CABI Ref.: FR/CABI-PK/BASIC/2011
CABI South Asia
Opposite 1-A, Satellite Town, Data Gunj Bakhsh Road Rawalpindi
Tele: 051-9290132, 9290332: Fax: 051-9290131
E-mail: cabisa@cabi.org

www.cabi.org

Desk Review on Climate Change in South Asia with Particular Focus on Pakistan

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KNOWLEDGE FOR LIFE

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CABI South Asia
Opposite 1-A, Data Gunj Baksh Road,
Satellite Town, PO Box 8,
Rawalpindi-Pakistan

Tel: +92 (0) 51 9290132
Email: cabisa@cabi.org

Introduction

1.1 What is climate change?

Climate change is widely believed to become the biggest challenge mankind has ever faced. On an international level, the realisation about the devastating impact and global importance of this threat to the whole of mankind has been very recent. The concept of greenhouse gases (GHGs) and global warming was first brought to the attention of international scientific forums in the late 1960s and politically for the first time in 1972 at the Stockholm Conference on the Environment. Firm scientific evidence of the connection between GHGs and global warming was made during the mid 1980s. The Intergovernmental Panel on Climate Change (IPCC) was only established in 1988 as an international forum to address the global issue of climate change. Until quite recently, climate change was still considered some event which is not to happen until some distant time in the future.

The 4th IPCC report 2007[1] has brought the most convincing scientific evidence that climate change is already happening. The report mentions that the evidence of a warming trend is "unequivocal," and that human activity has "very likely" been the driving force in that change over the last 50 years. In contrast, the last report by the group, the Intergovernmental Panel on Climate Change in 2001 had found that humanity had "likely" played a role. It has also helped to establish the long overdue realization among the most influential policy makers that climate change is only reversible if drastic changes will be made globally. The importance to combat the causes of climate change are now widely acknowledged.[2]

These necessary changes can be broadly categorised to fall into two groups: mitigation and adaptation approaches. While mitigation is mainly concerned with cutting GHG emissions, adaptation approaches aim to adjust systems to climate change. Agriculture has great potential for mitigation and adaptation. For full definitions of these two key concepts see section 1.3.

CC is becoming a mainstream issue not only in policy making, but also in discussions and trends of all aspects of human life, including not only the obvious sectors-- energy, industry, transport and agriculture-- but also areas like military defence and security strategy, human rights, psychology and insurance policy[3].

Already, climate change has risen to the top of some countries national security priorities (United States Special Envoy for Climate Change Issues, Todd Stern) [4]. From a security risk analysis point of view, climate change will, without resolute counteraction,

> *"overstretch many societies' adaptive capacities within the coming decades. This could result in destabilization and violence, jeopardizing national and international security to a new degree. However, climate change could also unite the international community, provided that it recognizes climate change as a threat to humankind and soon sets the course for the avoidance of dangerous anthropogenic climate change by adopting a dynamic and globally coordinated climate policy. If it fails to do so, climate change will draw ever-deeper lines of division and conflict in international relations, triggering numerous conflicts between and within countries over the distribution of resources, especially water and land, over the*

[1] 2007. IPCC. *4th Assessment Report of the Intergovernmental Panel on Climate Change*.
[2] China, which together with the U.S. produces about 40 percent of the world's greenhouse gases, maintains that the world "cannot afford a failure" at the upcoming Copenhagen Summit. "The Copenhagen conference must succeed for the sake of mankind," Yu Qingtai, the foreign ministry's climate-change envoy, said in Beijing. (Bloomberg.com: *Copenhagen May Help Set Warming Cap, Munich Re Says*, 07/08/2009)
[3] See interview with Peter Hoeppe, chief scientist at the largest reinsurance company.
[4] Voice of America 4th Aug. 2009.

> *management of migration, or over compensation payments between the countries mainly responsible for climate change and those countries most affected by its destructive effects.* [5]"

It is here were the human rights nexus to climate change comes in, because of its disproportionate impact on already vulnerable people and communities. As articulated by the UK Secretary of State for the Environment, 'socially, climate change raises profound questions of justice and equity: between generations, between the developing and developed worlds; between rich and poor within each country. The challenge is to find an equitable distribution of responsibilities and rights[6].

At the moment, "the international community seems to be less concerned about the failing climate system than about failing financial institutions[7]." The question that often arises is, "why do humans take so long to react to such threatening phenomena such as climate change"? This question was recently addressed by a task force on climate change of the American Psychological Association.

> *Scientific evidence shows the main influences of climate change are behavioral – population growth and energy consumption. " What is unique about current global climate change is the role of human behavior," said task force chair Janet Swim, PhD, of Pennsylvania State University. "We must look at the reasons people are not acting."*

Some of the factors identified were: *Uncertainty, Mistrust, Denial, Undervaluing Risks, Lack of Control* and *Habit--Ingrained behaviors are extremely resistant to permanent change while others change slowly. Habit is the most important obstacle to pro-environment behavior, according to the report.* [8]

Coping with climate change requires not only technological and economic, but also social, political and cultural changes that can be interpreted as another „great transformation"[9]. While previous transformations or "waves of innovation" [10] included the shift from nomadic hunting and gathering to sedentary agriculture, the inventions of script and metallurgy, the present challenge is to make a shift away from a carbon-based economy to one that is based on renewable energy and environmental sustainability.

The current policy direction is to manage this transformation through a "cap and trade" system, in which carbon/GHG emissions are governed through permissible ceilings and opportunities to buy carbon credits. This system, based on the Kyoto Protocol is also referred to as the Clean Development Mechanism. In this system, industries of industrialized countries which pay for climate change (annex 2 countries) can buy carbon credits from developing countries which mitigate carbon emissions through sequestration or reduction activities. The three large transitional economies China, India and Brazil are the main recipients of carbon credit funds through the CDM. China, currently the biggest polluter in the world is also pursuing a shift towards renewable energy and low-emission technologies.

1.1.1 **A Brief History of Climate Change**

In order to understand the concept of climate change in a social and political context, a brief description of the emergence of environmental awareness with focus on some highlights on recent environmental social and policy discourse will be helpful to understand the historical and political context of the key problem mankind is facing now: environmental destruction and climate change.

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[5] The New York Times: *Climate Change Seen as Threat to U.S. Security*. Aug. 10,2009; and German Advisory Council on Global Change-- *Climate Change as a Security Risk*, London and Sterling, VA.
[6] Australian Human Rights Commission: Background Paper --*Human Rights And Climate Change.*
[7] CCCD Report 2009. *Closing the Gaps—Disaster Risk Reduction and Adaptation to climate change in developing countries.* Commission on Climate Change and Development. http://www.ccdcommission.org
[8] Climate Change Task Force of the American Psychological Association.
[9] *The Great Transformation, Climate Change as Culture Change*, International Conference ; June 8-10, 2009, Essen, Germany presentation day 4 "Climate Change is Culture Change".
[10] 2009. Natural Capitalism Solutions (NCS). *The Business Case for Climate Protection.*

Environmentalism has its origins in romanticism and the industrial revolution, i.e. it is not older than 200 years. Early issues include the British Alkali Acts, passed in 1863, to regulate air pollution through soda ash production. Partly as a reaction to industrialization during the 18th century in Europe and America, romanticism propagated an emotional confrontation with nature as opposed to scientific rationalization and "use-value". Writers like Byron, Thoreaux, Goethe and Schiller as well as painters of the period expressed this sense of "awe" before "untamed" nature. The US Yosemite National Park is an early manifestation of this urge to set aside "untouched" as a value in itself. It was not until the middle of the 20th century, that environmental issues became important national policy issues.

The 1950's witness an emerging awareness about visible, audible and tangible pollutants. Air pollution, sewage, garbage, and industrial pollution was growing in the urban centres and added to a growing locally perceived environmental impact. In 1952, the UK's first Clean Air Act was passed to clean up the soot filled skies of London. Japan, USA and other Western European countries followed suit with similar laws. In 1959, a Japanese government commission concludes that "Minamoto Disease" is caused by mercury contained in industrial effluents that pollute the sea and enter the food chain via fish and shellfish.

The 1960s witness the emergence of awareness about unseen, silent pollutants, including nuclear fall-out and radioactivity as well as carcinogenic chemicals. Trans-boundary pollution (air-borne sulphur) and oil slicks where alarming new phenomena. The first super-tanker ship wreck of the *Torrey Canyon* and the resulting oil spill raised awareness about the vulnerability of marine ecosystems. In 1962. *Silent Spring*, the book by Rachel Carson, raises alarm that synthetic pesticides (most importantly DDT) were invading water tables and threatening entire food chains. As a result, the decade witnessed a heightened sense of awareness about regional impacts of environmental pollution, and a need to scientifically study and politically contain environmental issues emerged. Thus in 1964, UNESCO's International Biological Programme was launched to study environmental damage and the biological and ecological mechanisms through which it occurs.

The 1970s witnessed a realization that environmental issues are global and need to be advanced through civil action as well as national and international policy making. The concepts of "global warming" and "ozone layer depletion" emerge. The decade sees the rise of powerful civil movements like Greenpeace, which was formed in 1971 in Canada with an aggressive agenda to stop environmental damage through civil protests and non-violent interference. The focus of the organization later turned from its initial emphasis on anti-nuclear protest to other environmental issues: whaling, bottom trawling, global warming, old growth, nuclear power, and genetically modified organisms.

The influential works of authors such as E. F. Schumacher (*Small Is Beautiful: Economics As If People Mattered, 1973) and* the Club of Rome, which publishes *Limits to Growth* (1972) drive home the point that resources are finite and solutions to global problems have to incorporate "green" thinking. *Hans Jonas, in his main work The Imperative of Responsibility: In Search of Ethics for the Technological Age* (1979) takes the argument as far as justifying (ecological) dictatorship as a last resort to safe the preconditions for life on this planet, thus laying the philosophical foundation of the environmentalist movement. In the same year, James Lovelock, a former NASA scientist, published Gaia: A new look at life on Earth, which put forth the Gaia Hypothesis, proposing earth to be a single organism.

In the political arena, ground-breaking international policy developments were made. In 1971, the first international Conference on Environment and Development was held at Founex, Switzerland, the report of international experts of which calls for the integration of environment and development strategies to address poverty and *underdevelopment* (a popular term then). This levelled the ground for the first international milestone conference in 1972, the United Nations Conference on the Human Environment (aka "Stockholm Conference"). 113 nations attended. It represented a turning point in environmental awareness and a beginning in policy outline. For the first time, the need for international coordination, further research and co-ordinated financing to address environmental concerns is realized and included in a declaration and an international action plan. "Development without destruction" was one of the key themes. The terms "CFCs" and "global warming" are mentioned during the conference; however, not included in the Declaration or Policy

Recommendations. UNEP was established in 1972. In 1974, first proof appeared that if human use of CFC gases was to continue at an unaltered rate the ozone layer would be depleted significantly after some decades[11]. In 1975, the Worldwatch Institute is established in the USA to raise public awareness of global environmental threats to the point where it will support effective policy responses. In the same year, the Convention on International Trade in Endangered Species of Flora and Fauna (CITES) comes into effect. Late 1970s environmental catastrophes capture public attention. E.g. Amoco Cadiz oil spill and Three Mile Island nuclear reactor leak.

The 1980s finally witnessed the emergence of "ozone hole" and "climate change". Still a controversial proposition for many governments and private sector interests, the realization that "sustainable development" is the only option is made by most towards the end of the decade. This decade also saw the emergence of powerful non-governmental organizations and South-South cooperation. International policy making involving state, non-state and private sector parties also proved to become a new policy tool.

In 1980, the World Conservation Strategy was released by IUCN. The strategy defines development as "the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life". The section "Towards Sustainable Development" (possibly the first prominent use of the term) identifies the main agents of habitat destruction as poverty, population pressure, social inequity and the terms of trade.

In 1985, the Antarctic ozone hole is discovered. In the same year, a meeting called by World Meteorological Society, UNEP and International Council of Scientific Unions (ICSU) in Villach, Austria reports on the build-up of carbon dioxide and other greenhouse gases in the atmosphere. They predict global warming. The Montreal Protocol on Substances that Deplete the Ozone Layer is adopted in1987. In the same year, the World Commission on Environment and Development publishes "Our common Future", also known as the Brundtland Report[12]. The term "sustainable development" becomes mainstream. The Brundtland Report lays the thematic framework for the subsequent Earth Summit, aka Rio Conference in 1992.

The Inter-governmental Panel on Climate Change was established in 1988 with three working groups to assess the most up-to-date scientific, technical and socio-economic research in the field of climate change.

Rio becomes a major turning point for international environmental policy. International, national, and non-governmental policies from now on increasingly include mention of "sustainable development", "biological diversity" and "climate change". The Convention on Biological Diverstiy (CBD) and the Framework Convention on Climate Change (UNFCCC) were formed at Rio. Post-Rio policies become effective under the name of Agenda 21, the number 21 standing for 21st century. This action plan was signed by 178 governments.

The 1990s have witnessed the most powerful policies being forged for the environment, yet. Besides Rio's Agenda 21, the other outstanding policy developed in 1997, has been the Kyoto Protocol, in which the United Nations Framework Convention on Climate Change sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. These amount to an average of five per cent against 1990 levels over the five-year period 2008-2012. The Kyoto Protocol also
sets the policy framework for the Clean Development Mechanism (CDM), which became operational in and other mitigation measures as well as adaptation frameworks and funding mechanisms. All these mechanisms have been defined in the post-Kyoto process known as Convention of Parties (CoP) meetings. A brief synthesis of these meetings is given in box 1[13] below:

The **2002 Earth Summit** established the principle of 0.7% GDP for overseas aid commitments by the wealthy, industrialized countries. The 8 Millennium Development Goals (MDGs) were also

[11] Rowland and Molina in *Nature* magazine.
[12] Named after the former Norwegian Prime Minister, Gro Harlem Brundlandt, chairperson of the commission. The ToRs for this commission were discussed as early as 1982.
[13] Adopted from Saleemul Huq, Hannah Reid and Laurel A. Murray. *Climate Change and Development Links.* Gatekeeper Series 123. IIED. 2006 and Wikipedia (CoP 12-14).

developed, with a clear environmental focus for **Goal 7 : Ensure environmental sustainability.** The specific targets of this goal are A: Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources, and B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss. In detail this second target aims at

- *Proportion of land area covered by forest*
- *CO_2 emissions, total, per capita and per $1 GDP (PPP)*
- *Consumption of ozone-depleting substances*
- *Proportion of fish stocks within safe biological limits*
- *Proportion of total water resources used*
- *Proportion of terrestrial and marine areas protected*
- *Proportion of species threatened with extinction*

2005. World Summit. Paris Declaration. *"UN delivering as one."*

Upcoming event Dec. 2009: Copenhagen Conference (CoP 15). To determine post Kyoto Protocol (2012 onward) policies to mitigate and adapt to CC. Contrary to previous conferences, emphasis will be on adaptation instead of mitigation, also making operational the Adaptation Fund.

Box1: Post-Kyoto Protocol and Kyoto Protocol implementation

COP6 in Bonn,Germany (July 2001) established three new funds: the Special Climate Change Fund (SCCF), the Least Developed Countries Fund and the Adaptation Fund.

COP7 in Marrakech,Morocco (October-November 2001) prompted the formation of the LDC Expert Group.The COP also laid out the objectives of the three new funds.The SCCF will finance activities relating to climate change in the areas of adaptation, technology transfer, energy, transport, industry, agriculture, forestry and waste management.The LDC Fund will support the preparation of National Adaptation Programmes of Action (NAPAs) for LDCs. Lastly, the Adaptation Fund will be financed from the 2% charged on all Clean Development Mechanism projects and other sources of funding to fund adaptation initiatives.

COP8 in Delhi, India (October-November 2002) produced the Delhi Declaration,which reaffirms the importance of development and poverty eradication. It calls for policies and measures specific to national circumstances, and integration of climate change objectives into national sustainable development strategies.The COP proceedings also refuted the perceived divide between environment and development agendas.

COP10 in Buenos Aires, Argentina (December 2004) brought to light the difficulties of funding adaptation projects in the context of development. At present, the Global Environment Facility (which administers UNFCCC funds) will only finance projects with a core focus on adaptation. Adaptation projects with additional development benefits will not receive full-cost funding, even though in practice most adaptation projects are built on or embedded in larger national or local development projects. Co-financing from development and donor agencies would therefore be required,which puts an additional burden on poor countries seeking funds.

COP11 in Montreal, Canada (November-December 2005) finally adopted the Marrakech Accords, which enable the operation of the different international funds for adaptation (the LDC Fund and SCCF under the UNFCCC, and the Adaptation Fund under the Kyoto Protocol).The Montreal meeting was also the first Meeting of the Parties (MOP1) after the coming into force of the Kyoto Protocol. One important new element of discussion was the issue of raising funds for the Adaptation Fund from other flexible mechanisms besides the adaptation levy on the Clean Development Mechanism alone.

Box 1 continued:

COP 12 was held in Nairobi, Kenya from 6 to 17 November 2006. At the meeting, the phrase climate tourists was coined to describe some delegates who attended "to see Africa, take snaps of the wildlife, the poor, dying African children and women

COP-13 took place in Bali, Indonesia, between Dec 3 and Dec15, 2007. Agreement on a time-lined and structured negotiation on the post 2012 framework (a successor to the Kyoto Protocol) was achieved with the adoption of the Bali Action Plan (Decision 1/CP.13). The Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) was established as a new subsidiary body to conduct the negotiations aimed at urgently enhancing the implementation of the Convention now, up to and beyond 2012.

The COP-14 was held in Poznań, Poland on 1–12 December 2008. Delegates succeeded to agree on principles of financing for a fund to help the poorest nations cope with the effects of climate change. And also they approved a mechanism to incorporate forest protection into efforts.

COP15 will be held in Copenhagen, Denmark and will last two weeks from 7-18 Dec. 2009.

The overall goal for the COP15 United Nations Climate Change Conference hosted by Denmark is to establish an ambitious global climate agreement for the period from 2012 when the first commitment period under the Kyoto Protocol expires.

It is expected that ministers and officials from 192 countries will take part. In addition, there will be participants from a large number of organisations. The conference was preceded by the Climate Change: Global Risks, Challenges and Decisions scientific conference in March, co-located in Copenhagen (For synthesis report see http://www.climatecongress.ku.dk).

1.2 Major issues of Climate Change in South Asia with focus on Pakistan

'The human drama of climate change will largely be played out in Asia, where over 60 per cent of the world's population, around 4 billion people, live'[14]. Stronger storms and mass coral bleaching in the Philippines, higher sea levels and vanishing biodiversity in the Maldives and Vietnam, saltwater contamination of drinking water in India, massive floods wiping out coastal villages in Bangladesh and Indonesia, the glaciers melting in the Himalayas, widespread droughts in China, and many other impacts put life in Asia at risk[15]. There is a growing trend towards greater and more catastrophic natural disasters. Of the ten disasters with the highest death tolls since 1975, half have occurred in the five year period between 2003 and 2008.[16]

A particularly good summary of the different scenarios for likely dangerous climate change in Asia which draws from different IPCC studies as well as other sources, is given in the report *Climate Change as a Security Risk* by the German Advisory Council on Global Change, 2008:

> *"Climate change affects the South Asian countries of India, Pakistan and Bangladesh particularly severely. Its consequences include a rise in sea level, threatening areas such as the densely populated Ganges delta, changes in the monsoon rains that are so important for agriculture, the melting of the glaciers in the Hindukush-Karakorum-Himalaya region whose meltwaters are crucial for the water supply in the dry seasons, and the foreseeable increase in heavy rain events and intensity of tropical cyclones (IPCC, 2007). For the Indian subcontinent, comprising the countries of India, Pakistan and Bangladesh, climate models project warming of 2-4.7 °C, with the most probable level being around 3.3 °C by the year*

[14] Working Group on Climate Change and Development, *Up in Smoke? Asia and the Pacific,* November 2007,
[15] Business Mirror, 26th Aug., 2009..
[16] 2009 UN report on disaster risk reduction: assessing the challenge.

2100 (IPCC, 2007). Warming is expected to be more marked in the winter half of the year (3.6 °C) than in summer (2.7 °C), and it is stronger in the north than in the south. Most models project a decrease in precipitation quantity during the winter dry period (mean change -5 per cent, range -35 per cent to +15 per cent) and an increase for the rest of the year (mean change +11 per cent, range -3 per cent to +23 per cent). At the same time, an increase in heavy rain events is probable, particularly in the north of India, in Pakistan and in Bangladesh. The summer monsoon is crucial to the annual precipitation total of the Indian subcontinent (Lal et al., 2001). The effect that global warming will have on the Indian monsoon is still unclear, but increased variability in the monsoon rains is probable (Section 5.3.2; IPCC, 2007a). In addition, the strength of tropical cyclones, which represent a threat to the eastern coast of India and to Bangladesh, could increase (IPCC, 2007). The risk to these areas will be aggravate by rising sea levels (WBGU, 2006).. The impacts of climate change in India vary from region to region. The effect of possible changes in the intensity of the monsoons will be particularly sensitive, because large parts of India receive the majority of their annual precipitation during the summer monsoon rains, which already vary noticeably in different regions (Lal et al., 2001). Agriculture is highly dependent on the monsoon and therefore sensitive to changes in monsoon intensity. In the past, variable monsoon rains have already led to harvest losses as a result of droughts or heavy rain. The east coast of India, which lies in the path of tropical hurricanes from the Gulf of Bengal, is particularly at risk of being damaged by storms and floods (IPCC, 2007)."

According to the IPCC, Pakistan is affected both by increasing precipitation variability and accelerated melting of the glaciers in the Himalayas. However, both GCISC and various studies by GTZ and the Newcastle University point to evidence that glacier-melting is controversial, and perhaps the opposite trend might be the case. In a longitudinal study over the period 1961-2000[17],

"strong contrasts (were) found between the behaviour of winter and summer temperatures and between maximum and minimum temperatures. Winter mean and maximum temperatures show significant increases but, unlike the general global pattern, minimum summer temperatures show consistent decline. The behaviour of summer temperatures is more important than winter for the melt of glaciers and seasonal snow. Decreases of ~20% in summer runoff in the Hunza and Shyok since 1961 are estimated to have resulted from the observed 1° C fall in summer temperature. This is consistent with observed thickening and expansion of Karakoram glaciers. The Karakoram are showing a different response to global warming from other parts of the globe."

While being an interesting indication that climate change does not affect all regions uniformly, this study should not distract from the fact that Pakistan will be particularly badly affected by climate change. Also, while Pakistan's glaciers may or may not be expanding, ICIMOD's studies predict glacial retreat, decreasing permafrost and accelerating rises in temperatures at least for Nepal, and Tibet with increases in water stress leading to a 30% decrease in crop yields in Central and South Asia by the mid-21st century.18 Glacial Lake Outburst Floods or GLOFs are a related phenomenon, which threatens not only Nepal, but also Northern Pakistan and Bhutan, devastating whole villages along with their natural resource base[19].

Afghanistan will probably be hit the worst by climate change, with predictions of even more severe droughts, drying out of underground aquifers, deforestation, desertification and species loss[20]

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[17] *Conflicting signals of climatic change in the Upper Indus Basin*, by Hayley Fowler and David Archer, Journal of Climate, 19, (2006) 4276-4293.

[18] *The Melting Himalaya--Regional Challenges and Local Impacts of Climate Change on Mountain Ecosystems and Livelihoods,* Xu Jianchu, Arun Shrestha, Rameshananda Vaidya, Mats Eriksson, and Kenneth Hewitt International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal, June 2007.

[19] See ICIMOD 2007 (above), CLACC working paper no. 2. Bhutan, 2004, BCAS, Adverse Imacts of CC on Development of Bhutan: Integrating Adaptation into Policies and Activities. Mozaharul Alam and Dago Tshering.

[20] UNEP, GEF, Climate Change and Disaster Preparedness Working Group
Final Thematic Report, Feb. 2008.)

For Pakistan, a prognosis by the GCISC, looking only at a temperature increase, predicts that agricultural production will decrease for wheat and for rice. This scenario does not even look at changing precipitation patterns or changes in irrigation.

The increased frequency of heavy rain events anticipated in the north of the Indian subcontinent will lead to an increase in flooding. Bangladesh will be particularly severely affected by the effects of climate change. This is a result of its coastal location on the Gulf of Bengal and its geography, in particular the extensive delta of the Ganges and Brahmaputra rivers. Large areas of the country are predominantly flat and lie only a few meters above sea level. It is already prone to flooding; the risk will be heightened by the rise in sea level and by more intensive tropical cyclones over the Gulf of Bengal (IPCC, 2001; IPCC, 2007). In the greater part of India, deforestation and subsequent non-sustainable land use is the principal cause of soil degradation. In the northern regions overgrazing also plays a part. Soil salination occurs primarily in the north-west of India, but also in various regions of Pakistan. In both areas, overuse of the land is the main cause of degradation (Section 5.2). In Bangladesh, too, agriculture is responsible for soil degradation. In addition, soils become salinated through the intrusion of seawater. There is a very major risk of desertification in western Pakistan, north-western India and central India. In all these areas, agricultural irrigation is often not practised in a sustainable fashion. It must be assumed that agriculture and food production in the entire region will suffer as result of climate change and that the decline will be exacerbated by anthropogenic degradation. Studies show, for example, that in Bangladesh production of rice and wheat could fall by 8 per cent and 32 per cent, respectively, by the middle of the century; in India a rise in winter temperatures of 0.5 °C would reduce the wheat harvest by 0.45t per hectare (IPCC, 2007).

The major climatic problem already faced by South Asia is the availability of fresh water. Particularly the large river basins will be affected severely by floods, droughts and associated diarrheal diseases.[21] Climate change will worsen this situation. A change in precipitation patterns is predicted. One feared impact of climate change in South Asia is a delay in the onset of the monsoon. News on June 29, 2009: *"…The monsoon is now two weeks late and the impact of the delay is potentially devastating. The farmers cannot plant rice, cotton or sugarcane until the rains soften the parched, cracked soil, and if they don't plant in the next week or so their yields will plunge, prices will rise, and the number of farmer suicides will increase*."[22]

What all of this means for agriculture, the 4th IPCC report described in detail. In summarized form, the main adaptation measures put forward are to:

- increase adaptive capacity by modifying farming practices, improving crops and livestock through breeding and investing in new technologies and infrastructure. Specific examples include adaptation of grassland management to the actual environmental conditions as well as the practice of reasonable rotational grazing to ensure the sustainability of grassland resources ;
- improve irrigation systems and breeding of new rice varieties to minimise the risk of serious productivity losses caused by climate change;
- launch information, education and communication programmes to enhance the level of awareness and understanding of the vulnerable groups;
- make changes in management philosophy could also enhance adaptive capacity.

Hydrology measures feature as most important interventions. IPCC mentions in particular

[21] CCCD Report 2009, p.2. *Closing the Gaps—Disaster Risk Reduction and Adaptation to climate change in developing countries.* Commission on Climate Change and Development. http://www.ccdcommission.org

[22] Carbon Based: Praying for Rain in the Cauldron of Climate Change. June 29, http://carbon-based-ghg.blogspot.com/2009/06/praying-for-rain-in-cauldron-of-climate.html

- Water saving schemes for irrigation to avert water scarcity in regions already under water stress;
- In North Asia, recycling and reuse of municipal wastewater;
- increasing efficiency of water used for irrigation and other purposes,
- reduction of hydropower production and
- improved use of rivers for navigation

The conversion of cropland to forest (grassland), restoration and re-establishment of vegetation, improvement of the tree and herb varieties as well as the selection and cultivation of new drought-resistant varieties are suggested effective measures to prevent water scarcity due to climate change and will likely help avert water scarcity (4th IPCC report, Ch. 10: Asia).

1.3 Some working definitions

Adaptation:

- IPCC defines it as an —adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC 2007c: 6).
- Whereas the principle aim of greenhouse gas **mitigation** activities is to *reduce the amount of climate change* that is likely to be encountered, adaptation activities are intended to *reduce the adverse impacts* that a given amount of warming will cause (Fankhauser 1998: 1).
- Adaptive responses can range from the purely technological ones (such as sea defences and monitoring- and early warning systems), through behavioural responses (such as altered food and recreational choices), to managerial (e.g. altered farm practises) and to policy responses (e.g. planning and building regulations).

How does the CDM work?

Under the Kyoto Protocol, a number of flexible trading mechanisms were agreed, CDM being one of them. The basic principle is that the abatement of CO2 can be traded like any other commodity. The basic unit is one ton of carbon dioxide sequestered or mitigated = 1 CER. Annex 1 countries (38 ratifying industrialized countries of the Kyoto Protocol) can buy CERs from non-annex 1 countries who have signed the Kyoto Protocol to achieve their carbon emission reduction targets (5.2% reductions to the emission rates of the baseline year 1990). One CER is nowadays traded for around US$ 10, but may fluctuate like any other commodity due to supply and demand. The total carbon market is estimated to have grown from US$ 100m to US$ 150 billion in 2008. CERs are traded through the CDM @ of a minimum size of 50,000 CERs per project.

Major Climate Change Players in Pakistan and South Asia

This section looks into the organisational landscape in Pakistan and to a limited extent that of South Asia. Different types of organisations are explored—actors (NGOs, INGOs, IGOs), donors and government agencies. A brief profile for each organisation describes their role, which is followed by a brief discussion on the potential opportunities for CABI, which should be explored through (follow up) discussions with that particular organisation.

2.1 The Pakistan Ministry of Environment (MOE)

No activity of significant scope for the environment comes into being without the explicit consent and involvement of the MoE. This ministry has recently established the Climate Change Wing and a CDM Secretariat in the Ministry, the main task of which are to serve as a government interface between the Clean Development Mechanism (CDM) and the Government of Pakistan. CDM projects are currently in the pipeline. The CDM Secretariat is most closely involved in the formulation and approval procedures of 5 REDD forest conservation projects. Other priority activities of the MoE are a comprehensive study looking at adaptation and mitigation of the climate change in Pakistan, agroforestry activities, livestock and watershed management as well as methane capture and biogas generation. The MoE is very closely collaborating with IUCN, Winrock International and WWF to design and implement these and other activities.

CABI and the MoE: *The MoE expressed keen interest to involve CABI in its mandate, addressing some of its priorities. In a meeting with the Director General (Environment), Mr Jawed Ali Khan, CABI SA proposed to develop a conservation field school methodology which could be effectively used to make REDD projects more efficient and sustainable through better community participation. Other areas of interest for both, the MoE and CABI which were identified were agroforestry, agricultural early warning systems, bio-safety and a joint workshop on climate change and/or Clean Development Mechanism initiatives. . Discussing biological pest control, he suggested our involvement in biosafety in collaboration with EPA, which also falls under his jurisdiction. For the whole detail of this discussion and a draft Memorandum of Understanding between CABI and the MoE.*

As the focal ministry for climate change, the MoE is a logical partner for CABI. As a follow up action, CABI-SA will need to aggressively pursue this potential partnership through follow up visits and reminders. The draft Memorandum of Understanding still lies with the DG Environment. This desk study could, as was discussed, become an input not only into the CABI position paper on climate change, but also into the comprehensive study of the MoE mentioned above.

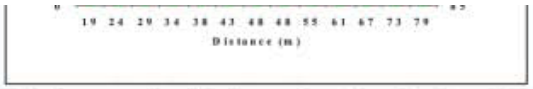
2.2 The Pakistan Agricultural Research Council (Parc)/National Agricultural Research Centre, Islamabad (NARC)

The PARC was established in 1981 by the Government of Pakistan with the mandate to undertake, promote and coordinate research to provide science-based solutions for agricultural development. Some other roles of PARC are to train high level scientific manpower, to generate, acquire and disseminate agricultural information and to establish a research library. Other important areas are technology development and demonstration as well as agricultural crisis management. Climate change has also become an area in which PARC has become active. Water harvesting systems are of central concern in this regard. The two pilot projects below are adopted from the PARC website (http://www.parc.gov.pk/ index.htm):

Impact of Water Diversion Structure in Rod-Kohi Areas

- Low cost water diversion structures were developed by local material and evaluated at head, middle and tail reaches of Daraban Zam, D.I. Khan. The soil erosion was reduced from 70-8- % and saved labor 70-75 % as compared to conventional method. Furthermore, these can also be used as drainage out lets of the upper elevated field and irrigation inlet for the lower field.

Improving Pumping Efficiency Through Windmill in *Rod Kohi* areas



Discharge and application uniformity of low head drip irrigation system installed in perennial rod kohi area

- Cultivated 20 acres of onion, wheat and lemon with dugwell irrigation in Rod Kohi areas of district Dadu, Sindh. Discharge of pump was 8 l sec with 43% pumping efficiency.
- A windmill was installed on a dugwell at a farmer's field in Rod Kohi areas of district Dadu, Sindh. Pumping head was 111 ft, wind velocity ranged 1.66-2.22 m sec and discharge varied from 1 to 6 l sec.

CABI and the PARC: *Already, by virtue of overlapping mandates, CABI and PARC have a long standing relationship and established contacts. An Memorandum of Understanding between the two organisations exists and project funding has been provided by PARC to CABI through their funding window of the Agricultural Linkages Programme (ALP). For future action, joint research projects and deeper cooperation in the context of water conservation and climate change adaptations should be explored.*

2.3 Global Change Impact Study Centre (GCISC)

The Global Change Impact Studies Centre (GCISC) was established in May 2002. The main purpose of the Centre is to serve as a think tank in aid of the national planners and decision makers for strategic policy planning in consonance with the changing global environment in areas such as Climate, Water, Energy, Food, Agriculture, Health, Ecology and new technologies. The GCISC is the lead agency in the analysis and interpretation of climatic models. The centre consists of five sections: Agriculture Section, Climate Section, Water Section, Environment Section, and the Biodiversity Group. Their mandates are given below:

Agriculture Section: The objective of this section is to study the likely impacts of climate and technological change, both positive and negative, on agricultural production and to identify appropriate measures for coping with the negative impacts. This is being done, through developing and testing crop simulation models and following system analysis approach with a view to assist the national planners in developing and incorporating suitable strategies in the national development plans. The results and outcomes are published as papers in journals of repute, conference/workshops proceedings and as scholarly reports.

In pursuit of its objectives, the Agriculture Section employs different tools for assessing the impact of climate change on agricultural productivity. The impact can be studied at various levels, such as on crop yields, on farm and village level outputs and income, on regional and national production and on global production and prices. Each level requires different set of research methods. These include Crop Simulation Models, Integrated System Models, Economic Models, Remote Sensing and GIS etc.

- Preliminary impact assessment of global warming on crops under different environmental conditions through use of crop growth models (DSSAT, CERES-Wheat, CERES-Rice, etc.)
- Applying crop growth models for predicting crop yield and crop management strategies in combination with spatial information

- Studying integrated food system in Gujrat district to understand interaction between food system and global environmental change. This will help enhance adaptive capacity of food system in the face of current and future change.
- Studying weather information system in rural Punjab to bolster the capacities of farming communities to counteract the harshness of climate variability and climate change.

Climate Section: The climate section of the Centre is involved in the following activities:

- Analysis of past climate data to establish baseline patterns of climate in various parts of Pakistan
- Evaluation/Validation of various GCMs data to assess their ability to simulate present-day climate of Pakistan and other parts of South Asia
- Use of the outputs of an ensemble of selected GCMs to construct plausible Climate Change scenarios for Pakistan and neighbouring areas
- Use of Statistical Downscaling techniques to improve spatial resolution of GCM based scenarios
- Use of RCMs for Dynamical Downscaling of GCM data to formulate high resolution CC scenarios
- Coupling of RCM with MM5 for improvement in spatial resolution
- Development of Indicators and Indices for Monitoring and Prediction of Extreme Climate Events

Water Section: The objectives of this section is the assessment of likely climate change impacts on fresh water resources of Pakistan in line with IPCC/CSERES climate change scenarios for the current century, and identification of appropriate coping mechanisms for the adverse impacts through application of computer models to simulate various hydrological processes in the Indus River Basin to reproduce inflows of various components of Indus River System and Use of validated models to quantify changes in river inflows as a result of projected climatic changes in the region:

- Assessing potential impacts of anthropogenic and CC-driven land cover changes on future water balance.
- Real-time Hydrological forecasting by integrating DHSVM with MM5.
- Developing integration with regional and meso-scale climate models for the assessment of future water resources.
- Development of spatial extrapolation techniques for radiation, temperature and precipitation over Himalayas.
- Development and Management of Basin databases for the Indus River System for the application of DHSVM.

Environment Section: This section is multidisciplinary and aims to harness center's expertise in the following two disciplines to tackle the key environmental issues of climate change. Research activities are focused on the assessment of Trans-boundary Air Pollution in South Asia and its effect on the air quality of Pakistan. Three models are currently under use for this purpose:

- The Regional Air Pollution Information and Simulation (RAINS-ASIA) model to analyze the cost effective strategies to reduce environmental impacts of SO2, Acid deposition, SO2 concentration present and future scenarios.
- Community Multiscale Air Quality (CMAQ) Model
- CALPUFF, an air quality dispersion model, to assess the long range transport of pollutants.

Biodiversity Group: GCISC's Biodiversity Programme aims to understand various changes in biological diversity of Pakistan with particular focus on Climate Change. A baseline study of biological diversity of Pakistan is being carried out with particular focus on threatened biomes. The section is currently in the process of compilation of vegetation simulation model BIOME4. BIOME4 is a coupled biogeography and biogeochemistry model which simulates the equilibrium distribution of 28 major potential natural vegetation types (biomes) from latitude (for the calculation of incoming short-wave and photosynthetically active solar radiation), atmospheric CO2 concentration, mean monthly climate (i.e. mean monthly precipitation, temperature, and percent sunshine) and soil physical properties (water holding capacity and percolation rate).

CABI and the GCISC: *Already, several meetings have taken place between the two organisations in the context of this desk review. Now, CABI and GCISC are in the process of entering into a formal relationship within the context of the proposed Climate Change Development Knowledge Network consortium.*

2.4 IUCN- International Union for Conservation of Nature

IUCN is one of the key players in climate change in Pakistan and South Asia. Supporting the Pakistan Ministry of Environment, IUCN played a key role in the established of the Technical Advisory Panel on Climate Change (TAP-CC) to facilitate Government of Pakistan (GoP) in fulfilling its obligations under UNFCCC. The Panel aims to bridge the gap between the technical knowledge being generated by various institutions and its application for enhancing the economic and social resilience of Pakistan's population to the adverse impacts of climate change. The TAP-CC is co-chaired by MoE and IUCN and the TAP Secretariat housed in IUCN Pakistan. At present TAP-CC have 6 regular members:

1. Ministry of Environment
2. Global Change Impact Studies Centre
3. Pakistan Agriculture Research Council
4. Pakistan Meteorological Department
5. Asia Pacific Network, Pakistan
6. IUCN – International Union for Conservation of Nature, and

Newly Approved Members are 1) SUPARCO,2) NIO, 3) Planning Commission, 4) WAPDA, 5) PCRWR, 6) PIDE, 7) Federal Flood Commission, 8) Academic Institutions (to be decided).

Scope of Work (role in TAP):

- Provide technical advisory services to the MoE on issues related to climate change, including national position briefs
- for international negotiations (COPs, MOPs) under UNFCCC and the Kyoto Protocol
- Identify, prioritise and recommend areas for conducting research, the results of which may be presented to and by TAP-CC, and will assist in incorporating the research findings into policies. (TAP members may themselves take up some of the research priorities.)
- Build linkages with regional organizations working on climate change, to benefit from regional experiences and knowledge
- Organize exchanges, study visits, and training (e.g. on negotiation skills for government delegates to COPs/ MOPs)
- Organize presentations and guest lectures by other actors working on climate change nationally, regionally and globally
- Produce and disseminate communication material and knowledge products for print and electronic media

Progress

- Seminars on climate change in Muzaffarabad and Lahore: Collaboration with government and civil society institutions on raising awareness;
- Compilation of climate change related research in Pakistan
  - Initiation of preliminary work on vulnerability studies
  - Studies on community perceptions on climate change in Shigar and Bagrot valleys (Northern Areas).

CABI and the IUCN: *IUCN seems a logical partner for CABI. While there are many overlaps in mandate, CABI has a definitive edge in terms of agriculture related capacities. Discussions towards the formulation of an MoU may be helpful for CABI to be included on policy panels, meetings, forums and discussions on climate change. The very close relationship of IUCN with the MoE may also be useful for CABI to become a serious player in climate change.*

2.5 ICIMOD—The International Centre for Integrated Mountain Development

ICIMOD is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of

mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. ICIMOD's new strategy focuses on responding to the challenges of global change: enhancing resilience and supporting adaptation of mountain communities'. Thus almost all ICIMOD activities are involved in some way with climate change in mountain areas, whether measuring change per se, or helping communities to recognise, respond, and adapt to such changes.

CABI and ICIMOD: *ICIMOD could become a useful partner for CABI in the context of mountain ecosystems. With considerable parts of Pakistan consisting of high mountains and the country's significant dependence on glacial melt for water and irrigation, mountain ecosystems play an important role in the country's agriculture and livelihood systems.*

2.6 Bangladesh Centre for Advanced Studies (BCAS)

BCAS is an independent, non-profit, non-governmental policy, research and implementation institute working on sustainable development at local, national, regional and global levels. It was established in 1986, and over the years has grown to become a leading institute in the non-government sector in Bangladesh and South Asia. BCAS participated in in all the preparatory meetings of UNCED in Rio and WSSD in Johannesburg as an NGO representative, where it played a key role in giving advice to the government delegations. BCAS provides secretarial support to the Global Forum on the Environment and Poverty (GFEP) originating during the earth Summit in Rio.

BCAS, together with the International Institute for the Environment and Development (IIED) and the Ring Alliance organized the 3rd International Conference on Community Based Adaptations to Climate Change. The also hosted the preceding events (The 1st International Workshop and 2nd International Conference on Community Based Adaptations to Climate Change). This international forum, which has grown over the years in importance and to a participation of delegates from over 50 countries, comprising 150 international and 40 selected Bangladeshi participants working on climate change related issues. CABI SA also participated this event and gave a presentation demonstrating the relevance of CABI's work to the climate change debate.

CABI and BCAS: *The participation in the 3rd Int'l Conference provided a good opportunity for CABI to project CABI's role in agriculture and climate change and to scope for new potential business and contacts. BCAS would be a logical partner for CABI's prospective business in Bangladesh. The major difference between CABI and BCAS is the importance of advocacy which the latter emphasized in all of its work.*

2.7 Climate Action Network South Asia (CANSA)

This network is meant for NGO's with a strong advocacy component. Governmental and inter-governmental organisations (like CABI) are sometimes granted observer status.

CABI and CANSA: As motivated by the South Asia Chair, Mr Malini Trivedi, CABI applied for observer status membership in CANSA. The application is still pending and should be followed up.

2.8 Lead Pakistan

The core objectives and building blocks of LEAD Pakistan's Climate Change Program are:

1. Research and initiating policy engagement;
2. Developing training programs for increased stakeholder engagement;
3. Creating and managing partnerships and multi-stakeholder networks;
4. Designing for Implementing mitigation and adaptation models and frameworks.

LEAD Pakistan maintains a well structured website with numerous useful links to organisations, events and resources (http://www.lead.org.pk/cc/index.html). The website is particularly useful to monitor ongoing events on climate change and it provides useful regional, Pakistan-specific, technical and general background information on CC.

LEAD Pakistan established its **Advisory Board on Climate Change** in February 2008 to support its Climate Change Program that aims to enhance the scope of climate change at regional, national and local levels. The Board provides guidance, direction and focus to the Climate Change Program and serves as a tremendous ally in LEAD's quest for creating a niche in the area of climate change.

The LEAD Advisory Board is an elite group of experts on climate change that are well respected national level individuals from the government, media, academia, NGO and corporate sector. These individuals are highly qualified with knowledge and experience in the area of climate change. Currently, the six members of the Advisory Board are **Dr. Ishfaq Ahmad**, Advisor, Science and Technology, Planning Commission / Minister of State,Govt. of Pakistan and Chair, Task Force on Climate Change Pakistan, **Malik Amin Aslam**, Former State Minister for Environment Pakistan, **Dr. Shams Kassim Lakha**, Former Caretaker Federal Minister for Education, Science and Technology Government of Pakistan, **Dr. Amir Mohammed**, Rector, FAST National University Pakistan, **Dr. Adil Najam**, Professor, Global Public Policy, Boston University USA and **Syed Ayub Qutub**, President Pakistan Institute for Environment-Development Action Research (PIEDAR) Pakistan

Knowledge Network on Climate Change (KNCC): LEAD Pakistan launched the Knowledge Network on Climate Change (an e-mail based moderated network) in March 2008. The Climate Change Knowledge Network aims to initiate a debate and discussion on the climate change issue for all segments of the society and provide a forum to share and exchange experiences and ideas. Currently, there are over 300 members on this network. The KNCC is moderated to ensure the flow of information is focused primarily on topics related to climate change (http://www.lead.org.pk/cc/registrationform_climate_change.html).

National Network on Climate Change (NNCC): The primary goal of establishing the National Network on Climate Change (NNCC) is to provide a forum for discussions and information exchange on cutting-edge scientific, economic, planning and research related to Climate Change.
The Network aims to raise the level of attention and interaction on climate change issues by involvement of different tiers of stakeholders including the government, civil society organizations, the media, decision makers, field practitioners, researchers, scientists and advocacy communities.
The objectives and scope of NNCC include:

- Promote knowledge sharing among scientists, decision-makers and stakeholders;
- Exchange\ share lessons learned;
- Assess and report on on-going mitigation and adaptation activities in the country;
- Facilitate research collaborations within and across the country on climate change related issues;
- Develop a shared research agenda on climate change issues with stakeholders;

NNCC-Members:

LEAD Pakistan has reached out to 20 leading institutes and high-profile organizations at the national level to become a part of this network. They include[23]:

- Global Climate Impact Study Center (GCISC), Islamabad
- HEJ Institute of Chemistry, Karachi
- Ministry of Environment & Planning Commission
- National Agricultural Research Centre (NARC), Islamabad
- Islamic University, Islamabad
- National Institute of Oceanography Intercooperation, Peshawar
- International Union for Conservation of Nature (IUCN), Karachi
- World Wild Fund (WWF), Lahore
- International Centre for Integrated Mountain Development (ICIMOD), Islamabad
- Space and Upper Atmosphere Research Commission (SUPARCO), Karachi
- COMSTECH, Islamabad
- International Waterlogging and Salinity Research Institute (IWASRI), Lahore
- Water and Power Development Authority (WAPDA)
- Pakistan Institute of Environment-Development Action Research (PIEDAR), Islamabad
- GC University, Lahore

CABI and LEAD: *LEAD appears a natural competitor to the mandate of the proposed DFID Climate Change and Development Knowledge Network. A strategy how to collaborate and exchange knowledge with LEAD while securing CABI's business needs to be developed by CABI SA.*

2.9 Winrock International

[23] For links to all the below listed institutions click http://www.lead.org.pk/cc/nationalnetwork_climate_change.html

As part of the commitments to the Kyoto Protocol, which Pakistan signed in 2005, the country as "host" or "non-annex 1" country is eligible for the sale of Certified (CO_2) Emissions Reduction Credits (CERs) under the Clean Development Mechanism (CDM). So far only one project has been approved and is being implemented. Another 9 projects are going through the validation process. In order to develop a strong pipeline of CDM projects in Pakistan, the Ministry of Environment, funded by the World Bank, has implemented this project with **Winrock International** as its implementing agency. For this purpose, Winrock Intl. organised a one day training workop on Jan. 22, 2009 in Islamabad. This event, in which alos participated, comprised of 1) the launching ceremony of the project and 2) a training session on Project Idea Note (PIN) formulation, the first step for CDM project submission. Over the next 18 months, the project has the target to develop 20 PINs and 4 full CDM proposals, called Project Development Documents or PDDs.
The launching ceremony included speeches by Winrock Country Director and main facilitator of the training, Mr Bikash Raj Pandey, the Chief Guest, Federal Minister of Environment, Mr Afridi, the Director General, Ministry of Environment Mr Jawed Ali Khan and Ms Saima Qadir from the World Bank Carbon Finance Unit.

What does the PIN format look like?: The Project Idea Note has a simple format, introducing the rudimentary points of the project. The main areas to cover in convincing detail are:

1. **Project Description.** Basic objectives in brief
2. **Project participant(s)** –those parties implementing and benefiting from the project
3. **Size (expected CERs) and schedule** (how many CERs in which year of the project and up to/including 2012, the last year of phase 1 of the CDM)
4. **Crediting period** (10 years or 7 years, the latter has the option of 3 consecutive phases with validations between each)
5. **Status of Government (DNA) approval** If Kyoto Protocol signatory or not
6. **Baseline emissions** (for renewable energy, waste management and energy efficiency projects--the PIN for re-/afforestation and REDD—Reduced Emissions from Deforestation and Degradation <financing forest conservation and land use> was unfortunately not subject of the PIN training provided). The baseline is calculated on the basis of the existing practices, i.e. carbon emissions without the emission reduction practices brought about by the project. In agriculture, this could for example be the difference between chemical fertilizer use before and after a Good Agriculture Practices project.
7. **Additionality:** CDM only finances projects which would not have been implemented without CER money. It can also be argued that the internal rate of return would not be high enough to risk the introduction of certain unproven technologies.
8. **Rest project financing:** How is the project actually financed. CERs only represent the "icing on the cake".
9. **Environmental and social benefits of the project**. While the buyer of the project usually only cares about the CERs, certain companies also like to write "poverty alleviation" or "social equity" etc. on their banners.

Potential opportunities for CABI: *While the most lucrative opportunities to make "easy money" from carbon credits, i.e. chloroflurocarbons, methane capture from landfilling sites, biogas etc are mostly taken up, the more difficult areas like land use and REDD are still virtually "virgin territory", the latter because of being new (recently approved methodologies). For land use, including agriculture, mechanism for validation have only started to be developed. Zero tillage and methane capture through appropriate compost making are the most obvious approaches here, while "organic" and many other agriculture practices are struggling to quantify benefits in terms of carbon sequestration. Currently, the only way to go with this is to work on fresh manure (biogas, methane capture).*

Another project idea which has clear potential is reduction of chemical fertilizer use and subsequent savings in CO_2 emissions. The reduction in CO_2 emissions would be measured in its equivalent of nitruous oxide emited (a GHG 300 times worse than CO_2) and CO_2 emitted in its production. After I had initial discussions to develop a PIN on this principle with the help of Winrock International, this plan came to nothing since the CDM validation methodology for this surprisingly has to be developed yet. I had initial discussions with Mr Pandey, who is extremely pleased to help… so they can clear their target of 20 PINs and he has forwarded a few links regarding the most recent approved methodologies and projects related to agriculture (see annex below). After digesting this information and following up with him on the best way to go, the scope and potential for CABI within this may become somewhat clearer.

While the CERs will not become income for CABI, they can become very useful as an additional incentive for farmers to change conventional farming practices towards more environmentally friendly ones, particularly if we are going for the introduction of some type of agricultural standard which helps farmers to market their produce as "organic" or anything along these lines. CABI SA has experience and will go for further promotion of GlobalGAP certification criteria to boost both export and environmental health. There might be some potential to claim some CERs in this area… once the methodologies are in place. What is an important point to mention here though is that the CERs generated through a project need to be "claimed" through PIN development before a project starts!

In order to be pro-active, CABI may also want to get involved in the development of the appropriate IPCC guidelines and validation methodologies for agricultural practices. Currently, FAO and others may have gotten a head start in this and may be in a better position to reap the benefits just like countries like Brazil, China and India have "run away" with 80% of the CDM funds.

Some potential follow-up actions are:

- *Explore potential for PIN development in Pakistan/South Asia with Winrock.*
- *Discuss slurry improvement options with RSPN: 30,000 farm-based biogas plants to be implemented with parallel CDM PIN development—We could take on the slurry that comes out after methane capture and develop training or methodology to transform this into some more attractive fertilizer for farmers (slurry has cultural acceptability problems in South Asia). Has anybody in CABI worked on this? Or are there already established fertilizer-making technologies, especially at a farm level with do it yourself trainings? There could be real money considering all of South Asia.*
- *Explore how CABI could become a "validator" in agriculture for the CDM;*
- *Explore ways of how CABI could get into the game of developing CDM methodologies in land use/agriculture for the IPCC/CDM;*
- *CABI SA: Follow up with Richard Garstang from the Wetlands project, who showed interest to create synergies regarding livelihood components implemented by CABI;*

Useful links for CDM follow up: *Here is the list of approved projects: http://cdm.unfccc.int/Projects/projsearch.html (On this page you need to highlight 'Agriculture (15)' which is last on the list of Sectoral Scopes and then hit Search. When you do this you will see a lit of 103 projects and by clicking on any of them you can see the full details of the project).*

Here is the list of approved methodologies: http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html?searchmode=advanced&searchon=1&scales=1&scales=2&scales=3&number=&title=&scopeoperation=or&scopes%3Alist=15&button=Search

Here too you can follow a similar procedure to look for methodologies specifically for Agriculture which have been approved. You will find that there are 5 such methodologies of which 4 are from manure management and one is for Urea offset by planting soybean.

This last one may be of the most interest to you and the details of this methodology is available at the Website: http://cdm.unfccc.int/UserManagement/FileStorage/CDM_AMSZWWIVT3A9ZK5RZHA0CDUBOER0LP1H1

The CDM bazaar: http://www.cdmbazaar.net/default.asp

2.10 Asian Development Bank (ADB)

Financing sectoral reform and modernization, ADB has recently made CC to one of their priorities. Hosted by ADB, the recent Climate and Clean Energy Week (June 16-19) thererore consist of two events. The High-Level Dialogue on Climate Change in Asia and the Pacific, to be held 16-17 June, will bring together policy makers to discuss the path forward for the Asia-Pacific region in the face of climate change. The dialogue will be followed by the 4th Asia Clean Energy Forum 2009, from 17-19 June, which will serve as a platform for exchanging experiences and forging new partnerships to advance clean energy solutions in the region.
With the 4th Asia Clean Energy Forum 2009, ADB wants to launch its Energy for All Partnership, which aims to provide clean, reliable energy to 100 million people in the Asia and Pacific region by

2015. ADB is also involved in designing a plan which outlines ongoing and planned responses to climate change in each of its five regions. While major emphases of ADB are on infrastructure and energy, there are also some projects on land-use, water management and the environment[24].

Ongoing and planned activities in Pakistan and South Asia:

- Glacial Melt and Downstream Impacts on Indus-Dependent Water Resources and Energy (Afghanistan/India). Total ADB Small Grant for Adaptation Project Cost: US$200,000. Mostly water and energy sector rapid climate impacts and risk screening, for details see http://www.adb.org/climate-change/afg-ind-downstream.asp.
- Forest Resources Management Sector Project (Sri Lanka, completed)
- Integrated Coastal Zone Management and Sustainable Coastal Protection (India)
- Addressing Climate Change in the Asia and Pacific Region
- Enabling ADB's Climate Change Interventions (Central and West Asia)
- TA Loan for Lahore Rapid Mass Transit System (Pakistan): Technical Assistance Special Fund US$150,000, and Loan-2424 PAK: Preparing the Lahore Rapid Mass Transit System Project (US$6.0 million).
- Sustainable Power Sector Development Program (Bangladesh)
- Green Power Development Project (Bhutan)
- Central Uttar Pradesh Gas Limited (India)
- Energy Efficiency Enhancement in the Power Generation Sector (India)
- Energy Efficiency Enhancement Project in Assam (India)
- Facilitating the Operations of the Energy Conservation Fund “Energy Smart” in Madhya Pradesh (India)
- Gujarat Paguthan Wind Energy Financing (India)
- Integrated Renewable Energy Development Project (India)
- Jammu and Kashmir State Clean Power Development (India)
- National Power Grid Corporation Transmission Project (India)
- Tata Power Wind Energy Financing Facility (India)
- Preparing Electricity Connectivity and Energy Efficiency Project (Nepal)
- Daharki Power Project (Pakistan)
- Renewable Energy Development Sector Investment Program (Pakistan)
- Sustainable Energy Efficiency Development Program (Pakistan)
- A Development Framework for Sustainable Urban Transport (Regional)
- Urban Governance and Infrastructure Improvement Project (Bangladesh)
- Jammu and Kashmir Urban Sector Development Investment Program (India)
- Kerala Sustainable Urban Development (India)
- Rajasthan Urban Infrastructure Development (India, up to May 2009)
- Uttaranchal Urban Development (India, up to Apr. 2009)
- Rawalpindi Environmental Improvement (Pakistan, completed 2008)

2.11 National Institute of Oceanography

The National Institute of Oceanography (NIO) is located in Karachi. It was established in 1981 by the Ministry of Science and Technology, Government of Pakistan (MoST). The main area of research of the Institute is the north Arabian Sea and beyond. The oceanic and atmospheric processes of the north Arabian Sea modify our climate, offer numerous living and non-living resources, Oceanographic research brings together all the scientific disciplines needed to study the ocean. Some of the areas the NIO is working on are:

- hydraulic and hydro-dynamic investigations,
- paleoceanography and reconstruction of climatic history from marine sediments,
- Spatial and temporal changes in the distribution and breeding patterns of marine organisms in the coastal and deep waters of Pakistan

Recently, Pakistan also submitted its continental shelf claim to the UN through the NIO.

[24] For a complete list of all ADB CC projects and their details click http://www.adb.org/climate-change/projects.asp

For more detail, see http://www.niopk.gov.pk/

CABI and the National Institute of Oceonography: As of now, CABI does not work in fisheries in Pakistan; however, if opportunity arises, this institute would be a logical partner.

2.12 Space and Upper Atmosphere Research Commission (Suparco), Karachi

SUPARCO is Pakistan's space agency. While most of its work is defence related, some attention is also given to communication, Geographic Information Systems (GIS) and natural resource surveying/environmental monitoring. Specific programs and missions of SUPARCO are:

- Scientific space research
- Remote sensing of Earth
- Satellite telecommunication systems
- Geographic Information System
- Natural Resource Surveying
- Environmental monitoring
- Acquisition of data for atmospheric/meteorological studies
- Development of the ground-based infrastructure for navigation and special information system
- Space activities in the interests of national security and defence
- Development of research, test and production base of the space sector

For more detail, see http://www.suparco.gov.pk/

Opportunities for CABI: *As a direct partner SUPARCO will probably not feature prominently for CABI. However, being one of the suppliers of GIS data, CABI's collaboration with the GCISC and MoE will indirectly benefit from data ultimately supplied by SUPARCO.*

2.13 Other Organisations

As unfortunately not all organisations presently involved in climate change related activities could be visited, the following list tries to capture some potentially useful linkages:

- World Wild Fund (WWF), Lahore, see: http://www.wwfpak.org/)
- International Waterlogging and Salinity Research Institute (IWASRI), Lahore;
- University of Newcastle: Hydrology studies on Indus Jhelum rivers in Northern Pakistan by David Archer and Hayley Fowler Oxfam, Pakistan
- DFID, Pakistan, India and Bangladesh (strong country programme in Bangladesh, very marginal programme in Pakistan, which is overseen by a focal person based in DFID, Pakistan).
- Society for the Conservation and Protection of the Environment (SCOPE, see http://www.scope.org.pk/index.html),
- OXFAM, Pakistan (small projects and studies linked to livelihoods theme).
- SDPI, Sustainable Development Policy Institute, Islamabad). Workshop and research work on climate change for several past years, see: http://www.sdpi.org/)
- COMSTECH, Islamabad (member of National Network on Climate Change (NNCC), LEAD Pakistan).
- Intercooperation, Peshawar (some small scale projects, see: http://www.intercooperation.org.pk/)

Policy Developments

Adaptation—In a nutshell, definitions,

What is adaptation? The UNFCCC provides a clear answer: “Adaptation is a process, through which societies make themselves better able to cope with an uncertain future. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes”

Adaptation is about building adaptive capacity and carrying out appropriate adaptive measures. Adaptive measures seek to address climate change impacts by, for example, a new seawall, crop insurance schemes, research on heat- and drought-tolerant crop varieties, agricultural diversification, vaccines, upgraded drainage systems, enhanced water use efficiency, enlarged reservoirs, or revised building codes.

Adaptive capacity increases with human development. It can be summarized under four simple headings – **wealth, health, education, and governance:**

Wealth, or access to assets, provides the buffers and backup, that takes people, through crises and enables them to recover.

Health safeguards the productive capacity of the individual and the integrity of families. This comes through clean water and effective sanitation, safe child birth, and food of the right kind and amount so that children grow to their full potential.

Education gives people access to information, knowledge of their options, and the ability to make informed choices.

Governance, or rather the institutional environment, provides the means through which people, working with others, have access to resources, articulate needs, and exercise their rights.

Understanding adaptation in this way tells us that adaptive action must be highly context specific. In countries and communities where human development indicators are low, priority must be given to strengthening the adaptive capacity of people and institutions. If capacity is already there, through assets, insurance, a healthy and well-educated population, and formal and informal institutions that mediate support and through which needs can be analyzed and articulated, then action will naturally emphasize climate-specific measures – that is, measures that would not have been necessary if climate change were not happening.

Adaptation to climate change is about forms of development in which the capacity to manage risk determines progress. Thus adaptation is much more than climate-proofing development efforts and official development assistance. The Commission finds that it requires action, additional funding, and deep cooperation between rich and poor nations and between rich and poor people within nations. It requires sustainable development: meeting the needs of the present in ways that do not compromise the ability of future generations to meet their needs.

Integration: Adaptation, mitigation, and human development goals are closely interrelated. Mitigation measures such as afforestation, reforestation, and avoided deforestation are also effective adaptation, as they improve economic and ecosystem resilience.

Climate Change Funding

4.1 Funding for Climate Change Adaptation and Mitigation

The recurrent costs to finance climate change adaptation are estimated between USD 10 to 100 billion[25] by different institutions such as the UNFCCC ($ 28-67bill. By 2030) the World Bank ($10-40 billion annually), UNDP ($86 annually, see table 2 below) and Christian Aid ($ 100 billion annually). This discrepancy is mostly due to the different ways of calculating the costs. Table 1 below shows the UNDP estimate:

Table1: Estimates of adaptation investment needs in 2015 from the 2007/2008 Human Development Report

Category	Costs in 2015 (USD billion)
Climate proofing development	44
Adapting poverty reduction to climate change	40
Strengthening disaster response	2
Total	**86**

Source: United Nations Development Programme. 2007. *Human Development Report 2007/2008. Fighting Climate Change: Human Solidarity in a Divided World.* Available at: <http://hdr.undp.org/en/reports/global/hdr2007-2008/>. Chapter 4.

Only a fraction of these predicted costs are actually currently matched through multilateral and bilateral pledges. The required funds incorporate many sectors (see table 2 below):

Table2: Additional investment and financial flows needed for adaptation in 2030, by sector

Sector	Areas/adaptation measures considered	Global cost (2005 USD billion)	Proportion needed in developing countries (%)
Agriculture, forestry and fisheries	Production and processing, research and development, extension activities	14	50
Water supply	Water supply infrastructure	11	80
Human health	Treating increased cases of diarrhoeal disease, malnutrition and malaria	5	100
Coastal zones	Beach nourishment and dykes	11	45
Infrastructure	New infrastructure	8–130	25

Source: UNFCCC, 2008

92. National adaptation programmes of action (NAPAs), which provide project level information on adaptation costs, identified through bottom up assessment have so far been completed by 38 LDCs. In total, these countries have identified about 430 "urgent and immediate" adaptation projects, of which 385 have been costed. The total cost of these projects is over USD 800 million with an average project cost of approximately USD 2 million (excluding a single USD 700 million project). Table 7 illustrates the sectoral breakdown of NAPA projects.

(quote from UNFCCC, 2008).

[25] Norwegian Church Aid. 2008. Occasional Paper. *Financing climate change adaptation in developing countries: Current picture and future possibilities.* Karoline Gaegstad Flam and Jon Birger Skjaerseth. Fridtjof Nansen Institute.

Table 3: Projects identified in national adaptation programmes of action, by sector

Sector	Number	Total cost (USD)
Agriculture/livestock/fisheries	104	269 692 234
Water resources	57	140 960 970
Coastal zone/marine ecosystems	34	95 671 300
Forestry	33	53 494 730
Health	31	40 043 000
Cross-sectoral	27	740 227 240
Terrestrial ecosystems/biodiversity	21	24 908 592
Early warning and forecasting	15	37 423 063
Energy	15	27 964 120
Fisheries	14	35 375 500
Infrastructure	13	16 881 631
Education	10	9 005 000
Disaster management	8	12 953 597
Tourism	2	1 250 000
Insurance	1	225 000
Total	**385**	**1 506 075 977**

Source: UNFCCC, 2008[26]

Table 4: Examples of adaptation actions according to type and nature of additionality

Type / Additionality	Capacity-building	Research and assessments	DRR and risk management	Specific interventions
Climate-proofing socio-economic activities	Develop and apply guidelines to climate-proof development (Uganda)	Research on micro hydropower production (Burundi)	Raise flood shelters to adapt to sea level rise (Bangladesh)	Increase water supplies to combat increasing drought (Comoros)
Expanding adaptive capacity to deal with future and not only current risks	Increase awareness of malaria prevention and treatment (Cambodia)	Research on drought-, flood- and saline-tolerant crop varieties (Bangladesh)	Strengthen early warning systems (Zambia)	Plant vegetation to reduce risks from storms (Cambodia)
Directly addressing observed impacts from climate change	Increase awareness of decision makers and communities about climate change impacts (Burundi)	Improve understanding of groundwater resources in the light of persistent drought (Mauritania)	Zoning for increased hazards from GLOFs (Bhutan)	Lowering of water levels in the Thorthormi Lake to reduce risk of a future GLOF (Bhutan)

Abbreviations: DRR = disaster risk reduction, GLOF = glacier lake outburst flood.
Note: Examples taken from national adaptation programmes of action.

Source: UNFCCC, 2008[27]

[26] UNFCCC, 26th November, 2008. *Investment and financial flows to address climate change: an update.* Technical Paper.

Table 5: Overview of financial mechanisms for climate change adaptations (unknown source)

Name and link	Type	Administered by	Areas of focus	Number of projects	Total funds disbursed to date (US$ millions)
Adaptation Fund	Multilateral	Adaptation Fund Board	Adaptation	0	$0.0
Clean Technology Fund	Multilateral	The World Bank	Mitigation - general	0	$0.0
Cool Earth Partnership	Bilateral	Government of Japan	Adaptation, Mitigation - general	0	$0.0
Environmental Transformation Fund - International Window	Bilateral	Government of the United Kingdom	Adaptation, Mitigation - general	0	$0.0
Forest Carbon Partnership Facility	Multilateral	The World Bank	Mitigation - REDD	0	$0.0
Forest Investment Program	Multilateral	The World bank	Mitigation - REDD	0	$0.0
GEF Trust Fund - Climate Change focal area	Multilateral	The Global Environment Facility (GEF)	Adaptation, Mitigation - general	591	$2,388.7
Global Climate Change Alliance	Bilateral	The European Commission	Adaptation, Mitigation - general, Mitigation - REDD	0	$0.0
International Climate Initiative	Bilateral	Government of Germany	Adaptation, Mitigation - general	128	$347.2
International Forest Carbon Initiative	Bilateral	Government of Australia	Mitigation - REDD	0	$0.0
Least Developed Countries Fund	Multilateral	The Global Environment Facility (GEF)	Adaptation	62	$47.5
MDG Achievement Fund – Environment and Climate Change thematic window	Multilateral	UNDP	Adaptation, Mitigation - general	16	$85.5
Pilot Program for Climate Resilience	Multilateral	The World Bank	Adaptation	0	$0.0
Scaling-Up Renewable Energy Program for Low Income Countries	Multilateral	The World Bank	Mitigation - general	0	$0.0
Special Climate Change Fund	Multilateral	The Global Environment Facility (GEF)	Adaptation	14	$59.8
Strategic Climate Fund	Multilateral	The World Bank	Adaptation, Mitigation - general, Mitigation - REDD	0	$0.0
Strategic Priority on Adaptation	Multilateral	The Global Environment Facility (GEF)	Adaptation	22	$50.0
UN-REDD Programme	Multilateral	UNDP	Mitigation - REDD	0	$0.0

And:

Table 6: Overview of the current and pledged financial resources for adaptation ($ mill)

	Estimated level of funding	Period	Nominal annual level of funding
Funding under the Convention			
SPA	50	GEF 3-GEF 4	
LDCF	172	As of 21 October 2008	NA
SCCF	91	As of 21 October 2008	NA
Adaptation Fund	400-1 500	2008–2012	80-300
	91	As of 31 October 2008	
Multilateral initiatives			
PPCR (World Bank)	240	2009–2012	60
GFDRR	11	2007–2008	5.5
Bilateral initiatives			
Cool Earth Partnership (Japan)[a]	1 000	2008–2012	200
International Climate Initiative (Germany)[b]	200	2008–2012	40
GCCA (European Commission)[c]	84	2008–2010	28
UNDP-Spain MDG Achievement Fund	22	2008–2011	5.5

Source: Porter G, Bird N, Kaur N and Peskett L. 2008. *New Finance for Climate Change and the Environment*. The Heinrich Boll Foundation and WWF, World Bank. 2008. *Trustee Report Financial Status of the CIF*. CTF/TFC.1/Inf.2.
Abbreviations: GCCA = Global Climate Change Alliance, GEF = Global Environment Facility, GFDRR = Global Facility for Disaster Reduction and Recovery, LDCF = Least Developed Countries Fund, MDG = Millennium Development Goal, PPCR = Pilot Programme for Climate Resilience, SCCF = Special Climate Change Fund, SPA = Strategic Priority on Adaptation.

[a] Of the overall USD 10 billion under the Cool Earth Partnership, Japan is earmarking up to USD 2 billion for adaptation to climate change and improved access to clean energy. It is assumed that the distribution among adaptation and clean energy is equal.

[b] <http://www.oecd.org/dataoecd/38/61/40633487.pdf>.

[c] <http://ec.europa.eu/development/policies/9interventionareas/environment/climate/climate_en.cfm>.

[27] UNFCCC, 26th November, 2008. *Investment and financial flows to address climate change: an update.* Technical Paper.

4.2 The Adaptation Fund

The Adaptation Fund represents the larges funding mechanism that was established to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.

The Adaptation Fund is financed from the share of proceeds on the clean development mechanism project activities and other sources of funding. The share of proceeds amounts to 2% of certified emission reductions (CERs) issued for a CDM project activity.

The Adaptation Fund is supervised and managed by the **Adaptation Fund Board** (AFB). The AFB is composed of 16 members and 16 alternates and meets at least twice a year (Membership as of May 2009 (72 kB)).

Upon invitation from Parties, the Global Environment Facility (GEF) provides secretariat services to the AFB and the World Bank serves as trustee of the Adaptation Fund on an interim basis. These interim institutional arrangements will be reviewed in 2011.

Opportunities for CABI: *While some funds cater to civil society (GEF Small Grants Programme), most funding will be channelled through the eligible Countries. Furthermore, the strategic direction of adaptation funding will target programme- rather than project work. This strategy is currently being strongly supported by the EU to maximize aid effectiveness in accordance with the Paris Declaration (UNFCCC, 2008). While all South Asian countries and almost all CABI member countries qualify for funding, CABI does not qualify for any direct funding. What needs to be done is for CABI to step up its bargaining position with the respective member governments' environment ministries by proposing suitable technical support in project development and implementation, both for CDM/mitigation oriented projects and for adaptation work. In Pakistan, this process was initiated by proposing "Conservation Field Schools" in the context of REDD projects and a number of other*

Approaches in Climate Change Adaptation

5.1 Assessment Methods

5.1.1 Climate Modelling

Regional climate models

Regional climate models (RCMs) are emerging tools that could provide more detailed predictions of future climatic conditions and, thus, support the understanding of climate change impacts at higher resolution levels. RCMs could also be useful in exploring local climate dynamics and, by extension, relevant adaptation options.

State of the art

GCMs, which are computer models that incorporate the basic physics and dynamics of the climate system and account for interactions between its various components, namely the atmosphere, biosphere, oceans, land and ice, have been the primary tools used for generating projections of climate change due to anthropogenic effects. The most advanced GCMs are capable of simulating the climate on a global scale and are known as (coupled) atmosphere–ocean general circulation models (AOGCMs). They provide a detailed, three-dimensional simulation of the circulations of the atmosphere and oceans.

The resolution of a typical AOGCM is limited by the computer resources required, and is typically in the range of 100 to 500 km. This is a key limitation to the use of AOGCMs for projections of climate change at the regional level, because significant differences in climate at this level can occur due to the presence of inland bodies of water, complex topography and coastlines, and other factors. In addition, AOGCMs are unable to describe extreme atmospheric events, such as hurricanes and tropical storms. Despite these limitations, the climate modelling community appears to recommend unanimously that methods be pursued to add detail to GCM simulations.

Adding finer detail to GCMs is an initial approach to modelling regional climate; in fact, available regional climate models are approximations of GCMs focused on the regional level. The fundamental assumption upon which RCMs are based is that, given large-scale atmospheric conditions, a limited-scale model with a good characterization of physical details (e.g. topography, land–water distribution, land-use patterns) and a less strongly parameterized description of climatic processes (e.g. convection) can generate realistic and dependable information consistent with large-scale models.

Different “regionalization” techniques have therefore been developed over the past decade or so to improve the regional information provided by AOGCMs, and to provide climate information at a fine scale. A number of techniques have been proposed for this “regionalization”. They fall in the categories outlined below:

High resolution experimentation This involves selecting short periods of time (“time-slices”) and modelling them at a higher resolution, which allows simulations to be conducted with a spatial resolution on the order of 50 km. This technique assumes that large-scale circulation patterns in both the course and the high resolution do not differ significantly. High-resolution experiments use the same algorithms, processes, and formulations used to reproduce current climate conditions at coarser spatial scales and, thus, some climatic processes may be

misrepresented at finer resolutions. Finally, although feedback effects are included from finer to coarser scales, they only apply to the local region under consideration, whereas it is known that feedbacks from different regions are interactive and should be accounted for.

Nesting techniques RCMs are mathematical representations of the atmosphere limited to specific regions of interest. RCMs need meteorological data from the boundaries of the domain under which they operate. Nesting techniques consist of using the output of a GCM (referred to as the "driving model") to provide "boundary conditions". Limitations to this technique derive from the fact that regional model simulations are affected by the systematic errors in the driving model. This technique requires high computational resources and data storage.

Statistical downscaling Empirical and statistical methods are used to downscale coarse resolution GCM outputs to finer resolution outputs that correspond to local and regional conditions. This can be done by, first, developing a mathematical model that relates large-scale climate information to regional and local variables; and, second, feeding the outputs from a GCM simulation into this mathematical model to estimate regional implications. An example of such a tool is the scenario generator (SCENGEN). This technique is limited because it is based on empirical models and not on models that describe the physical processes affecting the climate. In addition, it works under the assumption that the statistical relationships described for the present will remain valid in the future.

Modelling regional climate change is subject to several levels of uncertainty of differing nature, as follows:

(a) The uncertainty associated with the emission and corresponding concentration of forcing agents such as GHGs and aerosols

(b) The uncertainty resulting from the simulation of the transient climate response by AOGCMs for a given emission scenario. This uncertainty is associated with an imperfect knowledge and/or representation of physical processes, simplifications and assumptions in the models, and has both global and regional aspects

(c) The uncertainty relating to the regionalization of the AOGCM simulations, because different regionalization models provide different representation of local climates even under the same AOGCM forcing

It is also important to recognize that regional climate observations can be characterized by a high level of uncertainty, especially in remote regions and in regions of complex topography.

In order to improve the reliability of regional modelling, several technical activities have been undertaken, including:

(a) Better parameterization to ensure that the physics of higher resolution RCMs conform to local conditions

(b) Ensuring that RCMs can produce results consistent with observed climate. This depends on the accuracy of the GCM and on the quality of the regional model's representation of local features. Case studies are being conducted around the world to explore the question of how well RCMs are able to reproduce the driving data and observed climate, but more coordinated effort may be needed for better validations through improved models and climate observations

The application of RCMs in vulnerability and adaptation assessment and indeed of global climate models in general, remains a lively point of debate. Within national communications, almost all impact studies that followed a scenario-driven approach used regionalization techniques to obtain regional and local climate scenarios. The following is a list of the most widely used RCMs:

(a) PRECIS (Providing Regional Climates for Impact Studies) is a regional climate modelling system that can be applied to any area of the globe to generate detailed climate change predictions. Current applications include regional climate

simulations in China, India and South Africa

(b) HADRM3H is a regional model that has about a 50-km resolution and is forced at its lateral boundaries by a high resolution (150 km) atmosphere-only GCM. It has been used in the United Kingdom and southern Africa to examine local climate change scenarios for the future

(c) Canadian Regional Climate Model (CRCM), based on the MC2 (Mesoscale Compressible Community) GCM is currently being used to conduct simulations in two regions of North America

(d) ALADIN, based on a numerical weather prediction model, is being used by the Regional Centre Limited Area Modelling in Central Europe (LACE). The RCM has a horizontal resolution of about 20 km and is being used at a temporal scale of at least one year

(e) RegCM3 has been applied mostly in studies of regional climate and seasonal predictability around the world

(f) MM5 uses a 36-km domain that covers the continental United States and a 12-km resolution over the southeast United States.

Experiences in the application of RCMs are limited and lessons are slowly unfolding. Nevertheless, various experiences indicate that RCMs have a tendency to match up well in some regions and less well in others. For example, tests conducted using the CRCM for the winter season yielded high relative errors for the forecasting of precipitation rates in dry areas in North America; this was not the case when the model was applied to European conditions.

The appropriate role of RCMs in vulnerability and adaptation assessment ultimately depends on the questions that the models are able to address. In particular, a number of applications have shown that even the most sophisticated models still have severe limitations when it comes to generation of the type of information required in development planning. For development planning, models should provide future estimates of different climate characteristics, including their variability and extremes and not only values of mean temperature or precipitation, and at finer resolutions, which is associated with even higher uncertainty. With more time and resources, better models of future climate will no doubt be produced. It is unclear, however, how much improvement will be achieved and how soon. It is argued that the design of adaptation measures is unlikely to be influenced much by climate scenarios, at least in the short term.

Even given these limitations, however, it should be noted that GCM scenarios can be applied to usefully identify a range of uncertainties for the purpose of strategic policy-making. On a longer time frame, there is a need to understand stakeholders' demand for information relating to policy development and planning. Supplying this information requires development of risk assessment and risk management tools (such as probabilistic scenarios, not just RCMs), stakeholder identification of risk domains, and a wide array of tools to analyse decisions. Such multidisciplinary research and development is still lacking.

5.2.2 Participatory Assessment Approaches and tools Description, Origin, applied in. Country, strengths, weaknesses KK

General overview

The Intergovernmental Panel on Climate Change (IPCC) Assessment Reports (ARs) defines climate

Box 1. Definitions,
Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea level rise).
Climate impacts are consequences of climate change on natural and human systems.
Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, and its sensitivity and adaptive capacity.
Adaptation to climate change refers to adjustment in natural or human systems in response to actual and expected stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

change impact, vulnerability and adaptation assessment as the practice of identifying and evaluating the detrimental and beneficial consequences of climate change on natural and human systems, and identifying and evaluating options for adapting to climate change. The ARs also provides definitions of key aspects of assessment: sensitivity, impacts, vulnerability and adaptation (box 1)

There is a wide array of approaches, frameworks, methods and tools to assess impacts and vulnerability, and to prepare for adaptation, as well as many ways to categorize them. We will follow the outline proposed in the UNFCCC compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change – a web-based resource that provides key information on available frameworks, methods and tools, and their special features. It is designed to assist Parties and other potential users select the most appropriate methodology for their assessments of impacts and vulnerability, and development adaptation options. Following the structure of the compendium, this section considers broad frameworks and methods and tools (cross-cutting, multicultural methods and sector-specific).

1. Framework for assessment of impacts, vulnerability and adaptation

Framework refers to a combination of (a) approach (such as top-down or bottom-up) that prescribes an entire process of assessment and which may include a certain (b) method or methods (sequence of actions designed to achieve a prescribed result), which in turn might employ various (c) tools (such as computer climate models). Examples of vulnerability assessment and adaptation frameworks include: the IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations (the IPCC Guidelines), the United Nations Development Programme (UNDP) Adaptation Policy Framework (APF), and the national adaptation programmes of action (NAPA) guidelines developed in the UNFCCC process.

The approach to be followed depends on the scale of the assessment and the questions that the assessment is to explore. Vulnerability and adaptation assessment can be conducted on different scales – from a global to local – and address fundamental questions, such as:

(b) (a) What are the key long-term impacts of climate change?

(c) To what extent can the harmful effects of climate change be reduced through adaptation?

(d) What can a country or community do to adapt to climate change?

(e) How can adaptation policies best be developed and applied?

The choice of suitable approach, methods and tools depends on what question an assessment is focusing on, as well as a number of other issues, including the sector/system under consideration and time frame. Approaches typically fall into two major categories, namely: top-down (scenario-driven) and bottom-up (vulnerability-driven).

Top-down/scenario-driven approaches have been widely described in the IPCC Guidelines and elaborated in guidelines prepared for the United States Country Studies Program and the United Nations Environment Programme (UNEP) *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies.*

Taken together, these guidelines and the ways they have been applied have become known as the "standard approach" based on climate scenarios derived from general circulation models (GCMs), as well as on some consideration of socio-economic scenarios. The climate scenarios chosen were commonly applied to models of ecosystems, and to a variety of sectoral impact models designed to quantify the magnitude of the physical impacts on vulnerable sectors. Possible options to adapt to those future impacts were identified at the last stage of the assessment.

Studies using this approach (referred to in a number of sources as "first generation" of vulnerability and adaptation assessments) have an analytical thrust that emphasize the identification and quantification of impacts.

Key methods and tools used in this approach include various downscaling techniques for developing scenarios of future climate and socio-economic conditions, sectoral impact models, and sometimes tools for assessing and prioritizing adaptation options. The approach and tools are strong in biophysical aspects of impacts and certain types of dynamic interactions, but do not do

well in representing human interactions and local abilities to adapt. For example, crop impact modelling can yield information on the magnitude of potential impacts but sheds little light on the distribution of these impacts among local communities.

Bottom-up/vulnerability-driven approaches are oriented towards localized vulnerability. This type of approach (also called the "multi-stressors" approach) is increasingly considered the most appropriate. It centres on assessing current vulnerability to both climate related factors (e.g. climate variability, drought, flooding and extreme weather events) and non-climate factors (e.g. lack of resources, inadequate institutions and poverty) and examining current practices in adaptation. It also includes evaluation of vulnerability to future climate related risks (and involves key stakeholders in the evaluation process) and eventually leads to formulation of adaptation policies that strengthen adaptive capacity. The approach also addresses longer-term vulnerability to climate change, hence contributing to sustainable development. New frameworks are being developed (and tested), including the UNDP APF, and the NAPA guidelines.

Studies using this approach (referred to in a number of sources as "second generation" assessments) are more attuned to the local institutional, economic and productivity contexts, and are better able to represent local options and constraints than are scenario-driven studies. They are useful for developing specific strategies and in the implementation of policy. They are often limited, however, by lack of data (in terms of type and level of detail).

Key methods and tools used include stakeholder tools, risk assessment techniques and decision-support tools, which are strong in integrating information and accounting for dynamic interactions between human and natural systems but weak in addressing scale and magnitude. For example, community-level studies can yield information on how communities have managed to adapt to multiple local stresses (drought, poverty, etc.) but shed little light on how such experiences can be "scaled-up" or integrated over time and space.

The two approaches are not necessarily competing or exclusive. Studies using a vulnerability-driven approach can be conducted in parallel with or integrated in scenario-driven studies, and are designed to meet the needs of adaptation policy development. Moreover, no approach or type of approach is entirely adequate, and most methods can be used in a variety of contexts. For instance, any discussion of the future will rely on scenarios at some stage. Also, stakeholders should be involved at some stage in all assessments, even those that are top-down.

2. Methods and tools

The methods and tools used for vulnerability and adaptation assessment encompass a broad range of applications – from cross-cutting or multicultural (e.g. climate models, scenario-building methods, stakeholder analysis, decision-making tools) to specific sectoral (e.g. crop or vegetation models, methods for coastal zone vulnerability assessment).

The following paragraphs present specific tools and methods that have either been widely used or are likely to take a more prominent role in future vulnerability and adaptation assessments, based on emerging adaptation research results and a growing understanding of the links between vulnerability, impacts and adaptation.

Scenario methods and tools are mainly used by climate change analysts and decision makers asked to consider vulnerability and adaptation options in the context of different possible future conditions. The IPCC–Task Group on Scenarios for Climate Impact Assessment (TGCIA) *Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment* addresses this application generally, discussing a wide range of issues relating to the application of both climate scenarios and socio-economic baseline scenarios.

There are several methods and tools that can be used for downscaling climate data or developing socio-economic scenarios. The downscaling techniques can be used to produce small-scale climate data of the type often required by impact models and to develop future climate scenarios at the local and national scales. The approaches to socio-economic scenario construction are all part of larger frameworks but can be used separately. In practice, the process of developing scenarios depends on the nature of the planned assessment. None of the following is a "one size-fits-all" method/tool for developing socio-economic scenarios, but rather should be viewed as informing a necessarily ad hoc process.

Stakeholder analysis tools typically include a range of techniques that can be used to gain or account for on-the-ground perspectives – e.g. of highly vulnerable populations. They can also be used in processes aimed at untangling the sometimes competing perspectives of stakeholder groups. Some of the tools available are: agent-based simulation techniques, vulnerability indicators/indices, sustainable livelihood assessments, Delphi techniques, Expert judgement and stakeholder thematic networks. Much of the recent literature relating to incorporating adaptation into national planning contexts, as well as recent efforts in adaptation research, places emphasis on the use of such tools. They can be readily used in bottom-up processes to identify and assess the attractiveness of adaptation options. Some of these could also be considered decision-support tools. All are effective when used in the context of a stakeholder dialogue.

Decision-support tools encompass general analytical tools that assist analysts in making choices between adaptation options. They include cost–benefit analysis, multi criteria analysis, project screening/prioritization; decision matrices, environmental assessments and cost-effectiveness analysis. Some of these tools rely on a single monetary metric and focus on a single decision criterion (e.g. cost–benefit analysis). Others enable the user to define and incorporate more than one decision criterion (e.g. multi criteria analysis, tools for environmental assessment and management, and the adaptation decision matrix). Other tools seek to inform the larger policy decision questions, taking into account the institutions involved and affected when pursuing given adaptation options. Some are increasingly used within the context of NAPAs and adaptation research processes. These types of tools are used in bottom-up processes to identify and assess the attractiveness of adaptation options.

Sector-specific methods and tools, and tools for integrated assessment, mostly impact models, have been used in top-down/scenario-driven studies to assess impacts from climate change. They include crop models, water system evaluation tools, coastal resource tools, human health assessment methods and terrestrial vegetation tools. Some of the more recent tools have used integrated analysis and have expanded it to provide assessments of vulnerability in multiple sectors rather than just physical estimates of sector-specific impacts.

and/or systems due to future climate change. However, they are limited by the uncertainty inherent in the models and parameters, and by the fact that they are not able to represent local conditions well. Moreover, these tools are almost entirely limited to impact evaluation and do not lend themselves to evaluation of adaptation options.

Methodologies used in the disaster risk management (DRM) community can be grouped in the two categories: methodologies for risk assessment; and methodologies for assessment of past disaster damage and related needs.

The DRM community defines **risk assessment** the analysis of potential hazards and the evaluation of existing conditions of vulnerability that could pose a potential threat to people, property, livelihoods and the environment. It entails the quantitative and qualitative understanding of risk, its physical, social, economic and environmental factors, and its consequences. Risk assessment encompasses the systematic use of available information to determine the likelihood of certain events and the severity of their possible consequences. It is generally agreed that the process includes:

(a) Identifying the nature, location, intensity and probability of a threat
(b) Determining the existence and degree of vulnerabilities and exposure to those threats
(c) Identifying the capacities and resources available to address or manage threats
(d) Determining acceptable levels of risk.

The tools used by the DRM community vary from simple qualitative ones to quantitative ones. Some examples are summarized in box 3; other examples can be found in the guidelines developed by different international and national institutions and organizations.

2. Examples of methods and tools used in the disaster risk management community

Qualitative vulnerability and risk surveys: Examples include the Food and Agriculture Organization of the United Nations (FAO) and World Food Programme (WFP) assessment missions; and the Save the Children Fund–United Kingdom, Household Food Economy Approach

Database development and analysis using spreadsheets: Examples include the University of Pittsburgh Graduate School of Public and International Affairs, Interactive Intelligent Spatial Information System

Geographical Information Systems (GIS) and satellite technologies and mapping: Examples include the WFP–Vulnerability Analysis and Mapping Unit.

Vulnerability and Capacity Analysis (VCA): For example, as used by the Federation of Red Cross and Red Crescent Societies.

The insurance industry has developed advanced methodologies to assess risk to disasters. These are based on historical disaster databases to identify the dynamic aspects involved in vulnerability, providing the criteria to assign relative weights to different dimensions of vulnerability in risk assessment exercises.

In the DRM community, risk is assessed within the context of long-term preparedness and planning, and the approaches and tools required tend to rely on quantitative estimations. Such tools include computer modelling, databases and GIS and satellite technologies. In practice, these tools may be used to develop, for example, hydrologic stream flow models, risk maps, or a brief quantitative report of high risk groups. These approaches and tools are critical in providing information before analysts use on-site rapid appraisal techniques, and when an initial estimate of the number of people affected is needed during an emergency. They are also important given their capacity for prediction, insofar as they can assist decision makers in preparing and budgeting for future disasters by identifying potentially vulnerable areas and people.

Adaptive options, for example different levels of preparedness for drought response, can be weighed based on their ability to reduce vulnerability vis-à-vis the consequences of specific hazards. Often, adaptation is a cascade of interventions relating to timing (upstream before the hazard or downstream in response to a disaster) and level of effort. Thus, responses to a drought might be modelled as options ranging from diversification of household crop production (upstream, local) to supporting off-farm employment (upstream and downstream, often regional) and procedures for food relief (downstream, nationally organized).

Damage and needs assessments are set within an emergency relief framework approaches and tools are rapid, qualitative and rely on public consultations and stakeholder approaches at the national, regional and community levels. Such qualitative tools include rapid appraisals of people at risk of, for example, flood emersion or hunger. Good examples of this type of assessment are the ones conducted annually by FAO/WFP.

UNFCCC compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change

The UNFCCC compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change is a web based resource that provides users with key information about available frameworks, approaches, methods and tools, their application, special features of each, and information about how to obtain documentation, training, or publications supporting each tool.

It is organized in a way that allows existing adaptation analysis and decision frameworks and tools to be catalogued clearly. It is easy to use and does not prescribe or recommend methods or tools.

Below is a summary of the organization of the UNFCCC compendium, which can be accessed at <http://unfccc.int/program/mis/meth/index.html>.

Organization and examples of frameworks, methods and tools in the compendium

Complete frameworks and supporting toolkits

- IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations
- U.S. Country Studies Program (USCSP)
- UNDP Adaptation Policy Framework (APF)
- Guidelines for the Preparation of National Adaptation Programmes of Action (NAPA)
- United Kingdom Climate Impacts Programme (UKCIP) Climate Adaptation: Risk, Uncertainty and Decision Making

Cross-cutting issues and multi sector methods and tools

Application of Scenario Data in Impact and Adaptation Assessment

IPCC–TGCIA Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment

Climate downscaling techniques

- Statistical downscaling
- Statistical downscaling model (SDSM)
- Dynamical downscaling
- MAGICC/SCENGEN
- Weather generators

Socio-economic scenarios

Decision tools

- Policy exercise
- Benefit–cost analysis
- Cost-effectiveness analysis
- Multi criteria analysis (MCA)
- Tool for Environmental Assessment and Management (TEAM)
- Adaptation decision matrix (ADM)
- Screening of adaptation options

Stakeholder approaches

- Stakeholder networks and institutions
- Vulnerability indices
- Agent-based social simulation
- Livelihood sensitivity exercise
- Multi stakeholder processes
- Scoping
- Global sustainability Other multi sector scenarios tools

Sector-Specific Tools

Agriculture Sector Tools

- APSIM (agricultural production systems simulator)
- WOFOST
- ACRU (Agricultural Catchments Research Unit)
- Process Soil and Crop Models: CENTURY
- ORYZA 2000
- Information and Decision Support System for Climate Change Studies in South East South America (IDSS-SESA Climate Change)

  Decision support systems linking agro-climatic indices with GCM-originated climate change scenarios
- Process crop models: International Consortium for Application of Systems Approaches to Agriculture (ICASA) – International Benchmark Sites

Network for Agro technology Transfer (IBSNAT) Family of Models
- Process crop models: General-Purpose Atmospheric Plant Soil Simulator (GAPS 3.1)
- Process crop models: Erosion Productivity Impact Calculator (EPIC)
- Irrigation model: CROPWAT
- Process crop models: Alfalfa 1.4
- Process crop models: AFRC-Wheat
- Process crop models: RICEMOD
- Process crop models: GOSSYM/COMAX
- Process crop models: GLYCIM
- Economic models: Econometric (Ricardian-based) Models
- Economic models: Input-output modelling (with IMPLAN)

Water sector tools
- WaterWare
- Water Evaluation and Planning System (WEAP)
- RiverWare
- Interactive River and Aquifer Simulation (IRAS)
- Aquarius
- RIBASIM
- MIKE BASIN

Coastal resources tools
- Decision support models: COSMO (Coastal Zone Simulation Model)
- The South Pacific Island Methodology (SPIM)
- RamCo and ISLAND MODEL
- Dynamic Interactive Vulnerability Planning (DIVA)
- Shoreline Management Planning (SMP)

Human health sector tools
- MIASMA (Modelling Framework for the Health Impact Assessment of Man-Induced
  Atmospheric Changes)
- Environmental Burden of Disease Assessment
- CIMSiM and DENSiM (Dengue Simulation Model)
- UNFCCC Guidelines: Methods of Assessing Human Health Vulnerability and Public Health
  Adaptation to Climate Change
- LymSiM
- Mapping Malaria Risk in Africa (MARA) Low-end Information Tool (LITe)

Terrestrial vegetation sector tools
- LPJ (Lund-Postdam-Jena Model)
- IBIS (Integrated Biosphere Simulator)
- Medrush Vegetation Model
- Century
- MC1
- IMAGE (Integrated Model to Assess the Greenhouse Effect)
- AEZ (Agro-ecological Zones) Methodology
- CASA (Carnegie-Ames-Stanford Approach) Model
- TEM (Terrestrial Ecosystem Model)

Case Study: Adaptations to CC in Pakistan

6.1 Vulnerability and adoptions to climate change in the Barani areas (Greater Thal region) of Punjab

Acknowledgements

We are grateful to all those who guided us in conducting this survey. This study was made possible with the help and collaboration of many people including villagers, Government institutions and NGOs working in the study area.

The cooperation and facilitation of the National Rural Support Programme (NRSP), especially Regional Programme Manager, Mianwali region was very appreciable.

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Introduction

The Barani Areas [Greater Thal] are the least developed and most vulnerable regions to climate change and variability in Pakistan. The Greater Thal, including Mianwali, Bhakkar, and Khushab districts is particularly vulnerable because of the dominance of rain-fed rather than irrigated agriculture for food production.

Climate variability creates risks in many climate sensitive sectors such as in agriculture, livestock, and water resources. Climate variability and extremes also affect the welfare and livelihoods of rural populations. The impact of increased temperature from global warming and reduced and variable precipitation resulting from climate change is expected to reduce agricultural production, depress crop yields and put further pressure on marginal land holdings.

This case study was designed to study the exiting practices of the community towards climate change. In this study, we also aim to scope vulnerability and adaptations to climate change by assessing awareness and knowledge for adaptive capacity of the people in the study area.

Therefore we examined:

1. What are the climatic changes over the past 30 years?
2. How did these changes affect livelihood strategies in agriculture?
3. What has improved? Why? What deteriorated and how?
4. Is there awareness about CC?
5. Do Community Based Adaptation strategies exist?
6. What do people envision in the future to happen

The resulting output of the vulnerability assessment is the identification of trends in present and future vulnerability of the agricultural livelihood systems and the potential of future adaptation to climate change and variability in the Barani Areas of Punjab.

Study objectives

Barani Areas are the region most vulnerable to the adverse impacts of variability and extreme events that result from climate change. On the other hand, mechanisms for coping and adapting to these adverse effects of changing climate are weak or lacking.

In order to bridge this gap, CABI SA, under *Desk Study on Climate Change in Pakistan*, as part of the overall Review, aims to deal with the identification and analysis of the vulnerability and. adoptions.

The study objectives are:

- to conduct a vulnerability and adaptations assessment in the Barani Areas of Punjab.
- to identify entry points to support future planning of adaptation activities to climate change
- to examine the impacts of changing climate and climate variability on the evolution of agricultural production system.

As part of the assessment exercise, we made visits to collect information from key institutions. Information gathered from the assessment exercises was combined with survey data from the institutional visits to scope the regional context.

Based on our findings, we propose recommendations that thereby could increase capacity to adapt to climate change.

Methodology:

The methodology of this case study was based on semi-structured interviews and focus group discussions, according to Checklist for CBA to CC case study, as well as observations, transect walk and other associated participatory tools and methods.

The geographic scope of the study was typical of the agro-ecological zones of the Greater Thal regions of the Punjab.

The information in this report is based to a great extent on primary data collected during a ten-day field survey in the Rawalpindi, Chakwal, Mianwali, Bhakkar, and Khushab Districts of Punjab in August 2009. The report is supplemented by secondary data collected in the field.

The districts of Punjab were selected as a case study area for a combination of reasons. Due to its extreme physical environment, these districts of Punjab provide a unique laboratory for the study of natural hazards and the interaction between hazards and communities.

Semi-structured interviews and group discussions, especially with village elders, were carried out in 10 villages of the said districts. Qualitative data were collected through one on one semi-structured interviews and group discussions with villagers. The information was verified and complemented by interviews with key informants in research, government, and non-government institutions. The villages were selected in collaboration with the National Rural Support Programme and following discussions with key informants in the field.

Introduction of Barani area (Greater Thal region)

Following information about Greater Thal region is self explanatory.

Table 1 **General Information**

Total area	3.50 (Million hectares)	
Cultivated area	2.15 (Million hectares)	
Irrigated	1.18 (Million hectares)	
Rain fed	0.98 (Million hectares)	
Cultivable Waste	1.34 (Million hectares)	
Major Districts:	1-	Khushab.
	2-	Mianwali.
	3-	Bhakkar
	4-	Layyah
	5 -	Muzaffargarh
Average Rainfall:	150 to 350 mm/annum.	

Figure 1 **Agro ecological zones**

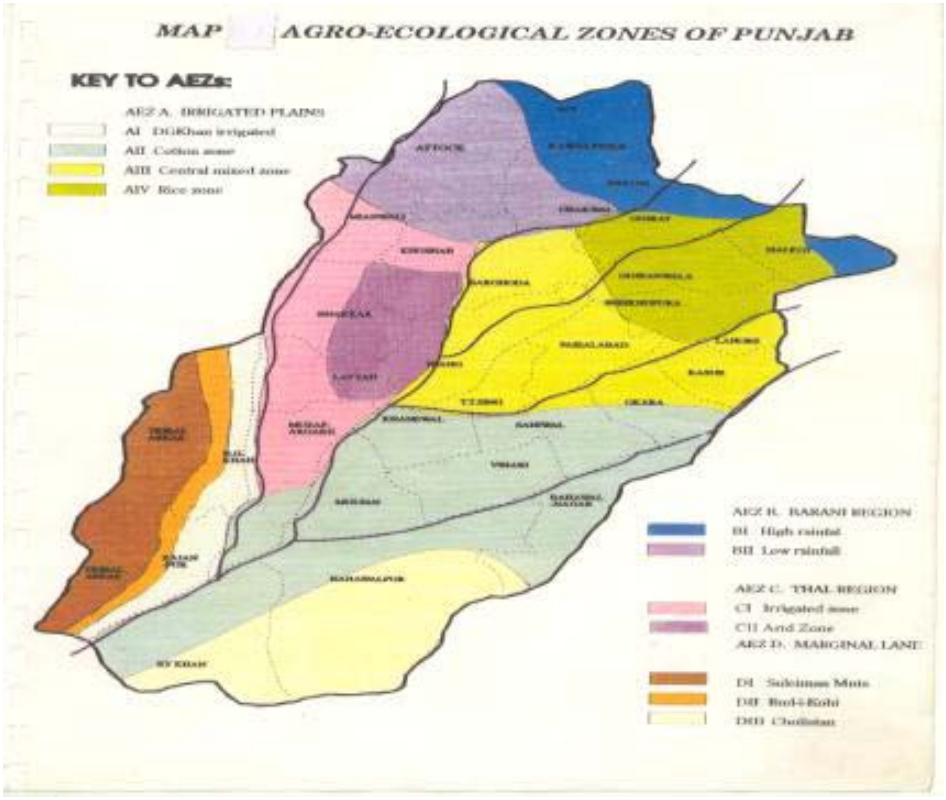

Figure 2

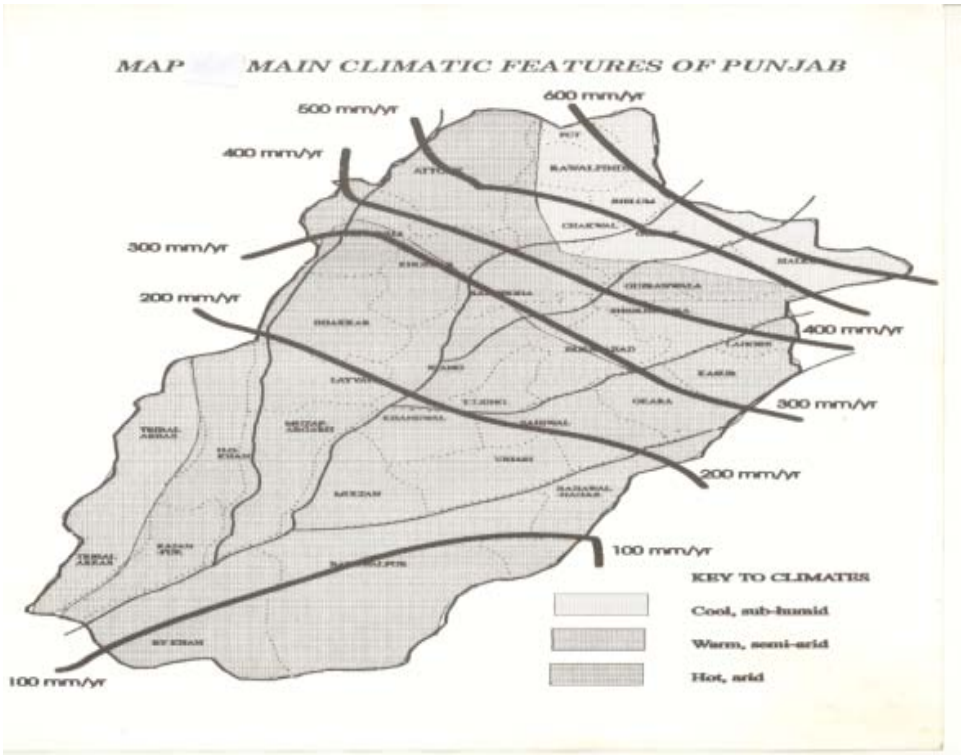

Table 2: Major Crops of Arid Zone (Thal Region)

Name of crop	Area in Punjab (M. Acres)	Area in Arid Zone (M. Acres)	Percentage of Punjab
Wheat	(15.00)	(2.00)	14%
Chickpea	(2.20)	(2.00)	88%
Mungbean	(0.45)	(0.38)	84%
Guar	(0.33)	(0.30)	95%

Mianwali District

Mianwali district consist of 3 Tehsils namely Isa Khel, Mianwali and Piplan. The areas falling under the Tehsil Isa Khel are mostly Barani and undulating. Area in the Northern side of the Tehsil is mountainous which is devoid of vegetative cover. Area of Tehsil Piplan and Mianwali are partly irrigated from Thal canal irrigation system whereas, remaining areas is either irrigated by tube wells or Barani Agriculture is in practices where the sand dunes are not in command of canal water and Tube well irrigation supply.

Climatic Profile (Now and 30 years Back)

Rainfall

See rainfall data given in appendix-2-4

Temperature

See detail temperature data given in appendix-I

Floods

No flood was seen after 1993. Thirty years back in 1964, 1976, 1992 and 1993 the flood destroyed the crops and houses in the area.

Natural Resources and Land use management

- **Agriculture Current situation**

Wheat, Maize, Cotton, Mong, Bajra, Juar, Potato, Onion, Rice and some orchards are the crops grown in the area. Now the variety of cotton is changed like people cultivating BT-121 and other improved varieties of crops which produce more yields. The agriculture mechanization brings changes in the lifestyle and living standards.

30 years back situation

Wheat, Pulses (Channa), Bajra, Juar and Jo-Jo were cultivated in the past. The people have tough life in the area. Before 30 years mostly desi cotton and local wheat was grown in the area.

- **Forestry**

Thirty years back almost 90% of the hills were covered with forest species like Bar, Pulai, Gorgora, Oack and Kaho. Now only 20% of the hills are covered with forest. The Govt. planted forest near the Chashma Barrage. The hillside of the forest is owned by the Govt. but people have free access for fuel wood collection. There is no proper management for fuel wood collection in the area.

- **Livestock**

Thirty years ago they have only sheep, goat and local cows. They feed their livestock's in the nearby rangelands / forest through free grazing. Currently more than 85 % people have improved breeds of cows, sheep and goats. The sheep and goats are free grazed in the area nearby houses while the cows and buffalos are feed at home.

- **Rangeland**

Rangelands are owned by the Govt. and some are individual ownership. Currently the people are cultivating the fodder crops in their fields for their livestock. In the past 30 years the

people were mostly dependent on the nearby rangelands as there was no restriction of fodder and fuel wood collection from the hillside. But now all the hills are barrens. There is no proper management system for these rangelands.

- **Water**

Mostly people have tube wells and pipe irrigation system developed through community participation program of NRSP. The rain fed area is cultivated and depends on the rainfall only. 30years back the animals like bull and camel were the source of cultivation and land levelling etc.

In the past mostly people were dependent on rainfall for their agriculture and domestic need. Rod Kohi stem was here in the village. After introduction of tube wells and pipe irrigation system the system of Rod Kohi and ponds was eliminated.

- **Land**

In the past 30 years back 95 % of the people have ownerships and utilized their land by themselves. Land holding was big in comparison to current situation. The land was divided into the families therefore now the lands holder is less as compare to 30 years back. Before 30 years 85 % of the areas were Barani / Rain fed but now 60 % of the area is irrigated and the remaining is rain fed. Due to decreasing land holding the agriculture intensification is increased in the area.

Livelihood portfolio

30 years back 100 % of the people livelihood depended on agriculture and livestock. Currently remittances and govt. / private services are also the second source of livelihood. For off farm business people are migrated to central Punjab etc.

Bhakkar District

This District was established on 01-07-1982. It comprises of Four Tehsils namely, Bhakkar, Kallurkot, Darya Khan and Mankera. Bhakkar District is surrounded by District Mianwali on Northern side, District Layyah on Southern, District Khushab and Jhang on Eastern and District Dera Ismail Khan on Western side.

The total area of the District is 20.05 lac acres out of which 17.03 lac acres are cultivated, out of these 7.05 lac acres are irrigated. The Government has established a Gram research Sub-Station, Arid Zone Research Institute (Thal Zone), Live Stock Experimental Station, Rakh Ghulaman, Four Agricultural Farms & a Drip Irrigation System Farm in the District.

Table 3 **General Information**

1	Population	8, 82,782
2	No. of Villages	636
3	No. of Union Councils	42
4	No. of Tehsil	4
5	No. of farm Families	72,578

Classification of Soils

The District is a part of Main Thal tract. The land is situated in valleys called Pattees (inter dunes valleys) and dunes. The 70-75% reported area of the District is covered by sand dunes. The inter dunes valleys are the only productive part of land resource.

The river Indus is good source of canal water rich in fine clay and silt particles and also supplemented by Calcium, Magnesium and Potash, contributes to build-up of fertility and improving its physical condition.

Katcha area is more productive followed by the area irrigated by the canal system, which is the good management of the soil, the inter dunes valleys arefairly productive.

Source of irrigation

Canal, Tube wells and Dug Wells constitutes the source of irrigation of crops, 38% of the total area is irrigated by these means, mainly by canals. The remaining 62% of the cropped area is farmed under Barani condition. Area irrigated by Tube wells is increasing day by day replacing well irrigated area:-

Canal Irrigated area	=	3, 44,371 Acres
Tube wells Irrigated area	=	3, 61,509 "
Well Irrigated area	=	12,402 "

Cropping system

There is no specific cropping system for the entire District. The appropriate cropping system depends upon the soil type, its potential, water resources, distance from the market and the investment capacity of the farmer himself. Wheat and Gram during winter and Cotton, Guara, Mung and Groundnut during summer were flourished. Sugarcane is also cultivated in Katcha area and in canal irrigated area. Vegetable, Melons and Fruit plants are also cultivated. Lucerne suits better as fodder crop. The crop rotations generally being followed are:

1	Wheat	-	Cotton	-	Wheat
2	Cotton	-	Sugarcane	-	Wheat
3	Wheat	-	Mung	-	Wheat
4	Gram	-	Fallow	-	Gram
5	Wheat	-	Guara	-	Wheat.

Natural Resources and Land use management

Cropping intensity

Cropping intensity varies from 50% to 150%. Over all cropping intensity of the District is 100%.

Major crops

Guara, Mung, Sugarcane and Cotton are major Kharif crops, Gram and Wheat are grown during Rabi season. Area and yield per acre of these crops varies widely depending upon the weather conditions.

Agriculture;

Wheat, Channa (88%), Guara and Bajra Maize, cotton are the major crop of the area. Farmer getting one crop annually. Different varieties were cultivated like Yellow Channa, etc.

30 years back mostly Pulses (Channa,) Guara Bajra, Moot were cultivated in the area. The area was totally dependent on rainfall. Before only one variety was cultivated i.e. black Channa.

Soon Valley Khushab District

Climatic Profile

No flood was seen after 1993. 30 years back in 1964, 1976, 1992 and 1993 the flood destroyed the crops and houses in the area.

Socio-Economic Profile

Livelihood portfolio

30years back 100 % of the people livelihood depended on agriculture and livestock. Currently remittances and Govt. / private services are also the second source of livelihood. For off farm business people are migrated to central Punjab etc.

Adaptive research farm Koror (Layyah)

Adaptive Research Farm Koror is one of the eight farms of Punjab, where research was started in May, 1988. The main aim to establish the Adaptive Research Farm at Koror (Layyah) is to conduct trails under Thal ecological conditions at Research Farms as well as on the farmer's fields (out reach trails).

Adaptive Research is one wing of Agriculture Extension, which aims at devising site-specific technology package for increasing Agricultural production. It helps to modify the results of research into suitable form before transmitting to the farmer's community. Keeping in view their local Agro-climatic and Socio-economic conditions, it bridges up the gap among research findings, farmer's achievements and extension. Its areas are 26.6 hectares. The comprising districts of Adaptive Research Farm Koror (Layyah) are Layyah, Bhakkar, Mianwali and Muzaffargarh.

Agro ecological position of agriculture farm Koror Thal zone

Soil, volume and quality of water and climatic conditions are the governing elements of plant culture in an area. In Thal areas the climatic is very hot and it is located in semi arid-region. The temperature may increase up- to 46 C^{O} in summer. While in winter, night temperature may fall up to 2 C^{O}

Altitude	Latitude	Longitude		
513 m		30-57	N	70-57 E

Result and discussions:

Climate change scenarios

The Study point out that climate change over much of the Greater Thal has implications for present and future vulnerability. The Study indicates that climate show an increase in average temperature. Precipitation is highly variable on spatial and temporal scales.

As indicated by people, rainfall changes in the area are relatively high, especially when compared with current rainfall variability. Seasonal changes in rainfall are expected to be large. Great uncertainty exists in relation to rainfall changes.

Predicted climate change

In whole region, awareness and knowledge on changes in climate is lacking. However, it can be said that a general increase in the intensity of drought and/ or rainfall variability events, is expected. Rainfall may well become rarer and remains speculative. In the Greater Thal extremes of low rainfall events occurring once every 10 years are feared to increase. Dry extremes are predicted to be severe. The net effect is higher probability of season failure to crops due to that rainfalls are increasingly unpredictable

Vulnerability to climate change

The Greater Thal is one of the most vulnerable regions to climate change and variability in Pakistan. Most population is vulnerable to extreme events, which leave poor household's livelihood exposed, and therefore highly vulnerable to the negative impacts of climate change.

Who is vulnerable?

The present study reveals that vulnerable people generally have a variety of alternatives to increase their adaptability and decrease their risk in times of stress and shock; however, economical and social pressures can limit choices. Impacts of emergent changes are usually felt unequally throughout the community. The severity of impacts depends on resource availability and on the capacities of individuals and communities to respond to climate variability. It has been observed that although various communities may face similar risks, they may not be equally vulnerable.

In the Greater Thal drought cycles are known to create new livelihood patterns. When drought cycles persist, many of the poor households move to urban cities

Climate change impacts on livelihood

When compared across region, land lords are least vulnerable to access to physical assets and development of human and social capital. There are high rates of poverty in whole region and there exists weak social structures among poor populations. In the vulnerability and adoption context, poverty and inequality worsen exposure to climate change.

Resilience to climate impacts

A great desire exists among people that resources should be mobilized within the region, to strengthen the adaptive capacity of vulnerable people.

Coping mechanisms and risk management

The expansion of adaptive capacity through development and capacity building will avoid impacts from climate change. Already some coping mechanisms exist and are currently implemented through projects from big farmers, NGOs and Government agencies.

The expansion of agricultural cultivation in the region is now forcing livestock holders to change their traditional lifestyle. Farmers can't keep maximum numbers of livestock as a necessary buffer against the impact of drought.

Adaptive capacity of the population needs to be increased.

Adaptations to reduce vulnerability

Adaptation is defined as adjustments in social or economic systems made in response to existing or anticipated climate changes. Adaptive capacity is the ability to cope with resulting impacts of climate change.

In the Greater Thal, people are uncertain regarding the direction and magnitude of climatic changes; therefore they expect adaptive capacity to vary among diverse socioeconomic groups. This implies that those with the least capacity to adapt are generally the most vulnerable to climate variability and change impacts.

Assessment of vulnerability

Because of the complex nature of the climate change issue, a holistic assessment is required in order to better understand the impacts of climate change on household livelihoods and adoptive strategies for influences from technological and impact of climatic changes.

Social inequality and marginalization are among the most critical determinants of vulnerability. Different people, groups and places within region differ in their ability to adapt

Agriculture and Food security

The prevalence of climate-sensitive livelihood systems, chronically high levels of vulnerability, and a highly variable climate make persistent food insecurity a regular occurrence in the Greater Thal.

Since much of the region is subject to rain fed agriculture, expansion of cultivation and diversification of land-use activities put increased burden on the ecological and economic integrity of lands.

Changes in land suitability to various production systems due to climate change may also reduce agricultural productivity. For instance, some areas which at the moment mainly produce food crops (wheat, beans, etc) may shift to cash crops such as cotton. Especially, the most significant shift is likely to affect Guara production.

Such a major shift would threaten food security. However, the extent of such change and the magnitude of its impact will depend on other factors besides climate change.

The intensification of agricultural systems in many places may force pastoral communities to face with the challenges.

Water resources

Increased temperatures due to global warming will most likely result in increased evaporations rates leading to increased water losses from open reservoirs. Ground water recharge capacity is also likely to decrease with lowering of water tables. Where surface and groundwater is the main water resource, this scenario will likely be making worse by drought conditions.

Grazing areas for pastoralists may be severely affected by increased temperatures as they could shrink drastically in size or disappear altogether. However, we can speculate that the magnitude of the impacts will depend on how the changes are managed and the level of the community's preparedness

Technology and Governance

It is difficult to disaggregate climate effects from other factors such as technological change and economic development. Technological advances are providing tools and opportunities to enable more effective action for adaptation to climate variability and change. However measuring the actual benefits of a technological innovation is generally not possible until years after it has matured in its development.

At present, there is the lack of effective institutional arrangements to facilitate the analysis and systematic integration of relevant climate data

Appendixes

Appendix 1:

Climatic Profile Mianwali

Mianwali Average Temperatures

Month	2004		2005		2006		2007		2008	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Jan	18.60	6.46	20.12	9	9.29	5.00	17.4	6.30	16.7	6.4
Feb	21.70	10.85	17.76	8.76	25.00	11.00	21.5	10.40	20.8	11.40
March	25.00	14.65	29.61	15.45	27.00	14.00	27.0	14.00	27.00	13.00
April	37.00	21.30	33.93	15.6	36.00	19.00	35.40	20.96	37.0	20.0
May	42.60	29.30	35.19	21	42.00	35.00	42.51	29.50	41.0	21.0
June	43.97	31.10	42.10	24.33	40.00	27.00	41.95	30.95	42.00	19.00
July	39.60	29.96	36.22	24.87	38.00	29.00	37.00	29.15	37.00	16.00
August	33.50	23.95	37.70	25.25	37.00	30.00	35.35	23.46	35.00	22.00
Sept.	36.30	25.80	37.50	23.33	37.00	25.00	34.97	25.35	35.0	25.30
Oct	33.10	22.76	32.66	14.66	33.00	13.00	31.50	22.16	31.0	22.60
Nov.	25.91	17.01	25.16	9.33	26.00	10.30	24.0	15.1	24.0	15.0
Dec.	18.01	9.98	21.16	2	20.00	10.00	17.35	9.75	17.40	8.75

Source: Agriculture Extension department Mainwali

Appendix 2

Rain fall Tehsil Isa Khall, Mianwali

Month		Rainfall received in MM					
	2002	2003	2004	2005	2006	2007	2008
January	-	20	25	17	16	-	30
February	29	40	46	92	10	121	16
March	16	21	-	161	49	66	-
April	6	22	43	8	11	6	72
May	-	10	17	6	27	-	53
June	-	17	66	6	-	106	75
July	-	94	20	60	27	77	176
August	38	102	138	108	64	22	64
September	21	12	16	61	-	40	25
October	-	-	-	-	-	-	-
November	-	3	-	-	4	-	-
December	30	1	60	-	6	05	25

Source: Agriculture Extension department Mainwali

Appendix 3

Rain fall Tehsil Mianwali

Month	Rainfall received in MM						
	2002	2003	2004	2005	2006	2007	2008
January	-	12	52	31	13	-	13
February	93	54	38	119	16	179	30
March	26	110	-	117	49	103	-
April	5	21	65	12	19	11	88
May	5	25	2	32	40	-	42
June	7	25	53	-	4	70	39
July	20	125	26	129	88	168	117
August	79	128	105	117	131	72	240
September	15	53	18	22	-	90	100
October	3	-	-	-	-	-	60
November	-	12	-	-	22	-	-
December	32	10	59	-	21	02	-

Source: Agriculture Extension department Mainwali

Appendix 4

Rain fall Piplan

Month		Rainfall received in MM					
	2002	2003	2004	2005	2006	2007	2008
January	-	3	17	18	12	-	02
February	53	27	101	92	-	150	14
March	-	-	-	60	19	38	-
April	-	5	23	15	-	10	64
May	-	11	6	68	16	-	15
June	7	30	51	-	-	73	57
July	-	30	35	66	46	62	61
August	50	58	52	86	92	75	172
September	21	70	-	19	-	25	69
October	-	-	-	-	-	-	50
November	-	-	-	-	9	-	-
December	17	-	33	-	5	-	-

Source: Agriculture Extension department Mainwali

Appendix 5

Bhakkar

Bhakkar Land Utilization

Particulars	TEHSIL WISE AREA ACRES				Total
	Bhakkar	Darya Khan	Kallurkot	Mankera	
Total area	418476	343097	414379	829707	2005659
Forest area	9652	7121	2430	95159	114362
Culturable waste	21016	9544	24995	7211	62766
Unculturable waste	43982	19812	25594	36124	125512
Cultivated area	343826	312620	357360	689213	1703019
Sailaba	2600	415	1076	-	4091
Barani	86924	183289	91420	631415	993048
Irrigated	254302	128916	264864	57798	705880
Canal Irrigated	146171	71230	110326	16644	344371
Tube well Irrigated	108131	57686	154538	41154	361509

Source: Barani Research institute Bakkar

Appendix 6

Bhakkar Rainfall Pattern

Month	Rainfall received in MM					
	2003	2004	2005	2006	2007	2008
January	6.5	20.0	37.0	4.0	0	3.0
February	30.0	13.1	53.0	9.0	128.0	33.0
March	35.0	-	25.0	15.0	74.0	5.0
April	3.0	3.0	24.0	2.0	7.0	
May	10.0	-	2.0	13.0	2.0	
June	-	20.0	-	23.0	18.0	
July	56.0	48.0	137.0	15.0	85.0	
August	150.0	80.0	50.0	95.0	6.0	
September	22.0	35.0	19.0	-	31.0	
October	-	2.0	-	15.0	0	
November	-	-		19.0	0	
December	-	17.0		8.0	3.0	
Total	313.0	238.1		218.0	354.0	

Source: Barani Research institute Bhakkar

Appendix 7

Tehsil Kallurkot Rainfall pattern

Month	Rainfall received in MM					
	2003	2004	2005	2006	2007	2008
January	6.0	41.0	54.0	12.0	0	7.0
February	32.0	11.0	72.0	5.0	127.0	27.0
March	18.0	-	92.0	45.0	50.0	6.0
April	3.0	33.0	19.0	6.0	4.0	-
May	14.0	-	10.0	16.0	0	-
June	81.0	94.0	5.0	8.0	34.0	
July	71.0	79.0	141.0	29.0	55.0	
August	68.0	127.0	41.0	106.0	51.0	
September	33.0	43.0	53.0	7.0	83.0	
October	-	12.0	-	9.0	-	
November	-	3.0	-	23.0	-	
December	-	9.0	-	16.0	3.0	
Total	326.0	493.0	487.0	282.0	407.0	

Source: Barani Research institute Bakkar

Appendix 8

Tehsil Mankera Rainfall pattern

Month	Rainfall received in MM					
	2003	2004	2005	2006	2007	2008
January	8.0	31.0	74.0	1.0	0	14.0
February	39.0	1.0	64.0	18.0	69.0	22.0
March	20.0	-	16.0	23.0	48.0	2.0
April	-	3.0	17.0	1.0	-	-
May	-	4.0	5.0	-	18.0	-
June	11.0	64.0	-	36.0	36.0	
July	155.0	12.0	254.0	36.0	78.0	
August	130.	65.0	48.0	36.0	-	
September	21.0	16.0	7.0	-	12.0	
October	-	-	-	11.0	3.0	
November	-	-	-	15.0	-	
December	-	12.0	-	24.0	1.0	
Total	384.0	416.0	485.0	201.0	265.0	

Source: Barani Research institute Bakkar

Appendix 9

Bhakkar Temperatures

Month	2003		2004		2005		2006		2007		2008	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Jan	15.6	3.5	17.87	4.91	16.32	2.70	18.29	2.58	18.35	2.80	17.61	1.74
Feb	21.0	5.2	22.34	7.65	16.46	6.35	24.42	8.96	18.92	7.67	21.13	5.03
March	22.0	10.0	31.2	12.54	24.50	12.19	25.67	11.22	22.90	11.25	31.51	12.74
April	30.5	15.3	36.43	17.86	32.66	14.20	35.20	16.56	36.04	17.83	32.5	16.6
May	36.5	19.6	40.06	21.03	35.77	19.03	41.13	23.74	35.96	22.0	39.12	20.96
June	40.0	23.5	39.06	23.93	42.10	24.33	39.26	23.70	38.76	25.20	39.96	26.04
July	35.2	25.5	38.87	25.77	36.22	24.87	38.22	26.91	36.48	25.30		
Aug.	36.15	24.96	33.38	24.74	37.70	25.25	35.58	24.67	35.96	25.70		
Sept.	35.0	22.9	34.3	21.86	35.70	22.60	33.9	22.53	36.03	24.00		
Oct.	32.06	14.29	29.03	14.48	32.38	15.58	32.83	17.16	32.39	15.26		
Nov.	26.4	8.4	24.06	9.46	25.8	8.5	22.63	11.76	26.66	11.50		
Dec.	20.32	4.58	20.93.	5.03	20.38	1.67	18.03	5.54	19.22	4.87		

Source: Barani Research institute Bhakkar

Appendix 10

Bhakkar area production and average yield of crops for the year 2003-04 to date.

Sr.No	Year	Name of Crop	Area (A)(000)	Prod. (000 Tons)	Average yield per acre (Kg)
		Guara	165.000	035.470	215.000
1	2003-04	Gram	1004.057	152.616	152.000
		Wheat	337.200	306.177	908.000
		Lentil	000.950	000.140	150.000
		Oil seed	004.859	000.923	190.000
		Cotton	010.500	011.865 (000 Bales)	001.130 (Bales)
		Sugarcane	050.200	943.760	18800.000
		Mung	205.300	041.060	200.000
		Guara	185.000	000.032	176.000
2	2004-05	Gram	1002.150	400.860	400.000
		Wheat	341.460	396.093	1160
		Lentil	000.825	000.127	155.000
		Oil seed	004.507	000.878	195.000
		Cotton	012.450	013.944 (000 Bales)	001.120-(Bales)
		Sugarcane	057.200	1079.936	18880.000
		Mung	205.300	040.854	199.000
		Guara	160.225	000.028	176.920
3	2005-06	Gram	1001.290	170.219	170.000
		Wheat	342.250	403.855	1180.000
		Lentil	000.835	000.175	210.000
		Oil seed	005.270	001.264	240.000
		Cotton	13250	015.900 (000 Bales)	001.020 (Bales)
		Sugarcane	062.285	1185.906	19040.000
		Mung	210.188	044.139	210.000

		Guara	163.270	029.388	180.000
5	2006-07	Gram	1015.270	297.776	270.000
		Wheat	362.160	461.869	1160.000
		Lentil	000.835	001.924	215.000
		Oil seed	006.710	001.761	245.000
		Cotton	015.400	19.857 (000 Bales)	1.28 (Bales)
		Sugarcane	067.500	1290.600	19120.000
		Mung	248.570	101.913	410.000
		Guara	165.000	032.010	194.000
6	2007-08	Gram	1017.000	122.04	120.00
		Wheat	374.130	351.682	940.00
		Lentil	000.845	0.200	237.00
		Oil seed	006.885	1.735	252.00
		Cotton	20.300	-	-
		Sugarcane	055.500	-	-
		Mung	249.320	-	-
		Guara	-	-	-

Source: Barani Research institute Bhakkar

Appendix 11

Meteorological data 2007-08 of Koror zone

Month	Mianwali			Bhakkar			Layyah			Muzaffargarh		
	Temperature C°		Rainfall (mm)	Temperature C°		Rainfall (mm)	Temperature C°		Rainfall (mm)	Temperature C°		Rainfall (mm)
	Min	Max		Min	Max		Min	Max		Min	Max	
Jul-07	27.60	36.0	168	25.30	36.48	85	27.45	40.03	17	44.5	27	27
Aug-07	26.20	37	72	25.70	35.96	51	27.74	39.93	-	39	26	22.75
Sep-07	24.40	35.80	97	24	36.03	19	25.33	38.5	-	40.5	21	9.75
Oct-07	16.70	34	-	15.26	32.39	-	15.56	34.66	-	37	13	-
Nov-07	10.98	28.4	2	11.50	26.66	-	11.10	29.43	-	33	10.05	-
Dec-07	5.90	19.40	-	4.87	19.22	-	6.83	21.93	-	24.8	5.8	4.75
Jan-08	1.20	17.90	-	1.74	17.61	7	2.00	19.29	-	21.7	0	7.75
Feb-08	5.0	21.40	30	5.03	21.13	33	4.72	22.41	32	30.5	0.6	-
Mar-08	15.20	33.00	-	12.7	31.51	5	14.90	31.06	10	36.2	11.8	-
Apr-08	18.20	33.10	64	16.6	32.5	40	18.8	35.56	33	41.0	15.5	25
May-08	24.02	39.5	42	20.90	39.12	6	29.51	40.12	30	44.2	20	8.75
Jun-08	27.7	40.00	39	26.0	39.96	47	28.43	43.46	-	27	43	3.5

Appendix 12

Area (acres) of crops of Koror zone Kharif 2007

Crops	Layyah	Bhakkar	Mianwali	M. Garh	Total
Cotton	98995	15400	28000	497111	639506
Sugar Cane	45397	68500	11000	100000	224897
Rice	5529	1000	4085	50000	55529
Mung	57530	248110	138900	-	444540
Bajra	70000	43500	41400	-	70000
Potato	2185	-	50	-	2185
Watermelon	1468	350	1280	-	1468
Musk Melon	475	1150	465	-	475
Chillies	1590	-	58	-	1590
Groundnut	-	1565	4515	-	4515

Rabi 2007-08

Crops	Layyah	Bhakkar	Mianwali	M. Garh	Total
Wheat	449000	374130	428200	716000	1967330
Gram	267910	1017000	105100	4000	1394010
Barley	10000	4200	2500	-	10000
Oil Seed	6530	6100	12500	9400	28430
Lentil	-	484	745	100	100

Appendix 13:

CHECKLIST FOR CBA TO CC CASE STUDY

OBJECTIVE OF THE SURVEY

What are the climatic changes over the past 30 years?
How did these changes affect your livelihood strategies in agriculture/NRM?
What has improved? Why? What deteriorated and how?
Is there awareness about CC?
Do CBA strategies exist?
What do people envision in the future to happen (NRM)?

Climatic Profile (local criteria, historical trends 30 yrs)

- Rainfall Pattern
- Temperatures
- Drought
- Flood
- Humidity
- Cyclones

Natural Resources and Land use management

- Agriculture (crops, varieties, variations, adaptations)
- Forestry (type/vegetation, usages, ownership/management)
- Livestock (animals/breeds, source of fodder, management practices)
- Rangeland (ownership/management, status, etc.)
- Water (sources, rain fed/irrigated, harvesting, availability, management)
- Land (availability, ownership, topography, status/degradation)
- Infrastructure (bunds, roads, etc.)

Socio-Economic Profile

- History/demography/culture/norms
- Livelihood portfolio (income, subsistence, farm/off-farm; trends)
- Value Chain Analysis (very rough trends from seeds to market, constraints & opportunities)

General CC Implications & Adaptation strategies

- Vulnerability Assessment (trends, social stratification: patron –client relationships, gender dynamics, marginal groups...)
- Local Adaptations (special focus NRM/on-farm)
- Mitigation Initiatives/Prospects (if applicable)
- CC Awareness (what is it? factors, responsibilities)

Annexure-I

List of Institutions /Persons visited

01. District Agriculture Statistical Department Mianwali
02. District Officer Agriculture Mianwali
03. Deputy Project Manager Sustainable Livelihood development project for Barani area. Mianwali
04. NRM Specialist National Rural Support Program (NRSP) Mianwali
05. Regional Program Officer National Rural Support Program (NRSP) Mianwali
06. Executive district officer Khushab

Annexure: 14 Photographs


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Conclusion

For CABI, “adaptation” should be defined as “agri-culture change”, because hitherto defined CBA approaches are nothing but “oxygen” for critically endangered farming communities. To make a meaningful, sustainable contribution to CC Adaptation, CABI must focus on farming system adaptations which will in almost all cases bring about drastic changes in the livelihood strategies of the target group. (Conclusion/hypothesis=New funding argument to secure projects!)

contact CABI

europe

CABI Head Office
Nosworthy Way, Wallingford, Oxfordshire, OX10 8DE, UK
T: +44 (0) 1491 832111, **E:** corporate@cabi.org

CABI Europe - UK
Bakeham Lane, Egham, Surrey, TW20 9TY, UK
T: +44 (0) 1491 829080

CABI Europe - Switzerland
Rue des Grillons 1, CH-2800 Del□mont, Switzerland
T: +41 (0) 32 4214870

asia

CABI South Asia
Opposite 1-A, Data Gunj Baksh Road, Satellite Town, PO Box 8, Rawalpindi-Pakistan
T: +92 (0) 51 9290132

CABI Southeast and East Asia
PO Box 210, 43400 UPM Serdang, Selangor, Malaysia
T: +60 (0) 3 89432921

CABI South Asia - India
2nd Floor, CG Block, NASC Complex, DP Shastri Marg, Opp. Todapur Village, PUSA,
New Delhi - 110012, India
T: +91 (0) 11 25841906

CABI Southeast and East Asia - China
C/o CAAS-CABI Project Office
C/o Internal Post Box 56, Chinese Academy of Agricultural Sciences,
12 Zhongguancun Nandajie, Beijing 100081, China
T: +86 (0) 10 62112118

africa

CABI Africa
ICRAF Complex, United Nations Avenue, Gigiri, PO Box 633-00621, Nairobi, Kenya
T: +254 (0) 20 7224450/62

americas

CABI Caribbean & Latin America
Gordon Street, Curepe, Trinidad and Tobago
T: +1 868 6457628

CABI North America
875 Massachusetts Avenue, 7th Floor, Cambridge, MA 02139, USA
T: +1 617 3954051