPCC models, to assess vulnerability of the country to climate change.

76. Across Asia, variations in climate are heavily influenced by changes in oceanic conditions in the Indian Ocean and the Pacific. Monitoring trends of Sea Surface Temperature (SST) and Sea Level are therefore essential in order to assess their impacts, particularly important in view of the threat posed by cyclone/typhoon and rising sea level.

77. In addition to global networks, a number of important regional oceanographic programmes and experiments are underway in the waters of South and Southwest Asia. These programmes currently measure and report a range of oceanographic and atmospheric variables including SST, wave height, air pressure, air temperature, and surface winds. Nevertheless, a major deficiency has been the absence of a unified approach for the systematic and sustained observation of the unique and complex ocean-atmosphere system in the region.

78. The SAARC Meteorological Research Centre (SMRC) is a regional organization in South Asia that concentrates primarily on the research aspects of weather forecasting and monitoring. The research areas include weather prediction and compiling climatological information. In addition to monitoring weather phenomena, SMRC is also engaged in developing a networking system among the Member States.

79. There is general acceptance that strengthening and upgrading the observation networks including telecommunications, data management, and smoothing out the irregular distribution of stations is necessary. In Asia there are many countries facing specific problems such as delays in the maintenance and replacement of equipment, resulting in data gaps. Equipment that cannot

be repaired is sometimes not replaced resulting in datasets that cannot be compiled and compared.

2. Regional Action Plan to Improve Systematic Observation in Asia

80. Decision 5/CP.5 of the UNFCCC COP invited the Global Climate Observing System (GCOS) to launch a regional workshop programme to facilitate improvements in climate observing systems. GCOS has organized three regional workshops and prepared regional action plans for the regions of East and Southeast Asia, South and Southwest Asia, and Central Asia.

81. All regional workshops have identified several global observational networks for the atmospheric component of the GCOS Initial Observing System (IOS). Specifically, a GCOS Surface Network (GSN) has been defined, a geographically representative GCOS Upper Air Network (GUAN) has been specified, and the Global Atmosphere Watch (GAW) network is now considered a component of the GCOS.

82. The GCOS workshops also recognized that these baseline networks represent the minimum required for characterizing global climate and also represent a stable and sustainable underpinning for national networks that operate on finer temporal and spatial scales. It is particularly important that stations in these global networks meet GCOS standards, operate continuously, produce high quality observations and deliver data and associated metadata in a timely fashion to designated GCOS data processing and archiving centers.

83. The recommendations and projects in this GCOS Action Plan are grouped under three overarching themes or planning elements: (a) Needs assessment, national reporting and preparation of national plans to meet user requirements for climate system data, (b) Capacity-building and infrastructure investment for improved planning and response to climate change, climate variability and climate extremes, and (c) Improving coordination at national and regional levels.

84. The Action Plans came up with eight projects for each region and enables: (a) ensuring sustainability of the existing network, and quality and data standard; (b) initiative for operational oceanographic network and increase representative observations; (c) improving hydrological network and quality of data; (d) increasing observations in large lakes and glaciers in Asia; (e) increasing applications of satellite and remote sensing for data generation and impact assessment.

85. The fourteenth session of the Steering Committee of GCOS held in 2006 asked for its advice on follow-up to the Regional Workshop Programme and potential for future actions in other areas of the developing world highlighted in the regional workshop programme.

B. Climate Scenario Generation, Impact Models and their Use

86. Most Asian countries have submitted their Initial NC. Some countries are now in the process of submitting their second NCs. Agriculture, water resources, ecosystem and biodiversity, coastal resources and human health are common sectors for which impacts and vulnerability assessment have been carried out using different models and scenarios. Adaptation options have been identified to reduce impacts and to help in meeting national development goals including poverty alleviation, livelihoods and disaster risk reduction.

87. For generating climate change scenarios, the NCs used General Circulation Models (GCMs) and Regional Circulation Models (RCMs), downsized using MAGICC/SCENGEN software. The most commonly used scenarios were those of the IPCC Special Report on Emissions Scenarios (SRES) for ‘reference’ and ‘policy’ scenarios. Some of the other models used to predict climate change impact on countries in Asia are CSIRO climate model and Hadley Centre Regional Climate Model (HadRM2).

88. Along with the models available globally and various scenarios published by the IPCC, a number of countries used additional tools and models for better impacts and vulnerability

assessment at national and sub-national level. Furthermore analysis of historical data on temperature and precipitation was used to strengthen the findings of the future climate change trends.

89. Resolution of the global scale models are not very suitable for assessing adaptation at local level although they provide scale of possible impacts and potential vulnerabilities of the biophysical system. Since the GCM model uses a very broad scale, it had to be downsized and used in conjunction with regional circulation models (RCM) to get better results. A major problem encountered when using models to get national level results was the need for readjustment to suit a country's individual needs.

C. Vulnerability-Based and Other Approaches to Adaptation and their Use

90. National Adaptation Programmes of Action in Asia's LDCs are being prepared using guidelines developed by the COP and elaborated by the LDC Expert Group (LEG). Bangladesh, Bhutan and Cambodia have already submitted their NAPAs. Other LDCs are developing their NAPAs. The bottom-up approach of NAPAs allows for vulnerability and adaptation assessments relevant to national circumstances, particularly those relating to food-security, poverty alleviation and livelihood options. This approach results in the identification of immediate and urgent needs to deal with adverse impacts of climate change and variability.

91. Involvement of different stakeholders (national, sectoral, local) are an integral part in the preparation process for assessing impacts, vulnerabilities and adaptation measures, while maintaining urgency and immediacy as the main principle of the NAPA. For example, Bangladesh has involved different stakeholders at the different stages of its NAPA formulation, allowing facilitation of mainstreaming adaptation into national and sectoral development policies, strategies and programmes (Box 1).

Box: 1. Preparation Process of the Bangladesh NAPA

The preparation process has engaged policy makers of Government, local representatives of the Government (Union Parishad Chairman and Members), scientific community members of the various research institutes, researchers, academicians, teachers (ranging from primary to tertiary levels), lawyers, doctors, ethnic groups, media, NGO and CBO representatives and indigenous women.

At the highest level it has a Project Steering Committee (PSC) headed by Secretary Ministry of Environment and Forest. The Project Steering Committee is represented by high level officials and experts from different government and non-government organizations to provide guidance. In addition to the Ministry of Environment and Forest, other noteworthy government ministries and agencies involved in the PSC are the Ministry of Planning, Economic Relation Division, Ministry of Agriculture, Ministry of Food and Disaster Management, Water Resource Planning Organization, Ministry of Fisheries and Livestock, Ministry of Land and Department of Environment. The Project Steering Committee is represented by government, non-government and international research institutes including Bangladesh Institute of Development Studies (BIDS), Bangladesh Forestry Research Institute (BFRI), Bangladesh Centre for Advanced Studies (BCAS) and IUCN Bangladesh.

The second group of stakeholders was a multi-disciplinary team of experts and sectoral working groups with critical roles and responsibilities to analyze vulnerability of the natural, economic and social systems and connect it with overall development of the country. The six Sectoral Working Groups (SWG) are a) Agriculture, Fisheries and Livestock coordinated by Bangladesh Agricultural Research Council (BARC), b) Forestry, Biodiversity and Land-use coordinated by IUCN, c) Water, Coastal Zone, Natural Disaster and Health coordinated by Water Resources Planning organization (WARPO), d) Livelihood, Gender, Local Governance and Food Security coordinated by Bangladesh Institute for Development Studies (BIDS), e) Industry and Infrastructure coordinated by Department of Environment (DoE), and f) Policies and Institutes coordinated by BCAS.

The third group of stakeholders involved in the preparation process was from local and regional (divisional towns) level including people from the local government, local level non-government organizations, farmers and women. The local level stakeholders were involved in the regional consultation workshops. Objectives of the regional stakeholder consultation workshops were a) identification and ranking of existing problems related to variability, extremes and climate change, b) Identification of existing coping mechanisms and measures, c) Suggestions for improvement of existing measures, d) Identification of new measures and ideas to address anticipated future change in intensity and extent of present problems. The identified problems and suggestions have been incorporated in the sectoral analysis and future programme of action. In addition to the regional stakeholder consultation workshops each sectoral working group has organized meetings with different sectoral agencies for checking the possibility of integrating plans into sectoral policies.

Source: Bangladesh National Adaptation Programme of Action, 2005

92. It is revealed from NCs and other assessment studies carried out in different Asian countries that top-down, scenario based approaches and tools, including impact and integrated models, are strong in terms of biophysical aspects of impacts and certain types of dynamic interactions, but do not perform well in representing human interactions and local abilities to adapt. Vulnerability based bottom-up approaches involving different stakeholders are more attuned to the local circumstances, and can give a picture of local level institutions that deal with the problems and productivity contexts. This approach is better able to represent local options and constraints than scenario-driven studies.

D. Institutional Capacity and Need

93. Institutional strength, capability and availability of reliable data are key issues for generating reliable climate scenarios. In developing countries of Asia, climate observation centers are mostly state governed institutions and therefore limited scope exists for research due to the lack of requisite technology/equipment, experts in the field and appropriate funding.

94. The situation is somewhat changing with the emergence of the threat of climate change to the development and economies of countries. Governments are investing in climate change studies and trying to provide technical knowledge in this area. There has been progress from private research and academic institutions with appropriate expertise that carry out climate change studies and predict scenarios. Furthermore, international organizations are supporting governments and private institutions to carry out advanced climate change research and assess vulnerability and adaptation options.

95. There is still a lack of baseline information for understanding the complex interplay between and within natural and human systems and a considerable gap in information on likely changes in climate and human systems in different ecosystems and agro-climatic systems. National scale assessment in many countries based on models failed to incorporate human dimensions, particularly livelihood aspects and inter-sectoral relationships. Without such national assessments as a sound basis for designing and planning adaptation policies, strategies and programmes, decisions on adaptation will remain uncertain and will not lead to effective results from implementation.

96. Understanding the effects of climate change, and associated enhanced climate variability and sea level rise, at the local and national levels is critical for adaptation, as is the capacity to select and apply appropriate methods and tools to prepare for adaptation. Furthermore, the development of technologies for adaptation; the use and integration of traditional knowledge for developing adaptation options; integration of local knowledge and scientific knowledge for technology transfer; and communication of vulnerability and adaptation both to vulnerable communities and policy makers are also essential. Documentation of successful pilot schemes on adaptation assessment with emphasis on processes; development of sharing mechanisms like the adaptation database of the UNFCCC (http://maindb.unfccc.int/public/adaptation/) and stronger public education and awareness programmes are all useful in disseminating information relating to adaptation activities to climate change and its benefits.

97. There is a need for building awareness about the potential impacts among the concerned people, and developing good quality databases. Systematic efforts are required to study the impact assessments of different climatic parameters. Studies about future projections of changing regional climate provide insights for methodological developments, including models for integrated assessment and GIS-based computer algorithms for supporting policy assessments at regional levels.

98. Considering commonality of problems, varied capacity (economic, social, and institutional) and existing experiences on assessment of impacts, vulnerability and adaptation, relevant cooperation among Asian countries would be helpful. Sharing experiences on disaster

risk reduction and preparedness and integration of climate change into disaster risk reduction are also necessary.

V. Adaptation to Climate Change

A. Adaptation Assessment and Work in the Context of the UNFCCC

99. Article 4 of the Convention stated a number of commitments both for Annex-I and Non-annex I Parties. The Kyoto Protocol created opportunity to participate in Clean Development Mechanism projects. Article 6 of the Convention also allows Parties to implement activities on education, awareness raising and training.

100. NCs and NAPAs of Asian countries have reported existing coping strategies and adaptation measures required to reduce vulnerability to climate change. Many adaptation measures reported to have been adopted are win-win options and also support national development goals and objectives.

1. Possible Adaptation Options

101. Despite differences in physical and socioeconomic characteristics, the countries of the Asian region have much in common as far as vulnerability to climate change is concerned. The sectors affected by climate change, variability and extreme weather events across Asia include agriculture, water resources, ecosystem and biodiversity and human health. However, priority areas to deal with climate related problems vary due to the scale of impacts and national development priorities, for example agriculture and water in Tropical Asia; ecosystems and water in Arid and Semi Arid Asia; water and agriculture in Temperate Asia.

102. In order to address impacts of climate change on different sectors, a sectoral approach has been suggested. Due to the complex nature of climatic problems and sectoral inter-dependency, for example with agriculture and water, adaptation options in one sector will contribute to others. A list of the identified adaptation measures are given below (Tables 1-3).

Table 1. A sector-wise summary of potential adaptation options identified for **Tropical Asia**

Sector	**Adaptation options**
Agriculture (flood, drought, salinity, coastal inundation)	• Adjust cropping calendar and crop rotation to deal with climatic variability and extremes • Develop and promote use of high-yielding varieties and sustainable technological applications (drought and saline tolerant varieties)
Water Resources (flood and water scarcity)	• Develop flood-and drought-control management systems • Reduce future developments in flood plains • Use appropriate measures for protection against soil erosion • Conserve groundwater supply, water impoundments, and efficient water resource systems • Improve preparedness for water related natural disasters
Ecosystems and Biodiversity	• Introduce integrated ecosystem planning and management • Reduce habitat fragmentation and promote development of migration corridors and buffer zones • Encourage mixed-use strategies • Prevent deforestation and conserve natural habitats in climatic transition zones inhabited by genetic biodiversity of potential for ecosystem restoration

Coastal Resources	• Protect wetlands and allow for migration • Prepare contingency plans for migration in response to sea level rise • Improve emergency preparedness for weather extremes (e.g. cyclones and storm surges) • Evaluate coastal subsidence rates in sensitive coastal regions for better coastal land use planning • Implement existing coastal zone management plans • Protect marine resources
Human health	• Build heat-resistant urban infrastructures and take additional measures to reduce air and water pollution • Adapt technological/engineering solutions to prevent vector-borne diseases/epidemics • Improve health care systems, including surveillance, monitoring, and information dissemination • Improve public education and literacy rate in various communities • Increase infrastructure for waste disposal • Improve sanitation facilities in developing countries

Source: IPCC-TAR and National Communications

Table 2. A sector-wise summary of potential adaptation options identified for **Arid and Semi Arid Asia**.

Sector	**Adaptation options**
Natural ecosystems (Expansion of Desert)	• Increase share of the forest (afforestation and reforestation) and forest protection • Introduction of endangered species into similar habitats, which will survive in case of climate change • Preservation of gene material in seed banks • Prevention of desertification processes • Monitoring of vulnerable ecosystems for better planning and readjustment
Water Resources	• Improvement of water resources management systems including regulation of river flows, increase systems efficiency • Increase of accumulation volumes of winter-spring river flow and construction of water reservoirs • Reconstruction of irrigation systems in order to reduce water loss and apply advanced water-saving methods of irrigation • Economic and rational use of water • Adjusting the operation of existing and planned water supply infrastructure • Reducing the extremely high demand for freshwater in the agricultural sector • Monitoring of water resources to readjust national and sectoral plans
Agriculture	• Change in agriculture system (introduction of humidity-preserving

	technologies, application of advanced agro-technical measures, and the introduction of new frost resistant, low water use and drought-resistant high-yielding varieties) • Revision of the zone distribution of irrigated lands • Enhanced resistance to diseases and pests • Reconstruction of existing irrigation system (introduction of sprinkling and drip irrigation) • Awareness of agrarian public about expected consequences related to forecasted climate change and other measures • Development of salt tolerant varieties and increased efficiency of water use for agriculture sector
Ecosystems and biodiversity	• Afforestation of eroded mountain slopes, binding of sands, rehabilitation • Forest tree improvement and use of fast growth species for reforestation and forestation
Coastal Zone and Sea Level	• Protection of settlements, industrial and infrastructure facilities in the Coastal Zone • Introduction of soil and water saving technologies • Provision of drainage congestion and irrigated lands • Improvement and re-cultivation of salinized soils • Integrate sea level rise considerations into national development policies and capacity-building for relevant agencies and department
Human Health	• Social, sanitary, preventive and administrative measures • Tracking of water quality, water treatment efficiency, and soil quality

Source: National Communications for Arid and Semi Arid Countries

Table 3. A sector-wise summary of potential adaptation options identified for **Temperate Asia**

Sector	**Adaptation options**
Water Resources	• Establishing a modern water conservancy management system and strengthening the unified management and protection of water resources • Increasing the capacity of reservoirs and river dams (prevent floods, tapping water sources to increase water-supply capacity) • Enhancing the protection and building of ecosystem (restoring vegetation cover, preventing and controlling soil erosion and loss) • Collection of rainwater for domestic use
Agriculture	• Building up a water-saving agriculture and industry (popularizing water-saving irrigation, developing sprinkle irrigation and dripping irrigation, extending the use of water-saving facilities so as to increase water use efficiency) • Adjustment of the structure of agricultural production (introduce early-maturing crops with short growing period, selection and cultivation of new varieties) • Improve land cultivation management • Studies on new crop varieties, cultivation of alternative crop species • Set appropriate sowing and planting dates according to expected

	temperature and precipitation
Forest and Biodiversity	• Enhance forest management (controlling and stopping the deforestation and the ecological damage) • Implementation of policy for the protection of natural forests • Plan to develop forestry planting and growth technology for each respective species • Preventive measures for forest hazards
Coastal Resources	• Changes in design and standard for coastal infrastructure (consideration of impacts of sea level) • Mangrove afforestation • Relocate basic structures and industries and establish harmony between environment and industry • Protective programme for coastal erosion and coastal facilities
Human Health	• Reinforcement of disease prevention measures • Epidemic prediction programmes • Strengthen preventative medicine activities in order to cope with possible vector borne diseases both for humans and domestic animals
Natural Disasters	• Strengthen the early warning system within the national meteorological and hydrological service • Undertake full assessment of wild fire-risk zones and increase public awareness

Source: National Communications of Temperate Asian Countries

103. The NAPAs have identified immediate and urgent needs to deal with adverse impacts of climate change. For example, the Bangladesh NAPA gave emphasis on coastal afforestation, development for agriculture, water resource management, increasing infrastructure resilience community based adaptation, and insurance options. The Bhutan NAPA gave emphasis on disaster management, landslide restoration, artificial lowering of glacier lakes, and hazard zoning. Awareness raising and capacity-building for vulnerable communities, planners and policy makers are common in the NAPAs.

2. Enabling Activities and Integration of Adaptation

104. Future impacts, vulnerability and adaptation assessment can be built on initial NCs and an integration of scenario based and vulnerability based assessment would be helpful for assessing both vulnerability of biophysical and social systems. This would provide better assessment, design, planning and implementation of adaptation projects. Involvement of different policy makers (national and sectoral) and other stakeholder groups in the preparation process will give a sense of ownership and future integration into sectoral policies and plans.

105. The link between climate change and development is obvious. Climate change impacts will significantly affect national development, particularly amongst the world's poorest communities. Showing linkage between adaptation to climate change and its contribution to development, and how adaptation to climate change will bring increased sustainability is crucial for motivating national and sectoral policy makers.

106. Many local communities are already adapting to the impacts of climate variability and climate change on a daily basis. Their experiences can offer lessons for national governments wishing to support adaptation activities. Experiences from disaster preparedness, and mainstreaming climate change adaptation measures to disaster management are essential.

B. Existing Local and Sectoral Coping Strategies

107. There are very limited experiences available on adaptation to climate change, but the Asian region has a large body of knowledge and experience at the local level on coping with climatic variability and extreme weather events such as floods, drought and cyclones/typhoons. Experiences of different sectors particularly infrastructural interventions like large scale irrigation for agriculture, coastal defence and flood protection, cyclone centre and warning systems are also significant in the Asian region.

108. Traditionally, farmers have observed a number of practices to adapt to climate variability, for example intercropping, mixed cropping, agro-forestry and animal husbandry. Moreover, over the years many Asian countries have adopted both surface water and groundwater irrigation and diversification in agriculture to deal with drought and structural or non-structural measures to deal with flood and coastal inundation.

109. Separate adaptation strategies for each country are not available but National Communications have identified and highlighted several adaptation needs and strategies for implementation. The most common criteria used in prioritizing adaptation to climate change are: complementarity to national development goals and objectives, cost-effectiveness, and building on existing practices. There is a need for capacity-building and awareness raising of targeted institutions and an emphasis on mainstreaming adaptation to climate change in national policy.

110. Several Community Based Adaptation (CBA) activities to climate change, variability and extreme events are implemented or being implemented in Asia. Most of these adaptation activities are small-scale and concentrate on agriculture, water and natural disaster amelioration. Most of the community based adaptation projects have an emphasis on livelihood of the impacted community, diversification of agriculture, conservation of water and awareness raising to change practices.

111. The NC of Saudi Arabia reported that it has already implemented a number of projects to deal with climate related problems. These include construction of 215 dams for water storage, installation of 30 desalination plants, enactment of water protection and conservation regulation, a leakage detection and control scheme, an advanced irrigation water conservation scheme and a system for modification of water pumping.

112. Traditional as well as technological approaches are used to cope with the risk of drought in India. Technological management of drought uses medium (seasonal) to long-term (annual to decadal) forecasts that are formulated using appropriate models. This information is then translated into early warning, and subsequently appropriate drought protection measures are taken.

113. In northern Sri Lanka, local farmers traditionally use Zero-tillage paddy cultivation which they say requires considerably less water than more common methods of rice planting. Over-grown weeds are slashed and removed from the paddy field, leaving the stubble intact. The paddy seeds are then dry-sown in the field over the stubble, and immediately covered with 8 cm of dry-paddy straws. The community elders use astrological consultations and religious ceremonies to determine an auspicious time and date to release the water. Farmers do not use any chemical fertilizers or pesticides. Average yields per hectare are about 20-30% less than with modern techniques, however profits are still relatively high, as the practice is relatively cheap.

114. In the Philippines, after Typhoon Sisang in 1987, which completely destroyed over 200,000 homes, the Department of Social Welfare and Development decided to instigate a programme of providing typhoon-resistant housing for those living in the most typhoon prone areas. The Core Shelter houses are designed to withstand wind speeds of 180 km/h and have typhoon resistant features.

115. Further examples of community based adaptation are available at <http://maindb.unfccc.int/public/adaptation>.

C. Adaptation Strategies

116. The IPCC-TAR states that many early signs of climate change are observed and these are predicted to become more prominent over the 21st century. Adaptations are already required to deal with vulnerabilities associated with climate variability. Priority areas for adaptation are land and water resources, food productivity and security, and disaster preparedness and planning particularly for poorer, resource dependent countries.

117. For many developing countries in Asia, climate change is only one of a host of problems, including poverty, hunger, water supply, waste, pollution and energy. Considering the availability of resources for adaptation and that adaptation responses are closely linked to development activities, then development of adaptation options need to be evaluated along with present and future development plans. Strategies require local involvement, inclusion of community perceptions, and recognition of multiple stresses on sustainable management of resources.

118. Vulnerability to climate change is complex and multi-dimensional, and there is no silver bullet for adaptation. Therefore the best choice may be a function of many factors pertaining to economic efficiency, risk reduction, robustness, resilience, reliability, etc. A common Framework for developing adaptation strategies is essential at the country level in order to design and implement adaptation options in an integrated manner. Local level planning and management strategies can be evolved and validated through this framework, so as to generate and evaluate various options suitable for local conditions.

119. Adaptation is location specific and therefore implementation of adaptation measures at cross-national and regional level would be difficult. However, maladaptation can be avoided, particularly in large watersheds shared by more than one country or region. Most importantly, processes of identifying adaptation measures, development of policies and strategies, engagement of different stakeholders, and linking adaptation with development can be shared among the countries having common characteristics and strength of economy. For example, experiences of a desalinization plant in a coastal area and drip irrigation system for agriculture for increasing efficiency of water can be shared and synergized.

120. Institutional capacities are a key element of community-based adaptation. Not just within the communities themselves, but also the institutions that interface with them. External actors who have already built up trust over years of working with the community, need an intermediary with the capacity to understand the problem. For successful capacity-building and to tap into more funding, the private sector needs to be involved. However, the full amount of committed official development assistance has yet to be disbursed. Climate change will require additional resources, which need to be allocated as agreed.

VI. Opportunities for Adaptation

121. Under the Convention and its Kyoto Protocol three funds have been created to support adaptation to climate change. The Global Environment Facility (GEF) is operating the Special Climate Change Fund (SCCF) and the Least Developed Country Fund (LDCF). Institutional arrangements to operate the Adaptation Fund under Kyoto Protocol are under discussion and expected to be finalized by COP13.

122. COP guidance on GEF support for adaptation identified three stages. Stage I provided support for the National Communications process, a portion of which is the vulnerability and adaptation assessment. Stage II provides further assistance for other capacity-building efforts for adaptation. Stage III refers to support for actual adaptation activities, including insurance, and has been implemented in the form of the GEF Strategic Priority on Adaptation (SPA). The GEF

has allocated US$ 50 million under SPA of which US$ 5 million is devoted to piloting community adaptation initiatives through the Small Grants Programme (SGP).

123. The goal of the Community-Based Adaptation (CBA) Programme is to pilot the community component of the GEF SPA, and provide the basis upon which the GEF and other stakeholders can effectively support small-scale adaptation activities. This goal will be realized through three immediate objectives: (a) development of a framework, including new knowledge and capacity, that spans the local to the intergovernmental levels (cross-scale 'policy laboratories'), to respond to unique community-based adaptation needs; (b) identification and financing of diverse community-based adaptation projects (small-scale 'policy laboratories') in a number of selected countries; and (c) capture and dissemination of lessons learned at the community level to all stakeholders, including governments.

124. The Least Developed Countries Fund was established to support, inter alia, the preparation and implementation of NAPAs. The operational modalities and procedures have been finalized and one project for Bhutan has already been approved under this fund. At present the LDCF has approximately US$ 115 million for funding priority activities in 48 LDCs under the UNFCCC.

125. The Special Climate Change Fund was established to finance developing country activities in adaptation, technology transfer, key sectors (energy, transport, industry, agriculture, forestry and waste management), and economic diversification for countries with economies dependent on the fossil fuel sector.

126. The Adaptation Fund is intended to fund concrete adaptation projects and programmes in developing countries that are particularly vulnerable to the adverse effects of climate change. The funding is provided by a 2% levy on proceeds from Clean Development Mechanism (CDM) projects (excluding those undertaken in LDCs), and "other sources". The total scale of the Adaptation Fund will therefore depend on the volume of CERs purchased through the CDM and the market value of those CERs. Based on a World Bank estimate of current CDM projects in the pipeline and an assumed CER market value of $15/CER, the fund would hypothetically stand at $102 million at present. Low and high estimates (of 900 million tonnes of carbon equivalent (MtC) and 2000 MtC respectively) for the first Commitment Period volume of CERs yield estimates between $270 M to $600 M for the total scale of the Adaptation Fund.

127. The GEF, under its different funding streams, has supported enabling activities and projects to support adaptation to climate change in Asia (Table 4). Adaptation projects are also being implemented by other bilateral agencies and non-government organizations in the Asia Region (Table 5).

128. In addition to ongoing adaptation projects, there are also other opportunities at the regional scale. At least 14 major international river watersheds exist in Asia. An integrated and decentralized system of restoration and conservation of the water cycle in these drainage basins is vital to reduce the negative consequences of natural and externally imposed perturbations. Watershed management is particularly challenging in countries where the people-to-land ratio is high and policy and management are inadequate, prompting use of even the most fragile and unsuitable areas in the watersheds for residential, cultivation, and other intensive uses. Many watersheds suffer badly from deforestation, indiscriminate land conversion, excessive soil erosion, declining land productivity, erratic and unreliable surface and groundwater resources, and loss of biodiversity. In the absence of appropriate adaptation strategies, these watersheds are highly vulnerable to climate change. Global climate change may also have serious water management implications on the territory of boreal Asia.

Table 4. Completed, Ongoing and Pipeline Projects funded under Different Funds Managed by GEF (2001 to 2006)

Project Name	**Country**
Enabling Activities for the Preparation of National Adaptation Programmes of Action (NAPAs)	Afghanistan
National Adaptation Programme of Action	Bangladesh
Community based adaptation to climate change through coastal afforestation	Bangladesh
Community-based Adaptation (CBA) Programme	Bangladesh, Bolivia, Niger, Samoa, Guatemala, Jamaica, Kazakhstan, Morocco, Namibia, Vietnam
Water Resources in South Asia: An Assessment of Climate Change-associated Vulnerabilities and Coping Mechanisms	Bangladesh, India, Nepal, Pakistan
Increasing the resilience of poor communities to cope with the impact of climate change	Bangladesh, Nepal, Pakistan, Sri Lanka; Allachy Trust, Practical Action; RDPI (Rural Development Policy Institute, Rawalpindi, Pakistan)
Piloting Climate Change Adaptation to Protect Human Health	Barbados, Fiji, Uzbekistan, Jordan, Bhutan, Kenya, China
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Bhutan
National Adaptation Programme of Action	Bhutan
Community Micro Hydro for Sustainable Livelihood	Bhutan
Reduce climate change- Induced Risks and vulnerabilities from Glacial Lake Outbursts in the Punakha-Wangdue and Chamkhar Valleys	Bhutan
Coastal Resilience to Climate Change: Developing a Generalizable Method for Assessing Vulnerability and Adaptation of Mangroves and Associated Ecosystems	Cameroon, Tanzania, Philippines, Fiji
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Cambodia
National Adaptation Programme of Action	Cambodia
Southeast Asia Regional Vulnerability to Changing Water Resource and Extreme Hydrological Events due to Climate Change	Cambodia, Lao PDR, Thailand, Viet Nam
Targeted Research Related to Climate Change	China
Rainwater harvesting project in Gansu Province (part of the UNEP Dams and Development Project)	China
Adaptation to Climate Change in the Tourism sector	Fiji, Maldives, Seychelles
Adaptation Learning Mechanism: Learning by Doing	Global
Providing Regional Climates for Impact Studies jointly funded by DEFRA and DFID, UK	Global
Enabling activities for Preparing India's Second National Communication to UNFCCC	India
Climate-resilient Development and Adaptation	India

Project Name	Country
Pilot adaptation project on development of information sharing system (ISS) to enhance coping capacities of communities in dealing with climate variability and change	India, Pakistan
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Indonesia
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Iran
Conservation and Sustainable Use of Dryland Agro-biodiversity in the Fertile Crescent	Iraq, Syria, Lebanon, Israel, Jordan
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Lao PDR
National Adaptation Programme of Action	Lao PDR
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Lebanon
National Adaptation Programme of Action	Maldives
Climate Change Enabling Activities	Maldives
Climate Change Enabling Activities Expedited Financing (Additional Financing for Capacity-building in Priority Areas)	Nepal
National Capacity-building to Enable the Sultanate of Oman to Prepare its National Action Plan and First National Communication	Oman
Expedited Financing for Interim Measures for Capacity-building in Priority Areas (Phase II)	Pakistan
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Philippines
An Integrated Assessment of Climate Change Impacts, Adaptation, and Vulnerability in Watershed Areas and Communities in Southeast Asia	Philippines, Indonesia, Laos, Vietnam, Cambodia
Enabling Activities to Support Saudi Arabia in Responding to its Commitments to the United Nations Framework Convention on Climate Change (UNFCCC)	Saudi Arabia
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Sri Lanka
Participatory Coastal Zone Restoration and Sustainable Management in the Eastern Province of Post-Tsunami Sri Lanka	Sri Lanka
Assessment of the Impacts of and Adaptations to Climate Change in the Plantation Sector, with Particular Reference to Coconut and Tea	Sri Lanka in particular
Climate Change Enabling Activity (Additional Financing for Capacity-building in Priority Areas)	Thailand
Systems Efficiency Improvement, Equitization and Renewables (SEER) Project - Renewables Components	Vietnam
Expedited Financing for Interim Measures for Capacity-building in Priority Areas (Phase II)	Vietnam
Development of a National Adaptation Programme of Action	Yemen

Table 5. Other completed and Ongoing Projects implemented through different multilateral, bilateral and non-government entities

Name of Project	Country	Involved Organizations and Agencies
Advancing Capacity to Support Climate Change Adaptation	Global	ACCCA
Integrated Assessments of Vulnerabilities and Adaptation to Climate Variability and Change in the Western Region of China	China	AIACC
An Integrated Assessment of Climate Change Impacts, Adaptation, and Vulnerability in Watershed Areas and Communities in Southeast Asia	Philippines, Indonesia, Laos, Vietnam, Cambodia	AIACC
Applying Climate Information to Enhance the Resilience of Farming Systems Exposed to Climatic Risk in South and Southeast Asia	Australia, India, Indonesia, Nepal, Pakistan, USA	Asia-Pacific Network for Global Change Research
Assessment of the Impacts of and Adaptations to Climate Change in the Plantation Sector, with Particular Reference to Coconut and Tea, in Sri Lanka	Sri Lanka in particular	AIACC
Building Adaptive Capacity to Environmental Change in Southeast Asia: Integrating Contributions from Theory, Models and Case Studies for Better Development Strategies	Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Philippines, Thailand, Vietnam	Asia-Pacific Network for Global Change Research
Building Capacity of Mekong River Countries to Assess Impacts of Climate Change - Case Study Approach on the Assessment of Community Vulnerability and Adaptation to Climate Change Impacts on Water Resources and Food Production	Mekong River Countries	Asia-Pacific Network for Global Change Research
Climate Change Impacts on the Ecology of the Rice Pest Complex and the Resulting Threat to Food Security and Farming Economy in South Asia	Bangladesh, India, Pakistan, Sri Lanka	Asia-Pacific Network for Global Change Research
Climate Change in Southeast Asia and Assessment on Impacts, Vulnerability and Adaptation on Rice Production and Water Resources	Thailand, Lao PDR, Viet Nam, Cambodia	Asia-Pacific Network for Global Change Research
Climate Outreach to Youth in India	India	(UK), TERI
DINAS-COAST (Dynamic and Interactive Assessment of National Regional and Global Vulnerability of Coastal Zones to Climate Change and Sea-Level Rise)		Potsdam Climate Research Institute (PIK)
Global Change Impact Assessment for Himalayan Mountain Regions for Environmental Management and Sustainable Development	India, Pakistan, Nepal	Asia-Pacific Network for Global Change Research

Name of Project	Country	Involved Organizations and Agencies
Improving Policy Responses to Interactions between Global Environmental Change and Food Security across the Indo-Gangetic Plain	Nepal, Bangladesh, India, Pakistan	Asia-Pacific Network for Global Change Research
Integrated Assessments of Vulnerabilities and Adaptation to Climate Variability and Change in the Western Region of China	China	AIACC
Integrated Model Development for Water and Food Security Assessments and Analysis of the Potential of Mitigation Options and Sustainable Development Opportunities in Temperate Northeast Asia	China, Mongolia, Russia	Asia-Pacific Network for Global Change Research
Integrating Carbon Management into Development Strategies of Cities—Establishing a Network of Case Studies of Urbanization in the Asia-Pacific	Australia, India, Indonesia, Japan, Malaysia, Philippines, P.R. China, Republic of Korea, Thailand, USA, Viet Nam	Asia-Pacific Network for Global Change Research
Inventory of Glaciers and Glacial Lakes and the Identification of Potential Glacial Lake Outburst Floods (GLOFs) Affected by Global Warming in the Mountains of India, Pakistan and China	Japan, Mongolia, China, Republic of Korea	Asia-Pacific Network for Global Change Research
Potential Impacts of Climate Change and Vulnerability and Adaptation Assessment for Grassland Ecosystem and Livestock Sector in Mongolia	Mongolia	AIACC
Linking Climate Change Adaptation to Sustainable Development in Southeast Asia	Philippines, Indonesia, Vietnam, Lao PDR	Asia-Pacific Network for Global Change Research
Potential Impacts of Climate Change and Vulnerability and Adaptation Assessment for Grassland Ecosystem and Livestock Sector in Mongolia	Mongolia	AIACC
Regional, Multi-scaled, Multi-temporal Land Use and Land Cover Data to Support Global Change Research, Land Use Management and Policy Making: A SEARRIN LUCC Project	Cambodia, Indonesia, Lao P.D.R., Malaysia, Philippines, P.R. China, Sri Lanka, USA, Viet Nam	Asia-Pacific Network for Global Change Research
Removing Barriers to Capacity-building in Least Developed Countries: Transferring Tools and Methodologies for Managing Vulnerability and Adaptation to Climate Change	Sri Lanka, Bangladesh, Lao PDR, Cambodia, Nepal	Asia-Pacific Network for Global Change Research
Southeast Asia Regional Vulnerability to Changing Water Resource and Extreme Hydrological Events due to Climate Change	Cambodia, Lao PDR, Thailand, Viet Nam	AIACC
The Mega-Deltas of Asia: A Conceptual Model and its Application to Future Delta Vulnerability	Australia, Bangladesh, Cambodia, India, Japan, Pakistan,	Asia-Pacific Network for Global Change Research

Name of Project	Country	Involved Organizations and Agencies
	P.R. China, Thailand , USA, Viet Nam	
SURVAS (Synthesis and Upscaling of sea-level Rise Vulnerability Assessment Studies) Project		Asia-Pacific Network for Global Change Research
Adaptation to climate change and managing disaster risk in the Caribbean and South-East Asia		Caribbean Disaster Emergency Response Agency (CDERA), Barbados
The Reducing Vulnerability to Climate Change (RVCC) Project	Bangladesh	CARE Canada
Adaptation in mountain communities in Tajikistan	Tajikistan	CARE Tajikistan, CIDA
Vulnerability of Indian Agriculture to Climate Change and Globalization	India	Canadian International Development Agency (CIDA), Norwegian Ministry of Foreign Affairs, IISD's Young Canadian Leaders for a Sustainable Future
Reducing Vulnerability to Environmental Change Project	Bangladesh	CIDA, CARE
Climate Change Adaptation Project, Phase II	India	Department for Environment, Food and Rural Affairs (DEFRA), UK
Climate Change and the Poor: Linking Adaptation Needs to Policy and Institutional Structures	Bangladesh	Department for International Development (DFID), UK
Building and Strengthening Institutional Capacity on Climate Change (BASIC)	Brazil, South Africa, India & China	European Union Directorate-General Environment
Adaptation to climate change in watersheds	India	GTZ
Climate Policy Project	Regional	Institute for Global Environmental Strategies
Comprehensive Disaster Management Programme (CDMP)	Bangladesh	Ministry of Food and Disaster Management, Department of Environment, NGOs
Promotion of adaptation to climate change and climate variability in Bangladesh	Bangladesh	Netherlands Climate Assistance Program
Climate Change and sustainable Livelihood of Rural People in Mongolia	Mongolia	Netherlands Climate Assistance Program
Climate Change Impacts in Huong River Basin and Adaptation in its Coastal District Phu Vang	Vietnam	Netherlands Climate Assistance Program
Yemen, Adapting to Climate Change Adapting to water scarcity for Yemen's vulnerable communities	Yemen	Netherlands Climate Assistance Program
Building Adaptation Strategy to Climate Change for Selected Drought and Flood Prone	Bangladesh	NOVIB (Oxfam)

Name of Project	Country	Involved Organizations and Agencies
Areas of Bangladesh		
(Fighting salinity through traditional practices. Adapting agriculture to climate change in Sri Lanka)	Sri Lanka	Practical Action
(Floating gardens - Adapting to climate change in Bangladesh)	Bangladesh	Practical Action
(Increasing the resilience of poor communities to cope with the impact of climate change)	Bangladesh, Nepal, Pakistan, Sri Lanka	Practical Action
(Resisting the rising waters - Adapting to climate change in Bangladesh)	Bangladesh	Practical Action
(Identifying and developing adaptation and coping strategies)	Nepal	Practical Action Nepal, Allachy Trust UK
Preparing for floods. Coping with climate change in Nepal	Nepal	Practical Action Nepal, Allachy Trust UK
Rainwater Harvesting. Adapting to Climate Change	Global	Practical Action
Integrated community based risk reduction	Indonesia - Jakarta	Red Cross/Red Crescent Centre of Climate Change and Disaster Preparedness
Preparedness for Disasters related to Climate Change	Vietnam	Red Cross/Red Crescent Centre of Climate Change and Disaster Preparedness
Capacity strengthening in the Least Developed Countries (LDCs) for Adaptation to Climate Change (CLACC)	Global	Royal Norwegian Ministry of Foreign Affairs, DFID UK, Dexter Trust Germany, NORAD, SIDA
Indonesia IAHRI (CILIWANG): WATERSHED MANAGEMENT – SSN 2: Indonesia - Adaptation Project	Indonesia	SouthSouth North
Adaptation to coral bleaching events resulting from climate change by increasing coral reef resilience in west Waigeo district	Indonesia	SouthSouth North
Bangladesh CARITAS (CHAPAI): DROUGHT – SSN 2: Bangladesh - Adaptation Project	Bangladesh	SouthSouth North
Bangladesh SOER (GOPALGONJ): FLOOD – SSN 2: Bangladesh - Adaptation Project	Bangladesh	SouthSouth North
Coastal community adaptation to the impacts of sea level rise by conserving mangroves in Ayau district	Indonesia	SouthSouth North
Community adaptation to saline water intrusion and cyclones in a southwest coastal region of Bangladesh	Bangladesh	SouthSouth North
Enhancing the adaptive capacity of a community vulnerable to drought in the northwest region of Bangladesh	Bangladesh	SouthSouth North
Enhancing the adaptive capacity of a floodplain community in south central Bangladesh to reduce their vulnerability to prolonged floods and water logging	Bangladesh	SouthSouth North

Name of Project	Country	Involved Organizations and Agencies
Management of water catchment area to promote degraded land conservation in Central Java	Indonesia	SouthSouth North
Livelihoods and Climate Change	Global	Swiss Agency for Development and Cooperation
Bihar and Andhra Pradesh: Water hand-pumps on raised platforms	India	Tearfund
Climate change impact and adaptation assessment project in the plantation section in Sri Lanka	Sri Lanka	The International Research Institute for Climate and Society
Integrated river basin management: climate variability and adaptation strategies for Sri Lanka	Sri Lanka	The International Research Institute for Climate and Society
Adapting to Climate Change by Managing Climate Variability in Southeast Asia	Regional	The International Research Institute for Climate and Society (IRI); Asian Disaster Preparedness Centre (ADPC); NOAA/Office of Global Programs
Towards Development of Training Modules on Vulnerability and Adaptation issues for Arid Areas	India	M. S. Swaminathan Research Foundation, Winrock International India
Development and Climate Project	Global	UN Foundations, governments of the Netherlands,Canada, France and Germany
Community-based climate adaptation	Vietnam	Vietnam Red Cross, Netherlands Red Cross, the Netherlands Government
A Review of Vulnerability to Climate Change and Adaptation Strategies in India: Droughts and Floods	India	World Bank

VII. Regional and International Collaboration

129. Considering the importance and need for capacity-building to deal with climate change, a number of networks are working in the Asia Region. Most of them are supporting research, generating knowledge, bringing new ideas and debate, and sharing knowledge among different climate communities including researchers, policy makers and negotiators.

130. The Asia-Pacific Network for Global Change Research (APN) is an inter-governmental network whose primary purposes are to facilitate global environmental change research in the Asia-Pacific region, increase developing country participation in that research, and strengthen links between the science community and policy makers. It promotes, encourages and supports research activities on long-term global changes in climate, ocean and terrestrial systems, and on related physical, chemical, biological and socio-economic processes. It realized that global change research cannot succeed without a high level of international cooperation and thus supports collaborative projects implemented under international research programmes. Projects being implemented by APN can be categorized as Capacity-building, Comprehensive Research, and Adaptation to Climate Change, for example the 'Linking Climate Change Adaptation to Sustainable Development in Southeast Asia' project. In Asian LDCs, the network has built

capacity through transferring tools and methodologies, assessment, training and awareness raising. It has also generated new knowledge on climate change and its impacts on water resources and agriculture.

131. START, the global change SysTem for Analysis, Research and Training, provides an international framework for capacity-building in scientific knowledge and technology to conduct regional and local research and to inform and influence decision-makers. START has forged strong linkages with regional governmental organizations, such as the Asia-Pacific Network for Global Change Research (APN), the Inter-American Institute (IAI), the New Partnership for Africa's Development, and the European Commission (EC). START furthermore collaborates with other organizations dedicated to building scientific research capacity across disciplines in developing regions, such as the Third World Academy of Science (TWAS), the International Foundation for Science (IFS), and the United Nations University (UNU). The START Regional Networks include Southeast Asia, South Asia and Temperate East Asia.

132. START completed its Assessments of Impacts and Adaptation to Climate Change (AIACC) project in Asia where potential impacts of climate change and vulnerability and adaptation assessment have been carried out for some sectors and countries. Advancing Capacity to Support Climate Change Adaptation (ACCCA) is an ongoing project of START focusing on community-based adaptation measures to weather related disasters, integration of adaptation strategies into development policies by effectively communicating climate risks and adaptation measures in agriculture and water sectors and mainstreaming climate change adaptation in watershed management and upland farming.

133. The International Center for Integrated Mountain Development (ICIMOD), with financial support from UNEP, is assisting governments with the development of an inventory of glacial lakes; establishment of early warning systems; and development of adaptation measures. Inventories have been completed for Bhutan, Nepal, Astor basin in Pakistan, Pumqu basin in China, and Tista basin in India. Twenty glacial lakes in Nepal and 24 in Bhutan were identified as potentially dangerous and were recommended for further detailed investigation.

134. The Centre for International Forest Research (CIFOR) is an international research and global knowledge institution committed to conserving forests and improving the livelihoods of people in the tropics. CIFOR's high impact research helps local communities and small farmers gain their rightful share of forest resources, while increasing the production and value of forest products. CIFOR's three research programmes address the needs of the rural poor as well as environmental concerns. The Environmental Services and Sustainable Use of Forests Programme oversees research on biodiversity, carbon, fires, watershed functions, and the sustainable management and harvesting of forest products; the Governance Programme examines the process of making and implementing decisions about the management of forests by people and organizations beyond the scale of the individual household or small enterprise; and the Forests and Livelihoods Programme closely investigates how forest resources and their management, use and trade contribute to the livelihoods of the rural and urban poor.

135. The International Water Management Institute (IWMI) is a non-profit scientific organization funded by the Consultative Group on International Agricultural Research (CGIAR). IWMI's research agenda is organized around four priority themes covering key issues relating to land, water, livelihoods, health and environment. The Institute concentrates on water and related land management challenges faced by poor rural communities. The challenges are those that affect their nutrition, livelihoods and health, as well as the integrity of environmental services on which these depend. IWMI works through collaborative research with partners in the North and South, to develop tools and practices to help developing countries eradicate poverty and better manage their water and land resources. For disaster preparedness, rapid response and assessment, a Remote Sensed and GIS Based Knowledge Base System for Sri Lanka (KBS-LANKA) is being implemented by IWMI.

136. The Asian Disaster Preparedness Center (ADPC) is a non-profit organization supporting the advancement of safer communities and sustainable development, through implementing programmes and projects that reduce the impact of disasters upon countries and communities in Asia and the Pacific. ADPC is working on raising awareness, strengthening institutions, providing training and mainstreaming disaster reduction in development management in Asia.

137. The Institute for Global Environmental Strategies (IGES) is a research institute that conducts pragmatic and innovative strategic policy research to support sustainable development in the Asia-Pacific region. IGES collaborates with a broad range of stakeholders, such as national governments, non-governmental organisations, businesses and citizens groups, to carry out research, aiming to ensure that the results are reflected in the policy-making process. It has produced a number of policy documents on adaptation with special focus on adaptation beyond 2012.

138. The World Conservation Union (IUCN) is the world's largest and most important conservation network working on climate change issues in Asia. This organization is involved in the National Capacity Self-Assessment Programme.

139. The Red Cross/Red Crescent Climate Centre aims to support the International Federation of Red Cross and Red Crescent Societies (IFRC) and other interested parties to reduce people's vulnerability to climate risks. The activities of the Climate Centre include: (a) providing education and communication support about climate risk management within the Red Cross and Red Crescent Movement and among the general public; (b) Supporting the integration of climate risk management into Red Cross/Red Crescent programmes through the ´Preparedness for climate change` programme that formally started on January 1, 2006; (c) Bringing concerns about the impacts of climate change on vulnerable people and experiences with climate risk reduction to national and international policy makers; (d) Analyzing, documenting and sharing knowledge and experiences on climate risk management. For example, the climate change group is working in Indonesia on integrated community based risk reduction and in Vietnam on community-based climate adaptation.

140. SouthSouthNorth (SSN) is a network-based non-profit organisation working in the fields of climate change and social development. They aim to reduce poverty by building capacity in the South and delivering community based mitigation and adaptation projects. SSN has developed a methodology for preparing community based adaptation projects known as SouthSouthNorth Adaptation Project Protocol (SSNAPP).

141. Capacity Strengthening of LDCs for Adaptation to Climate Change (CLACC) is an initiative of southern institutes working on sustainable development. Initiated in 2004 by the International Institute for Environment and Development (IIED) and the Regional and International Networking Group (RING) partner institutions, CLACC receives financial and technical support from a number of northern institutes. CLACC aims to strengthen the capacity of organizations working with civil society in environment and development while integrating climate change issues in the planning and implementation of projects.

142. The Energy and Research Institute (TERI) in India develops solutions to global problems in the fields of energy, environment and current patterns of development which are largely unsustainable. The central element of TERI's philosophy has been its reliance on entrepreneurial skills to create benefits for society through the development and dissemination of intellectual property. The institute not only identifies and articulates intellectual challenges straddling a number of disciplines of knowledge but also mounts research, training and demonstration projects leading to the development of specific problem-based advanced technologies that help carry benefits to society at large. TERI works closely with several multilateral organizations, national governments, corporate organizations, NGOs, and academia around the world.

143. The Bangladesh Centre for Advanced Studies (BCAS) is an independent, non-profit, non-governmental, policy, research, and implementation institute working on sustainable

development at local, national, regional and global levels. BCAS envisions promoting people-centred sustainable development by applying and advancing scientific, technical and local knowledge through research, by developing models, demonstration, policy advocacy and project implementation. It works with leading NGOs, research institutes, universities and government agencies in South Asia and other parts of the world.

VIII. Summary and issues for consideration

A. Key Observations

144. Asia still faces formidable challenges in its effort to protect valuable natural resources and the environment. Land and ecosystems are being degraded, threatening to undermine food security. In addition, water quality and availability are deteriorating while continued increases in consumption and associated waste have contributed to the exponential growth in the region's existing environmental problems. Furthermore, the region is highly subject to natural hazards.

145. Countries in the Asian region have assessed impacts, vulnerability and adaptation to climate change using model-based and vulnerability-based approaches. The vulnerability-based or bottom-up approach was found to be good for identification of adaptation measures which are more people centred. The availability of data with the necessary geographic detail is the major limitation rather than computational capability or basic understanding particularly for agriculture, water and coastal zones.

146. Climate change induced key biophysical vulnerabilities vary widely across the region due to differences in physical, social and economic circumstances. It is revealed from the NCs and NAPAs that the most vulnerable sectors are agriculture and food security, water resources, natural ecosystems, forestry and biodiversity, coastal zones and sea level rise, natural disasters and human health. The projected impacts of climate change are likely to exacerbate water stress and shortages in some regions and increase the frequency and intensity of floods and droughts.

147. A wide range of precautionary measures are available at the regional and national level to reduce economic and social impacts of natural disasters. Integration of disaster risk reduction and climate change is emerging in many Asian countries.

148. Adaptive capacities vary between countries, depending on social structure, culture, economic capacity, and the level of environmental disruptions. Limiting factors include poor resource and infrastructure bases, poverty and disparities in income, weak institutions, and limited technology. The challenge in Asia lies in identifying opportunities to facilitate sustainable development with strategies that make climate-sensitive sectors resilient to climate variability.

149. In general, financial, technological and institutional barriers usually hamper the implementation of adaptation measures to climate variability and change in many Asian countries, particularly LDCs. For example, the current water policy of India aims at integrated water resources development and management to tackle water stress, but its implementation is constrained by financial and technological limitations.

B. Future needs

150. Many of the problems associated with climate impacts are also priorities on the development agenda and have been for a long time, irrespective of climate change. Environmental degradation and links between the environment and development have been well documented and analysed since the 1970s. Enough is known of the risks posed by climate variability and climate change to develop and implement adaptation projects immediately. Specific focus is necessary on the following issues;

(a) Development of effective adaptation strategies should take a more systems-oriented, people centred approach, emphasizing multiple interactive stresses, with less dependence on climate scenarios;

(b) Adaptation should aim to strengthen traditional coping mechanisms: optimizing current systems whilst building flexibility to cope with the uncertainties posed by climate change. Introducing new technology can be sustainable where it strengthens and builds on traditional approaches and reinforces local knowledge;

(c) An assessment of exiting coping strategies and its effectiveness under the warmer climate is necessary to modify practices for readjusting with changing condition that climate change will bring;

(d) Implementation of adaptation measures identified in National Communications and National Adaptation Programmes of Action should be supported effectively;

(e) Capacity-building and enhancement of technical capacity is needed to assess, plan and integrate adaptation needs into sectoral development plans that deal with the adverse impacts of climate change;

(f) The development of educational and public awareness programmes on climate change, the provision of public access to information on climate change issues and public participation (including NGOs) are important components of both the implementation of the UNFCCC and the development of national action plans;

(g) There is a need to support mainstreaming of adaptation into sectoral policy, particularly water, agriculture, coastal zones and managing natural ecosystems;

(h) More work is needed to promote mechanisms to increase funds for adaptation to climate change.

151. In order to address adaptation to climate change, including variability and extreme events, it is vital to continue to research the circumstances of the poor and vulnerable, both *for* the poor and vulnerable and *on* the poor and vulnerable. This requires stakeholder involvement, and will not be based exclusively on a top-down approach. This research must be communicated in a clear, targeted manner to relevant stakeholders including the communities themselves, NGOs active in the communities, local and national authorities, higher education institutes, global scientists, policymakers and decision makers.

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Annex I

Table 1. Socio-economic condition of People living in different Asian Countries

Country	Population (mil) 2004	GDP per capita (PPP US $)	Total GDP (PPP Billion US$)	Life Expectancy at birth	Adult Literacy Rate (% 15>)	Access to improved Sanitation (%)	Access to improved Water source (%)
Afghanistan	28,574 (th)	-	-	46.0	28.1	-	-
Armenia	3.0	4,101	12.4	71.6	99.4	83	92
Azerbaijan	8.4	4,153	34.5	67.0	98.8	54	77
Bahrain	0.7	20,758	14.9	74.5	86.5	-	-
Bangladesh	139.2	1,870	260.4	63.3	-	39	74
Bhutan	2.1	1,969	-	63.4	47.0	70	62
Brunei Darussalam	0.4	19,210	-	76.6	92.7	-	-
Cambodia	13.8	2,423	33.4	56.5	73.6	17	41
China	1308.0	5,896	7,642.3	71.9	90.9	44	77
Georgia	4.5	2,844	12.8	70.6	100.0	94	82
India	1,087.1	3,139	3,389.7	63.6	61.0	33	86
Indonesia	220.1	3,609	785.2	67.2	90.4	55	77
Iran	68.8	7,525	504.2	70.7	77.0	-	94
Iraq	28,057 (th)	-	-	58.5	58.8	-	-
Israel	6.6	24,382	165.7	80.0	97.1	-	100
Japan	127.9	29,251	3,737.3	82.2	99.0	100	100
Jordan	5.6	4,688	25.5	71.6	89.9	93	97
Kazakhstan	14.8	7,440	111.6	63.4	99.5	72	86
North Korea (DPR)	22,384 (th)	-		63.0	-	-	-
South Korea (RK)	47.6	20,499	985.6	77.3	98.0	-	92
Kuwait	2.6	19,384	47.7	77.1	93.3	-	-
Kyrgyzstan	5.2	1,935	9.9	67.1	98.7	59	77
Laos	5.8	1,954	11.3	55.1	68.7	30	51
Lebanon	3.5	5,837	20.7	72.2	-	98	100
Malaysia	24.9	10,276	255.8	73.4	88.7	94	99
Maldives	0.3	-	-	67.0	96.3	59	83
Mongolia	2.6	2,056	5.2	64.5	97.8	59	62
Myanmar	50	1,027	-	60.5	89.9	77	78
Nepal	26.6	1,490	39.6	62.1	48.6	35	90
Oman	2.5	15,259	38.7	74.3	81.4	-	-
Pakistan	154.8	2,225	338.4	63.4	49.9	59	91
Philippines	81.6	4,614	376.6	70.7	92.6	72	85
Qatar	0.8	19,844	-	73.0	89.0	100	100
Saudi Arabia	24	13,825	331.1	72.0	79.4	-	-
Singapore	4.3	28,077	119.1	78.9	92.5	100	100
Sri Lanka	20.6	4,390	85.2	74.3	90.7	91	79
Syrian Arab Republic	18.6	3,610	67.1	73.6	79.6	90	93
Tajikistan	6.4	1,202	7.7	63.7	99.5	51	59
Thailand	63.7	8,090	515.3	70.3	92.6	99	99
Turkey	72.2	7,753	556.1	68.9	87.4	88	96
Turkmenistan	4.8	4,584	20.9[a]	62.5	98.8	62	72
United Arab Emirates	4.3	24,056	103.9	78.3	-	98	100
Uzbekistan	26.2	1,869	49.0	66.6	-	67	82
Vietnam	83.1	2,745	225.5	70.8	90.3	61	85

Country	Population (mil) 2004	GDP per capita (PPP US $)	Total GDP (PPP Billion US$)	Life Expectancy at birth	Adult Literacy Rate (% 15>)	Access to improved Sanitation (%)	Access to improved Water source (%)
Yemen	20.3	879	17.9	61.1	-	43	67

Source: Human Development Report, UNDP, 2006. All data are for the year 2004
Notes:
a Data refers to 2001

Table 2. Geographical Region, Climatic Zones and Countries in Asia

Geographical Region	Climatic Zones	Countries
Central Asia	Arid and Semi-Arid	Kazakhstan, Kyrgyzstan, Tajikistan. Turkmenistan, Uzbekistan
Eastern Asia	Temperate	China, Japan, Mongolia, North Korea (DPR), South Korea (Republic)
Southeastern Asia	Tropical	Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam
Southern Asia	Tropical, Arid and Semi-Arid	*Tropical:* Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka *Arid and Semi-Arid:* Afghanistan, Iran, Pakistan
Western Asia	Arid and Semi-Arid	Armenia, Azerbaijan, Bahrain, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen

Table 3. Matrix showing comparative situation of different regions in Asia

Region		Northern Asia	Central Asia	Western Asia (Middle East)	Southern Asia	Eastern Asia	South eastern Asia
Envir-onmental Problems	Deforestation and Desertification		High for desertification	High for desertification	Medium to Low	Low	Low
	Pollution		Medium	Medium	High	High	High
	Loss of Biodiversity			Medium to High	High	Medium	High
	Extreme Events (cyclones, floods, storms etc.)	Low?		Medium to Low	High	High	High

	Water Resources		Medium	High	High	High	High
Socio Economic Indicators	Poverty		Low	Low	High	Medium	Medium
	Health Problems		Low	Low	High	Medium	Medium
	Education/ Literacy		High	High	Low	Medium	High
Climate Change Scenario	Sea Level Rise	Low	None	High to Medium	High	High	High
	Seasonal Change (temperature, rainfall etc)		Significant	Significant	Significant	Significant	Significant

Table 4. Submission of National Communications by non-Annex I Asian Parties to UNFCCC and Kyoto Protocol

	Country	**NC**	**NAPA**	**Party to UNFCCC**	**Party to Kyoto Protocol**
1	Afghanistan			*	
2	Armenia	*		*	*
3	Azerbaijan	*		*	*
4	Bahrain	*		*	*
5	Bangladesh	*	*	*	*
6	Bhutan	*	*	*	*
7	Brunei Darussalam			Observer State	
8	Cambodia	*	*	*	*
9	China (Host)	*		*	*
10	Georgia	*		*	*
11	India	*		*	*
12	Indonesia	*		*	*
13	Iran	*		*	*
14	Iraq			Observer State	
15	Israel	*		*	*
16	Jordan	*		*	*
17	Democratic People's Republic of Korea (North)			*	*
18	Republic of Korea (South Korea)	* 1st, 2nd		*	*
19	Kuwait			*	*
20	Kyrgyzstan	*		*	*
21	Laos	*		*	*

	Country	NC	NAPA	Party to UNFCCC	Party to Kyoto Protocol
22	Lebanon	*		*	*
23	Malaysia	*		*	*
24	Maldives	*		*	*
25	Mongolia	*		*	*
26	Myanmar			*	*
27	Nepal	*		*	*
28	Oman			*	*
29	Pakistan	*		*	*
30	Philippines	*		*	*
31	Qatar			*	*
32	Saudi Arabia	*		*	*
33	Singapore	*		*	*
34	Sri Lanka	*		*	*
35	Syrian Arab Republic			*	*
36	Tajikistan	*		*	
37	Thailand	*		*	*
38	Turkey			*	
39	Turkmenistan	*		*	*
40	United Arab Emirates	*		*	*
41	Uzbekistan	*		*	*
42	Vietnam	*		*	*
43	Yemen	*		*	*

Shaded Box: NC not on UNFCCC website.