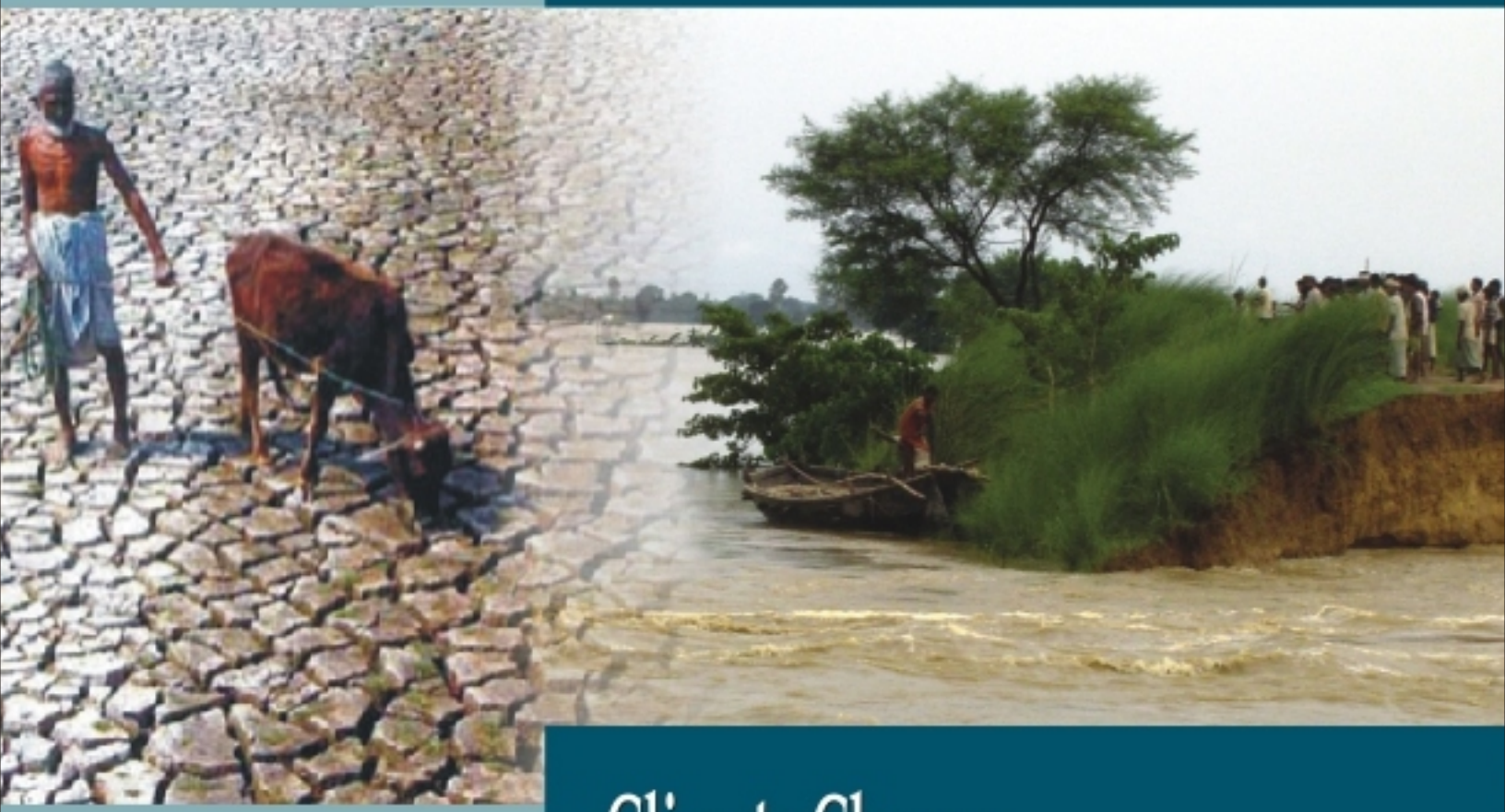

Climate Change Adaptation Activities in India

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Supported by :
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New Delhi

Climate Change Adaptation Activities in India

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The study is based on a review of the current initiatives and programmes being implemented by various agencies and organizations, including the Government, in the seven UNDAF states (Bihar, Chattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan and Uttar Pradesh). Information has been collected from desk reviews and consultations with key stakeholders. The study was compiled in a very short period and hence contact with all the key players and visits to states was not possible.

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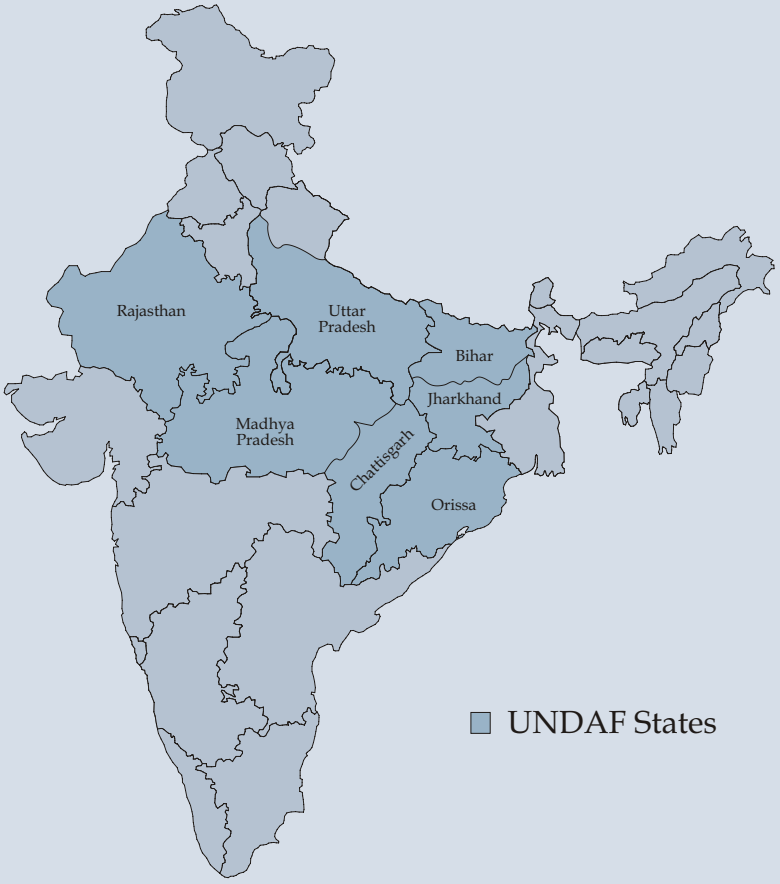
Rajasthan
Uttar Pradesh
Bihar
Jharkhand
Madhya Pradesh
Chattisgarh
Orissa
UNDAF States

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Abbreviations

AAA	:	Agrarian Assistance Association
AAP	:	Adaptation Action Programmes
ADB	:	Asian Development Bank
ALCGAS	:	Asian Least Cost Greenhouse Abatement Study
ANM	:	Auxilliary Nuerses Midwife
API	:	Agricultural Parity Index
ATI	:	Administrative Training Institute
BDO	:	Block Development Officer
BIS	:	Bureau of Indian Standards
BPL	:	Below Poverty Line
BRGF	:	Backward Regions Grant Fund
BSDMA	:	Bihar State Disaster Management Authority
CAD	:	Command Area Development Programme
CDP	:	City Development Plan
CMRF	:	Chief Minister's Relief Fund
COD	:	Committee of Directions
CPAP	:	Country Programme Action Plan
CRF	:	Calamity Relief Fund
CWC	:	Central Water Commission
DDMA	:	District Disaster Management Authority
DDP	:	Desert Development Programme
DEFRA	:	Department for Environment, Food and Rural Affairs
DPAP	:	Drought Prone Areas Programme
DRM	:	Disaster Risk Management
EAS	:	Employment Assurance Scheme
EOC	:	Emergency Operations Centre
FFW	:	Food For Work
FPR	:	Flood Prone Rivers
FPS	:	Fair Price Shop
FWPR	:	Female Workforce Participation Rates
GCM	:	General Circulation Models (Global Climate Model)
GDI	:	Gender Development Index
GDP	:	Gross Domestic Product
GEAG	:	Gorakhpur Environmental Action Group
GEF	:	Global Environment Facility
GOI	:	Government of India
GOUP	:	Government of Uttar Pradesh
GP	:	Gram Panchayat
GSDP	:	Gross State Domestic Product
HDI	:	Human Development Index
HHS	:	House Holds
IAY	:	Indira Awas Yojana (Rural Housing)
ICDS	:	Integrated Child Development Scheme
ICT	:	Information and Communication Technology
IDRN	:	India Disaster Resource Network
IIT	:	Indian Institute of Technology
IMR	:	Infant Mortality Rate
IPCC	:	Intergovernmental Panel on Climate Change
IRCS	:	Indian Red Cross Society
IRDP	:	Integrated Rural Development Programme
IRN	:	International Rivers Network
ITK	:	Indigenous Traditional Knowledge
IWDP	:	Integrated Watershed Development Programme
JNNURN	:	Jawaharlal Nehru National Urban Renewal Mission
JRY	:	Jawahar Rozgar Yojana

LDC	:	Least Developed County
MCS	:	Multi Purpose Cyclone Shelters
MDG	:	Millennium Development Goals
MHA	:	Ministry of Home Affairs
MoEF	:	Ministry of Environment and Forests
MoUD	:	Ministry of Urban Development
MP	:	Madhya Pradesh
NAPA	:	National Programme of Action
NASDORA	:	National Authority of Sustainable Development of Rainfed Areas
NATCOM	:	India's Initial National Communication (to the UNFCCC)
NCRMP	:	National Cyclone Risk Mitigation Programme
NDMA	:	National Disaster Management Authority
NE	:	North East
NEUPA	:	National University of Education Planning and Administration
NFCR	:	National Fund for Calamity Relief
NFHS	:	National Family Health Survey
NIFT	:	National Institute of Fashion Technology
NPCBAERM	:	National Programme for Capacity Building of Architects in Earthquake Risk Management
NPCBEERM	:	National Programme for Capacity Building of Engineers in Earthquake Risk Management
NREGA	:	National Rural Employment Guarantee Act
NREGS	:	National Rural Employment Guarantee Scheme
NREP	:	National Rural Employment Programme
NSS	:	National Sample Survey
NTFP	:	Non-timber Timber Forest Produce
NW	:	North West
NWDPRA	:	National Watershed Development Programme for Rainfed Areas
NYK	:	Nehru Yuva Kendra
OBC	:	Other Backward Castes
ORC	:	Orissa Relief Code
OSDMA	:	Orissa State Disaster Mitigation Authority
PDS	:	Public Distribution System
PMGY	:	Pradhan Mantri Gramodaya Yojana (Rural Housing)
PMRF	:	Prime Minister's Rilief Fund
POLENET	:	The Polar Earth Observing Network
PRI	:	Panchayati Raj Institution
RLEGP	:	Rural Landless Employment Guarantee Programme
RVP	:	River Valley Projects
SC	:	Scheduled Caste
SDMA	:	State Disaster Management Authority
SFDA	:	Small Farmer's Development Agency
SGSY	:	Swaran Jayanti Gram Swarozgar Yojana
SJGSY	:	Swarn Jayanti Gramin Swarojgar Yojana
SLR	:	Sea Level Rise
SPS	:	Samaj Pragati Sahyogarivartan Samudaya
SPWD	:	Society for Promotion of Wasteland Development
SRS	:	Sample Registration System
ST	:	Scheduled Tribe
TADP	:	Tribal Area Development Programme
TFR	:	Total Fertility Rate
UEVR	:	Urban Earthquake Vulnerability Reduction Programme
UNDAF	:	United Nations Development Assistance Framework
UNDP	:	United Nations Development Programme
UNICEF	:	United Nations Children's Fund
UP	:	Uttar Pradesh
UPDASP	:	Uttar Pradesh Diversified Agriculture Project
UPHDR	:	Uttar Pradesh Human Development Report
UPLDC	:	Uttar Pradesh Land Development Corporation

EXECUTIVE SUMMARY

This report, to support the implementation of United Nations Development Programme's (UNDP) India Country Programme Action Plan (CPAP), 2008-2012, is based on an assessment study on climate change adaptation activities in the country. The study, primarily based on a desk review of the literature and consultations with key persons, looked at the initiatives and programmes being implemented in the country by various agencies and organisations, including the Government, but focusing more on the seven United Nations Development Assistance Framework (UNDAF) states Uttar Pradesh (UP), Bihar, Jharkhand, Madhya Pradesh (MP), Chhattisgarh, Orissa and Rajasthan. The objective of the study was to identify the issues and constraints in the current initiatives as well as provide suggestions for areas/issues that need to be addressed and suggest a more effective implementation mechanism for activities/programmes.

Impacts of Climate Change

The projected impacts of climate change in India are an increase in average temperatures by 2-4 °C and marginal changes in rainfall during monsoon months, with large changes during the non-monsoonal months. The number of rainy days during the monsoons is projected to decrease by more than 15 days while the rainfall intensity is expected to rise by as much as 1-4 mm/day. Cyclonic storms are likely to increase in frequency and intensity.

Overall, the inter- and intra-annual (seasonal) variability is expected to increase; in fact, this has already started happening in many parts of the country. Falling winter temperatures has led to, for instance, a reduction in the production of wheat and other winter crops. Climatic changes are manifested, amongst other things, through variability in water availability.

The impacts on Indian agriculture, still mostly rainfed, are potentially disastrous. Increasing pest attacks accentuate the crises being felt by millions of marginal and small farmers. Human health is affected by an increase in vector-borne diseases like malaria; the increase in malaria has been about 10 percent over the last few years. Other, water-borne, diseases too are on the rise. The coastal areas of the country are threatened by a rise in the sea level, leading to crises of drinking water caused by saline ingress and infrastructure and flow losses. In some areas, like coastal Tamil Nadu, marine stocks too, according to fisherfolk, are declining.

Climate change increases the vulnerability of the poor, and those dependent on natural resources for their livelihoods. It leads to less secure livelihoods due to depleted social, financial, physical and natural resources and human assets; increasing health risks due to diseases like malaria, dengue, cholera, dysentery, malnutrition and exposure, and constrained economic opportunities due to short and long term impacts of droughts and floods, and other extreme events. Taken together, all these factors render attaining the millennium development goals (MDGs) difficult.

Executive Summary

Adaptation and Disaster Risk Mitigation

Adaptation is the response to actual or expected climate stimuli that moderates harm or exploits beneficial opportunities. In brief, adaptation is the ability of people and systems to adjust to climate change. In natural systems, adaptation is reactive by definition, but in human systems, it is both anticipatory and reactive; implemented by public and private actors.

Though adaptation and disaster risk reduction have gained acceptance in common parlance, clarity is needed in the use of these concepts. Disaster risk reduction need not be the same as adaptation. Central to the conceptualisation of adaptation or enhancement of adaptive capacities is the notion of vulnerability and resilience. In the literature, the term 'vulnerability' is used in many ways; but, essentially, the concept describes a condition of susceptibility shaped by exposure, sensitivity and resilience.

Resilience can be hard or soft. Hard resilience generally includes options that have physical characteristics ranging from flood control structures (dams/ barrages) to information and communication technology (ICT).

Soft resilience options refer to skills, processes, institutions, social systems, policies and programmes.

The usual approach to disaster risk mitigation consists of hard options. What is missing is the emphasis on the soft options or a judicious mix of the hard with the soft, in participatory ways.

This is all the more important, as resilience and adaptive capacities ultimately depend on:

- Flexibility (within livelihood, economic, water management and institutional systems)
- Diversification (involving multiple independent flows to livelihood systems)
- The ability to learn from events (at both individual and institutional levels)
- Education (the knowledge base required to develop new systems when existing ones are disrupted)
- Mobility (an attribute of flexibility)
- Risk pooling and spreading
- Operational techniques for risk reduction before and following disruptions
- Convertible assets (or recovery) It has to be noted that the above are not stand alone factors, but in real life operate in myriad permutations and combinations.

The National Scenario

Nationally, some capacity, in about a quarter of Indian states, has been built for single rapid onset (such as earthquakes) and long onset (droughts) disasters and risks. By and large, the reliance is on hard resilience options. Managing a complex portfolio of hazard risks and vulnerabilities is beyond the capability of current institutional setup (public institutions and the nascent private re-insurance and insurance).

What is needed is a geographical estimation of probabilistic hazard risks and vulnerability, and the imputed composite multi-hazard economic risks. This should be accompanied by risk prioritisation by hazard; subsequently, elements at risk and their location can be undertaken and used for creating evidence based investment, as well as building regional, rural and urban development policies and building a bridge between public agencies, communities and the private sector.

The two aspects of climate change, the inter-annual variability, with extreme intensity and frequencies (both low and high), and gradual changes in temperature and precipitation, have implications for ecosystems in their having to shift to higher altitudes; for instance, crops that are grown in a particular area (or at a particular altitude) will no longer be suitable in those areas; these issues will have to be kept in mind in building the kinds of partnerships implied above.

Moreover, these kinds of changes will need 'incremental' treatment, calling for responsive institutions and knowledge generation, both on scientific and social dimensions. Static analyses, including the linkages with poverty alleviation, might not work in the contemporary situation of climate change, as historical trends in temperature and precipitation may not be valid for future projections. There are elements of uncertainty and there will be surprises (such as long duration droughts as well as droughts in conventionally flood-prone areas and vice versa). It will be necessary to analyse the inter-linkages between the natural, physical, social, financial and human capital in a given time and space context and then predict the possible changes in these individually as well as in conjunction with each other, with a view to reducing or mitigating the impacts at individual /household/ societal levels, and enhancing the capacity to recover from impacts. At the very least, this requires an integrated approach and not the kind of piecemeal and isolated planning that prevails today. This would be possible by detailing, through participatory ways, the mix of hard and soft options relevant to each region and sub-region, backed by proactive action research and the setting up of monitoring mechanisms that have in-built corrective mechanisms. These propositions become apparent in the detailed review considered for this study.

The State Level Situation

The seven UNDAF states are at the bottom of the Indian states in terms of human development index, gender development indicators, percentage below the poverty line and almost every other indicator of growth. These states are also chronically drought- and flood-prone, but increasingly over the years, floods have occurred in areas traditionally drought prone and vice-versa. The overall adaptation and disaster risk mitigation situation is rather grim, posing greater challenges for the achieving the MDGs in these states.

While all the states have in place some kind of machinery to deal with natural disasters like floods, major droughts or earthquakes, some of the states, like Jharkhand, do not have a disaster management policy. The stress is more on post-disaster activities rather than on preventive measures for mitigation. The approach is generally reactive and the emphasis, by and large, is on hard resilience interventions. Soft resilience efforts, mainly due to the UNDP's Disaster Risk Management (DRM) programme, have been in the form of creation of some awareness amongst the communities and governments. So far the notion of disasters, especially of the slower kinds, like temperature changes, or changes in the rainfall pattern, droughts in the flood plains or floods in the typically drought-prone areas, have not received the required attention even though they have already become a reality in many areas.

Health issues, already a major crisis due to weak supply and delivery systems, are in a greater predicament with new vectors coming up in many places due to climate change.

There are a variety of central programmes running in all the states, such as those for watershed development, command area development, drought prone areas'

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programme, crop diversification, expansion of irrigation and integrated water management, flood control and mitigation, National Rural Employment Guarantee Act (NREGA) and other programmes for poverty alleviation. For environmental regeneration there are numerous watershed development and soil conservation programmes. There are also programmes for agricultural development. Some of these programmes and interventions are decades old. Yet, despite the existence of these programmes, ground realities reveal that large sections of the population are deprived of their entitlements.

There is an urgent need to revisit the interventions and, if necessary, modify programme design and implementation sot at to better to meet the challenges posed by climate change.

The conceptual frameworks and documented evidence that underpin disaster risk reduction theories and practices have long emphasised that disasters disproportionately affect the poor and that poverty is a key factor in shaping and configuring disaster risk. Recurrent and major disasters would perpetuate poverty. In addition, the immediate and longer term impacts of disasters challenge the progress made towards achieving poverty reduction goals and sometimes (re)create conditions in which marginal communities are likely to be perpetually 'at risk'.

Evidence also shows that poverty would seem to be a key factor in increasing disaster risk. Poverty outcomes, determined by various socio-economic, political and environmental factors, are often manifested in the livelihood options people adopt, and in the kind of “built” environment they live in. Livelihoods actively shape a community's 'context of vulnerability', and in turn determine the mutual interactions between poverty and disaster risks.

Poverty plays a key role in the accumulation of extensive risk over time and space and acts in both directions dynamically. Thus, poverty is a factor in processes such as urbanisation and environmental degradation that in themselves generate extensive risk. Simultaneously, the outcomes of extensive risk, particularly the livelihood impacts, contribute to perpetuating or exacerbating poverty. Moreover, while mortality and economic loss is intensively concentrated in a few large-scale catastrophes, losses in livelihoods and assets would seem to be extensively distributed in space and time and manifested as frequently occurring small-scale disasters or even day to day disasters.

The situation is further confounded by the fact that there is very little systematic investigation into the relationship between poverty and extensive patterns of risk. Most programmes address only the specific target population, excluding large sections of the population whose needs are not addressed. Apart from the well-recognised BPL population, where chronic food shortages prevail, even households not normally deprived of food are rendered vulnerable in the regions prone to droughts.

Empirical evidence based on comprehensive and holistic conceptualisation is lacking, as the present study found. It is essential to analyse the relationship between natural hazards and poverty through quantitative and qualitative approaches. This would then strengthen the argument for hazard risk reduction as a key instrument to reduce poverty and for poverty reduction strategies in turn, to contribute to reducing people's susceptibility to hazard events. This would also facilitate a better understanding of adaptation strategies both locally, and at the level of the state and the nation.

Addressing this lacuna is an urgent imperative, for this will also then form the basis of comprehensive modelling for vulnerability assessment mapping. This study found that there is a serious lack of vulnerability assessment and mapping in most of the states, despite it being a necessary precursor for designing and implementing programmes for poverty reduction, disaster risk mitigation or climate change adaptation.

The above discussion points to substantial research gaps. In sum, the following research needs could be identified:

- Systematic investigation of poverty vulnerability (climate risk) linkages in each distinct agro-economic zone within each state, with environmental, socio-economic and political factors
- Estimating potential losses (both stock and flow)
- Understanding and establishing the links between climate change and inter-annual variability at smaller resolutions through scientific and technical research (such as by downscaling global climate models)
- Identification of the drivers of poverty in climate change in specific contexts through research on changing patterns and types of poverty dimensions due to climatic extremes, using quantitative and qualitative approaches
- Mapping and modeling of current and future vulnerability
- Identification of priority sectors (including which cities)
- Developing and supporting financial mechanisms for risk spreading and pooling - insurance instruments with public-private partnership (in the agricultural sector, for instance)
- Indigenous technologies of water harvesting, crop management and the whole gamut of agrarian practices that can be supported to enhance the adaptation strategies; already, there are several NGOs in these states Society for Promotion of Wasteland Development (SPWD) and Tarun Bharat Sangh in Rajasthan, Samaj Pragati Sahyog (SPS) in Madhya Pradesh or the Gorakhpur Environmental Action Group (GEAG) in UP and Professional Assistance for Development Action (PRADAN) and Agrarian Assistance Association (AAA) in Jharkhand that are working along these lines
- Analyses of the roles and impacts of NGOs working in this sector seeking to bring about change through soft options or institutional mechanisms, essentially giving primacy to people's participation and process ownership, in bringing the required structural changes in the institutional mechanisms for State interventions
- The locale specific impacts of climate change on the industrial sector and vice-versa to enable better locating of industries
- Low cost technologies that promote employment but at the same time mitigate global warming and promote climate change adaptation

The above research would also enable the determination of the optimum mix of hard and soft options for building up resilience, and also help determine realistic time lines for the actualisation of the mix of options in an informed way.

Actions, Experimentation and Demonstration

Substantial structural and institutional changes and a paradigm shift towards climate change, development and poverty are needed. The study identified the following possible action,

Executive Summary

Executive Summary

experimentation and demonstration paths:

- Identification of practical actions for vulnerability (and poverty) reduction (matrices) in specific contexts
- Development of climate change adaptation and vulnerability analysis frameworks at various levels -- national, state and local through a series of consultative processes
- Developing a national adaptation framework
- Developing inter-ministerial coordination that is the key to resolving the problem
- Finding ways to integrate the 73rd and 74th Constitutional amendments in the climate change adaptation frameworks
- Linking mitigation with adaptation (revenue model of carbon credit-forestry financing adaptation; Ministry of Finance and Planning Commission)
- Upgrading the National Disaster Management Authority (NDMA) under the Ministry of Home Affairs (MHA) to address climate change adaptation (by, for instance, working out ways to upgrade and implement the National Cyclone Risk Mitigation Programme, NCRMP, to address climate change issues)
- Promoting demonstration models for operationalising integrated climate change adaptation into regional and rurban sectoral and investment planning
- Developing regional climate risk reduction (adaptation) models, taking into consideration both rural and urban areas and inter-linkages (eg ecosystem servicesdrinking water, pollution), especially around mega cities
- Capacity building to address climate extremeshow could the State Disaster Management Authority's (SDMA) be capacitated to address climate change impacts (State level Adaptation Action Plans)
- Integrating adaptation interventions with existing structures (e.g., the Jawaharlal Nehru National Urban Renewal Mission, JNNURM)
- Education, training and capacity building at schools and universities for public functionaries, managers and the media
- Preparing a National Risk and Vulnerability Atlas
- Developing new building and infrastructure codes (in cooperation with the Bureau of India Standards, BIS)

An important issue relates to the role of NGOs and other civil society organisations. A large number of NGOs such as the SPWD in Rajasthan, the SPS in Madhya Pradesh or the GEAG in UP and the AAA and PRADAN in Jharkhand, are doing good work in the seven states, in various fields related to disaster risk mitigation and empowerment of the people. They work in almost every field, from agriculture to health and education, women's empowerment, bio-diversity management to watershed development; specifically, they have worked on indigenous water harvesting systems, promotion of traditional seed varieties that require less water and are less disease prone or adjustments that are made by farmers to combat the impact of droughts and floods, such as by shifting to crops that have shorter/different cycles. Useful lessons can be learnt from these experiences. However, removing poverty and promotion of adaptive strategies obviously remain the ultimate responsibility of the state.

Impacts of Climate Change

1 IMPACTS OF CLIMATE CHANGE

1. Context

To support the implementation of the United Nations Development Programme's (UNDP) India Country Programme Action Plan (CPAP) (2008-2012), select activities and studies have been envisaged as a "Programme Initiation Plan" (PIP) that would provide the India Country Office (CO) information critical to the development of future initiatives. The results of these studies will serve as a basis for the development of new UNDP initiatives and will ensure that the CPAP is properly implemented and the stated development results achieved.

The overall objective of this assessment study is to provide information on climate change adaptation activities through a detailed review of the existing initiatives and programmes in India.

The overall objective of this assessment study is to provide information on climate change adaptation activities through a detailed review of the existing initiatives and programmes in India. This will form the basis for the activities and programmes in the seven designated/identified United Nations Development Assistance Framework (UNDAF) states[1] for the UNDP India Country Office.

2.Scope and Strategy

Given this context, a review was undertaken of the current initiatives and programmes being implemented by various agencies and organisations, including the Government,, but focusing more on the seven UNDAF states. Given the limitations of time and resources, information from various sources was collected for desk review. This was followed by discussions and consultations with key stakeholders such as experts, NGOs, funding organisations and senior government officials. The present report has been drafted based on the above and seeks to highlight the issues and constraints in the current initiatives and provide suggestions for areas/ issues that need to be addressed in the formation of an effective implementation mechanism for activities/programmes.

3. Impacts of Climate Change

The importance of monsoons in the Indian context cannot be emphasised enough: a large part of Indian agriculture dependent on the monsoons, so that even share markets show fluctuations due to early/delayed arrival of the monsoons. Any change in the country's rainfall pattern impacts agriculture, and hence the country's economy and food security. Yet global warming poses serious threats to the weather system, which can potentially affect millions of small, marginal and poor farmers and all those who depend on agriculture for their livelihood.

In this context, adaptation strategies are of key significance. Adaptation to climate change, briefly put, involves the adjustment of practices, processes and structures to reduce the negative effects of change while simultaneously taking advantage of any opportunities associated with climate change.

Despite the problems with the forecasting models, it is now more or less accepted that due to the impact of global warming, the following climate changes will occur between 2040 and 2060 (CSE: FACT 17; Mall et al., 2006):

1 The seven UNDAF states are Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Rajasthan, Orissa and Uttar Pradesh.

- The average surface temperature will rise by 2-4 °C
- There will be marginal changes in the rainfall expected in monsoon months
- Large changes during non-monsoon months are expected
- Number of rainy days is set to decrease by more than 15 days
- Intensity of rains is projected to increase by 1-4 mm/day, and
- Cyclonic storms are likely to increase in frequency and intensity

It is predicted that the semi-arid regions of western India are expected to receive higher than normal rainfall as temperatures soar while central India will experience a decrease between 10 to 20 percent in winter rainfall by the 2050s (CSE: FACT 17). The predicted climate change impacts, according to various studies that have used different models and parameters, are given in table 1 (Mall et al., 2006).

Table 1 : Predicted climate change scenarios

Region	Temperature	Rainfall
All India	Increase in winter temperature by 1-4° degrees C with increased CO_2 concentration	Precipitation increase of about 20 percent Increase in heavy rainfall days during summer monsoon and increased inter-annual variability
All India	Over the region south of 25°N (south of cities like Udaipur, Khajuraho and Varanasi) maximum temperature will increase by 2-4°C during 2050s. In the northern region, increase in maximum temperature may exceed 4°C. A general increase in minimum temperature upto 4°C all over the country	Decrease in the number of rainy days over a major part of the country. This decrease is more in the western and central parts (by more than 15 days) while near the foothills of the Himalayas (Uttaranchal) and in northeast India, the number of rainy days may increase by 5-10 days. Increase in rainy days intensity by 1-4 mm/day, except for small areas in northwest India where rainfall intensity may decrease by 1mm/day.
All India	Average temperature change is predicted to be in the range of 2.33 to 4.78°C with a doubling in CO_2 concentration	Increased frequency of heavy rainfall events.
All India	Average annual mean surface temperature rise is projected to range between 3.5°C and 5.5°C degrees C by the end of the century More warming in winter	Increase of about 7-10 percent in annual mean precipitation; decline of 5.25 percent in winter precipitation. Increase in monsoon precipitation is 10-15 percent Monsoons over NW India - Increase of more than 30 percent by 2050. Western semi-arid region could receive higher than normal rainfall in a warmer atmosphere. Decrease in winter precipitation by 10-20 percent over Central India by 2050.

Source: Mall et al, 2006

There may be disputes about the forecasting models and accuracy of the predictions, but in many parts of the country, the impacts of climate change are already being felt. Two of the most obvious impacts are on agriculture and health. Other impacts will be on bio-diversity, especially in the coastal and mountain eco-systems that have the potential of affecting the large human populations dependent on them.

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Agriculture

Agriculture will be affected adversely by an increase or decrease in the overall amounts of rainfall and also by the shifts in the timing of precipitation. For instance, over the last few years, the Chhattisgarh region has received less than its share of pre-monsoon showers in May and June. These showers are important to ensure adequate moisture in fields being prepared for rice crops. Agriculture will be adversely affected in the coastal regions of Gujarat and Maharashtra where agriculturally fertile lands are vulnerable to inundation and salinisation. Standing crops in these regions are more likely to be damaged due to cyclonic activity. In Rajasthan, a 2°C rise in temperature was estimated to reduce production of pearl millet by 10-15 percent (CSE: FACT 17).

An increase in CO_2 in the atmosphere could have a dubious benefit for Madhya Pradesh, where soybean is grown on 77 percent of all agricultural land; according to some studies, soybean yields could go up by almost 50 percent if the CO_2 concentration in the atmosphere doubles. However, if this increase in CO_2 is accompanied by an increase in temperature, as expected, then soybean yields could actually decrease. If the maximum and minimum temperatures go up by 1° C and 5° C, the gain in yield comes down to 35 percent. If the maximum and minimum temperatures rise by 3° C and 3.5° C respectively, then soybean yields will decrease by 5 percent compared to 1998 (CSE: FACT 17).

Changes in the soil, pests and weeds brought about by climate change will also affect agriculture in India. For instance, the amount of moisture in the soil will be affected by changes in factors such as precipitation, run-off and evaporation.

Creation of irrigation potential has been a major key to India's agricultural development, production stability and food security. Apart from the monsoon rains, India has, for centuries, depended on the Himalayan rivers for its water resource development. Temperature increases associated with global warming will increase the rate of snow melting, and consequently, snow cover will decrease. In the short term, this may increase water flow in many rivers that may, in turn, lead to increased frequency of floods, especially in systems where water carrying capacity has decreased due to sedimentation. In the long run, however, a receding snow line would result in reduced water flow in the rivers. Under the climate change scenario, the onset of the summer monsoon over India is projected to become delayed and often uncertain. This will directly affect the rainfed crops as well as water storage, placing stress on water available for irrigation. Since the availability of water for cultivation would face tremendous competition for alternate uses, agriculture would be under greater strain.

Practically all soil processes important for agriculture are directly affected by climatic factors. Changes in precipitation patterns, amount and temperature can influence soil water content run-off and erosion, workability, temperature, salinisation, biodiversity and organic carbon and nitrogen content. Changes in soil water induced by global climate change may affect all soil processes and

ultimately, crop growth. An increase in temperature would also lead to increased evapotranspiration, resulting in the lowering of the ground water table in places. Increased temperature along with reduced rainfall may lead to upward water movement, causing accumulation of salt in upper soil layers.

Organic matter content, already reduced in most parts of the county, will continue to remain low, but climatic change through temperature and precipitation mediated processes may affect its quality. An increase of 1° C in the soil temperature may lead to higher mineralisation but nitrogen availability for crop growth may still decrease due to increased gaseous losses. Biological nitrogen fixation under elevated CO_2 may show an increase, provided other nutrients are not strongly limiting. The change in amount and frequency of rainfall and pattern of winds may alter the severity, frequency and extent of soil erosion. These changes may further compound the direct effects of temperature and CO_2 on crop growth and yield.

Most crops in India, even in irrigated environments, are very sensitive to climatic variability, which considerably affects the nation's food security, despite impressive development of the irrigation potential. In the field and regional situations, it is not easy to quantify the impact of climatic variation on food production due to the impact of the changing technologies used. India had a record harvest of 75.5 Mt wheat in 1999-2000, an increase of 5 Mt over 1998-2000, with almost the same technology level. The change was largely due to the cool weather during January to March 2000 that was favourable to grain formation and filling. Such variations in food production would be much larger in paddy, pulses and oilseeds, where a large portion of the cropped area is rainfed. The gluts and shortages of rice, onions and potatoes in recent times could be due to the effects of climatic variability (in addition to short-sighted policy and mismanagement).

According to the India's Initial National Communication (Natcom) to the United Nations Framework Convention on Climate Change (UNFCCC), agriculture productivity will be impacted due to changes in temperature and rainfall, rise in CO_2 concentration in the atmosphere and occurrence of pests and disease. The wheat yield is projected to decline 4 to 24 percent in different regions, while rice yield will generally decrease with the rise in temperature. The doubling of CO_2 and warming (3 °C), accompanied with reduction in rainfall, will lead to reduction in yields of several dry-land crops, and losses in farm-level net revenue is predicted (Natcom, 2004).

Most crops in India, even in irrigated environments, are very sensitive to climatic variability, which considerably affects the nation's food security, despite the impressive development of the irrigation potential.

Health

In the summer of 1994, western India experienced temperatures as high as 50 °C, providing favourable conditions for disease carrying vectors to breed. Not surprisingly, 1994 was also the year Surat was hit by an epidemic of pneumonic plague, resulting in 59 deaths. In the same year, as summer gave way to the monsoon and western India was flooded with rains for three months, Surat was hit by a malaria epidemic (CSE: FACT 17).

Weather conditions determine transmission of vector-borne diseases to a considerable extent. Heavy rainfall results in puddles, providing breeding grounds for mosquitoes. In areas of western Rajasthan and Gujarat, malaria epidemics have often followed excessive rainfall. In parts of eastern UP, the recurrent annual toll of Japanese encephalitis is a recent phenomenon. In very humid climates, drought may also turn rivers into puddles.

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days and the drain on the scarce resources of an impoverished population due to diseases that are boosted by the impact of climate change. However, all the health impacts of climate change are yet to be fully understood.

According to the Natcom, by the 2080s, malaria will penetrate elevations above 1,800 metres and some coastal areas. Ten percent more states may offer climatic opportunities for malaria vector breeding throughout the year with respect to the year 2000. The transmission windows in Jammu and Kashmir and Rajasthan are likely to increase by 3 to 5 months. In the southern states, however, the window is likely to shorten by 2 to 3 months (Natcom, 2004).

Industry

Needless to say, the industrial sector too would be affected by climate change.

Some industries will be directly affected. These include those in coastal areas like the hotel and hospitality industry, and sectors like salt manufacturing, fisheries, coastal refineries and so on. Coastal infrastructure, such as ports, railway networks (like the Konkan railway) and roads are particularly at risk. The change in energy consumption due to increased space cooling requirements in building and transportation sectors and due to changed irrigation requirements are also some of the projected direct impacts.

Nearly all industries would potentially be affected due to escalating energy costs. These include the various agro industries, those dependent on the forestry sector (building, paper, power generation), as also transportation and insurance. Another possible indirect impact will be due to the poor health of workers.

There is a lot of scope in the industrial sector to mitigate the impacts of climate change. The contemporary climate change scenario offers business opportunities like clean air technology transfers and energy efficiency improvements. Moreover, funding mechanisms are also available for incorporating such technologies.

The construction sector, one of the major sources of pollution, has been growing steadily for the last two decades. Construction related activities account for quite a large portion of carbon dioxide emissions. The contribution of the building industry to global warming cannot be ignored anymore.

Energy consumption in modern buildings occurs in five phases. The first phase corresponds to the manufacturing of building materials and components, which is termed as embodied energy. The second and third phases correspond to the energy used to transport materials from production plants to the building site and the energy used in the actual construction of the building, which is referred to as grey energy and induced energy. Fourthly, energy is consumed at the operational phase, which corresponds to the running of the building when occupied. Finally, energy is consumed in the demolition process of buildings as well as in the recycling of their parts, when this is promoted.

Cost effective construction technologies can bring down the embodied energy level associated with the production of building materials by lowering the use of energy consuming materials. This embodied energy is a crucial factor for sustainable construction practices, effective reduction of which would contribute in mitigating global warming. Cost effective construction technologies would emerge as the most acceptable case of sustainable technologies in India, both in terms of cost and environment. Also the employment potential is very high (Sengupta, 2008).

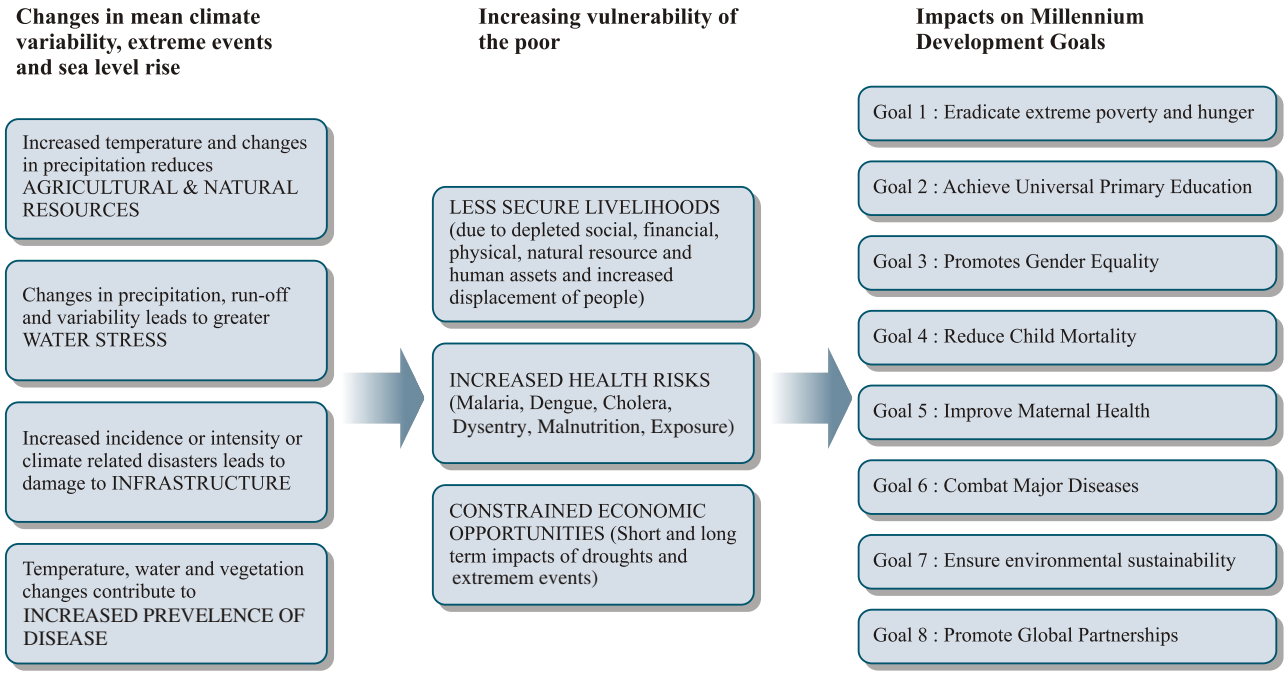
Impact of Climate Change in Coastal Areas

The coastal areas of the country, in the states of Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa and Gujarat, face grave risks due to climate change. There is the risk of cyclones and tsunamis, the intensity of which is predicted to rise. Rising sea-levels, which could flood land (including agricultural land) and cause damage to coastal infrastructure and other property, pose another threat. For instance, Goa stands to lose a large percentage of its land area, including many of its famous beaches and tourist infrastructure. A one metre rise in sea level, it is estimated, will affect 7 percent of Goa's population and cause damage to the tune of Rs 8,100 crore. Similarly, in Maharashtra, over 13 lakh people are at risk; in Mumbai alone, the cost of damage is estimated to be Rs 228,700 crore. Mumbai's northern suburbs, like Versova beach and other populated areas along tidal mud flats and creeks, are also vulnerable to land loss and increased flooding due to sea level rise (CSE: FACT 17).

Beyond actual inundation, rising sea levels will also put millions of people at greater risk of flooding. This will displace a large number of people and result in rapid urbanisation, while straining resources and putting more pressure on civic amenities. Increased sea water percolation may further reduce freshwater supplies.

Indeed, the full impact of climate change is yet to be understood totally. The problem is compounded by the lack of comprehensive data or accurate models and the sheer complexity of the problem. The impacts work in compound, interactive ways. This renders adaptation all the more important, and without adequate investment in adaptation, it may not be possible to attain the MDG goals (see figure 1).

Figure 1: Impact of climate change on the MDGs



Source : WB, 2002 : 16

Poor countries face a host of development challenges apart from climate variability and climate change, such as the threat of HIV/AIDS, environmental degradation, declining export prices, demographic changes and so on. Climate change is an additional challenge that though significant, has often been overlooked in addressing poverty reduction and sustainable development.

Climate change is very much a development problem, since the poor, with the least adaptive capacities and hence the greatest vulnerability, are expected to suffer the most adverse effects. Vulnerability to climate variability and climate change is only one set of challenges the poor face, especially in the poorer states. Other challenges include indebtedness, HIV/AIDS, food insecurity, environmental degradation, impacts of global trade, conflict, economic decline, increasing urban poor, increasing inequality and macro-economic shocks. Climate change provides an additional threat that adds to, interacts with and can reinforce these existing risks, placing additional strain on the livelihoods and coping strategies of the poor. Climate change is expected to have both direct and indirect effects on poverty.

Although greenhouse gas emissions need to be reduced to mitigate climate change and avoid future human suffering, adaptation to climate change is also necessary.

There is a serious danger that climate change in the form of more extreme droughts, floods and storms, rise in sea level and more intense rainfalls will undermine development interventions and MDGs, and increase poverty (IPCC, 2007).

Although greenhouse gas emissions need to be reduced to mitigate climate change and avoid future human suffering, adaptation to climate change is also necessary. As explained earlier, adaptation to climate change is the adjustment of practices, processes and structures to reduce the negative effects and take advantage of any opportunities associated with climate change. Due to past greenhouse emissions, some level of human induced climate change over the next decades is inevitable. But at the same time, societal changes such as privatisation of natural resources, declining health, conflicts and insecurity do affect populations and make them increasingly vulnerable even to present climatic variability such as seasonal droughts and extreme events. This is because these developments may have placed people's livelihoods at the brink of collapse or undermined their existing adaptation strategies.

4. Adaptation: Approaches and Issues

The World Bank conceptualises adaptation in natural or human systems as "a response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities" and looks on adaptation as all those "responses to climatic conditions that may be used to reduce vulnerability. Adaptation is a broad concept and can be used in a variety of ways. Adaptation to the (expected) negative impacts of climate change generally takes place in two ways: anticipatory (before the impacts take place) and reactive (as a response to initial impacts). In natural systems, adaptation is reactive by definition. In human systems, adaptation can be both anticipatory and reactive and can be implemented by public and private actors. Private actors include individuals, households, communities, commercial companies and other actors such as NGOs. Public actors include government bodies at all levels" (WB, 2002).

Adaptive capacity is defined as the "ability of people and systems to adjust to climate change; e.g., by individual or collective coping strategies for the reduction and mitigation of risks or by changes in practices, processes or

structures of systems. Adaptive capacity cannot be easily measured since it is related to general levels of sustainable development such as political stability (civil conflict, functioning democracy), economic well being (GDP growth, incidence of poverty), human and social capital (literacy, life expectancy, level of local organisation, micro-finance institutions) and climate specific aspects (such as existing disaster prevention and mitigation systems)" (ibid.)

Adaptation and disaster risk reduction are now common currency in policy debates, the media and public dialogue. Yet a comprehensive understanding of what climate risk reduction or adaptation to the impacts of climate change actually entails is elusive (Moench and Dixit,2007: 2).

As has been pointed out, challenges of responding to climate risk are shaped by complex interactions between dynamic natural, social, economic, cultural and political systems. These dynamics are due to their complexity, dependence on initial conditions and non-linearity, which are inherently chaotic and difficult to predict. Consequently, attempts to develop "integrated" approaches that respond to all the potential consequences and dynamic changes in human and natural systems will be ineffective and are inherently inappropriate (Holling and Meffe, 1996). Instead, approaches need to be founded on an understanding of systems broad perspectives that recognise the complex interplay between systems (Gunderson 1999; Holling, 2001; Gunderson and Holling, 2002).

There has been substantive conceptualisation and theorisation of adaptation and related notions (see Moench and Dixit, 2007; IISD et al., 2003). Irrespective of future greenhouse gas emissions, inevitability of changes to climate is accepted widely. In this context, there is a consensus that adaptation to climate change is, therefore, no longer a secondary and long-term response option only to be used as a last resort. Climate change is a reality and, for those communities already vulnerable to the impacts of present day climate hazards, adaptation issues require urgent attention. Indeed, globally there is acceptance that successful adaptation must be accomplished through actions that target and reduce the vulnerabilities poor people now face, as they are likely to become more prevalent as the climate changes (cf. IISD et al., 2003; Moench and Dixit, 2007; WGCCD, 2007). Adaptation, though not proposed as panacea for the world's ills, does offer a new opening to revisit some long-standing problems of the environment and development in an innovative way.

Important in the understanding of adaptation are the notions of disaster risk reduction (DRR) and contextualising vulnerability within it. DRR, simply put, relates to the people and institutions involved in preparedness, mitigation and prevention activities associated with extreme events. These include hazard forecasting and immediate relief efforts for major disasters resulting from floods, cyclones and, in some cases, pollution events (IISD, et al 2003: 4)[2].

Vulnerability is a term that is used in many different ways, usually describing a condition of susceptibility shaped by exposure, sensitivity and resilience (Kasperson et al., 1996). For the poor , vulnerability is both a condition and a determinant of poverty and refers to the (in)ability of people to avoid, cope with or recover from the harmful impacts of factors that disrupt their lives and that are beyond their immediate control. This includes the impacts of shocks (sudden changes such as natural hazards, war or collapsing market prices) and trends (for example, gradual environmental degradation, oppressive political systems

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2 For more detailed discussions of DRR, see Moench and Dixit, 2007.

In relation to climate change, vulnerability relates to direct effects such as more storms, lower rainfall or sea level rises that lead to displacement and to indirect effects such as lower productivity from changing ecosystems or disruption to economic systems.

or deteriorating terms of trade). The need for, and scale of, adaptation reflects the vulnerability of people and natural systems to disruption from changes that reflect the impacts of climate conditions (IISD et al., 2003: 6).

In relation to climate change, vulnerability relates to direct effects such as more storms, lower rainfall or sea level rises that lead to displacement and to indirect effects such as lower productivity from changing ecosystems or disruption to economic systems. With the poor being more directly dependent on ecosystem services and products for their livelihoods, the vulnerability of natural systems has profound implications. Any consideration of the need for adaptation to help poor communities to adjust to the effects of climate change must take into account all of these different forms of vulnerability. Of course, exactly how the effects of climate change will impact upon different people in different places is largely unknown one of the many uncertainties that surround the climate change debate. This is because of the uncertainties inherent in specifying these impacts and because the vulnerability of people will be affected by many events and conditions beyond climate change (IISD et al., 2003).

Central to the understanding of vulnerability is the concept of resilience. The resilience of the poor represents their ability to withstand the impact of the trends and shocks mentioned above, absorbing them while maintaining function (Folke et al., 2002). Resilience varies greatly from household to household, even in one locality. It is determined by two characteristics of peoples' livelihoods: the assets they possess and the services provided by external infrastructure and institutions. Both assets and services are extremely broad in their scope. Assets include the amount and quality of knowledge and labour available to the household, the physical and financial capital they possess, their social relations and their access to natural resources. External services include those provided by flood control, coastal protection and other infrastructure, transport and communications, access to credit and financial systems, access to markets and emergency relief systems. For many poor people in developing countries, access to these external services is extremely limited, so that their resilience is in large part a reflection of the local asset base. Strategies to strengthen the resilience of communities, particularly poor communities, should be based on the most effective combination of measures to secure and enhance the community's asset base and measures to provide improved external services. The best balance in any one place needs to be determined through effective assessments of local needs and capabilities.

Concepts of resilience take two broad forms:

- Hard resilience: these are the direct strength of structures or institutions when placed under pressure
- Soft resilience: this connotes the ability of systems to absorb and recover from the impact of disruptive events without fundamental changes in function or structure

In the disaster context, resilience is often treated as the simple inverse of fragility. Engineers, for instance, often refer to increasing the resilience of a structure through specific strengthening measures to reduce their probability of collapse with respect, for example, to earthquake intensities, wind loading or other physical stresses. As resilience increases, the degree of damage for a given intensity hazard decreases. Such approaches fall largely under the category of strengthening hard resilience (Moench and Dixit, 2007).

However, resilience can be viewed more comprehensively, encompassing the entire ecosystem. Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary. Resilience in social systems has the added capacity of humans who are able to anticipate and plan for the future. As part of the natural world humans depend on ecological systems for survival and also continuously impact the ecosystems in which they live, from the local to the global scale. Resilience is a property of these linked social ecological systems. Resilience, as applied to ecosystems or to integrated systems of people and the natural environment, has three defining characteristics (Girot, 2002; IISD, 2003: 7; Moench and Dixit, 2007):

- The amount of change the system can undergo and still retain the same controls on function and structure
- The degree to which the system is capable of self organisation
- The ability to build and increase the capacity for learning and adaptation

Rather than simply strengthening structures or institutions in relation to specific stresses, soft resilience attributes depend on the flexibility and adaptive capacity of the system as a whole. Research in South Asia (Moench and Dixit, 2004) indicates that resilience and adaptive capacities in communities depends on:

- Flexibility (within livelihood, economic, water management and institutional systems)
- Diversification (multiple independent flows to livelihood systems)
- The ability to learn from events (at both individual and institutional levels)
- Education (the knowledge base required to develop new systems when existing ones are disrupted)
- Mobility (an attribute of flexibility)
- Risk pooling and spreading (institutional arrangements or other mechanisms for spreading and pooling the impacts of disruptions on the system as a whole)
- Operational techniques for risk reduction before and following disruptions (that is, techniques for directing the reorganisation process so that growth and conservation phases do not increase rigidity and ultimate vulnerability)
- Convertible assets (the ability to convert assets accumulated during periods of growth into other forms when disruptions occur)

All of the above contribute to system resilience that is, the ability to adjust to shocks and variability without fundamental changes in the overall system, structurally as well as functionally.

Understanding these notions is important as the poor in India already face multiple risks, including that of global economic forces, deprivation of their entitlements and development dues to which are added the risks associated with climate change. Climate change and associated ecological changes also pose threats to the viability of many economic and social structures, even where people are not displaced or in serious physical risk; this is particularly true in situations where changes will lead to decline in the availability or quality of natural resources, such as water or land, on which the livelihoods of many poor people are based. This is the ultimate goal of adaptation processes: to provide security to people who face greater

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threats because of changes to the climate conditions in which they live.

5. The National Scenario

India has undertaken four officially supported national technical assessments of Climate Change risks, impacts, adaptation and mitigation options since 1992.

Central to the notion of adaptation to climate change is the provisioning of security to people who face greater threats because of changes to the climate conditions in which they live. India made a late start in engaging with questions of climate change. Public engagement with this question picked up only recently, in spite of early environmentalist and academic positions on these questions (Agarwal et al., 1993). This is largely because of the country's post-Rio (1992) pre-occupation with pressing poverty, economic/social development and political challenges, at a time when climate change began to gain significance in the global policy agenda (IPCC, 1995).

India has undertaken four officially supported national technical assessments of climate change risks, impacts, adaptation and mitigation options since 1992. The first was supported by the Asian Development Bank (ADB); the second, the Asian Least Cost Greenhouse Abatement Study (ALCGAS) was supported by the Global Environment Facility (GEF); the third was a Climate Impact Assessment study funded by the Department of Environment, Food, and Rural Affairs (DEFRA), Government of the United Kingdom; and the fourth was the recently concluded National Communication Project supported by the Global Environment Facility (GEF) (Sathaye et al., 2006). These assessments shared three common features: one, they were largely externally funded and driven; two, they were coordinated by the Ministry of Environment and Forests (MoEF), Government of India (GoI); three, they were primarily focused on the "science" of climate change, closely allied to the Intergovernmental Panel on Climate Change (IPCC) agenda and trends of analysis, and, therefore, were weak in engaging with the complex nature and intensity of vulnerability in India, which is probably the most critical factor in risk mitigation (Revi, 2005). A range of long-range resource, energy and sustainable development studies have also been undertaken, but have had limited impact on the GoI agenda (Planning Commission, 2002; TERI, 1998).

Addressing a complex of six major risk groups: temperature and precipitation variability; drought; flooding and extreme rainfall; cyclone and storm surge; sea-level rise; and linked environmental health risk, is a serious public policy and adaptation management challenge for India.

An important new method that can help address these concerns is composite risk assessment and adaptation planning. This enables a geographically explicit estimation of probabilistic hazard risk, vulnerability and the imputed composite multi-hazard economic risks. Risk prioritisation by hazard, elements at risk and location can thereafter be undertaken, assisting in creating evidence-based investment and regional, rural and urban development policies, and building a bridge between public agencies, communities and the private sector (GSDMA/TARU, 2005).

While some capacity has been built nationally and in about a quarter of Indian states to address single rapid-onset (e.g., earthquake) and long-onset (e.g., drought) risk, nevertheless, managing a complex portfolio of hazard risks and vulnerabilities is both beyond the current mix of public institutions and the nascent private re-insurance and insurance industry.

India has no robust national estimates of composite economic risk due to natural hazards, unlike Bangladesh (Benson and

Clay, 2002). A national Vulnerability Atlas (BMTPC, 1997) is being updated to assess district-level building vulnerability to cyclone, storm surge, earthquake and a broad-brush estimate of flood risk exposure. Unfortunately, this does not use probabilistic methods of risk assessment and the fragility functions used are based on a very limited analysis of loss. Further, no economic loss estimates have been derived. China, on the other hand, is moving towards probabilistic risk assessment methods in cooperation with global re-insurance industry (Shi, 2002).

The only robust state-level estimates of composite risk indicates an annual Gross State Domestic Product (GSDP) compression of about 2 percent for Gujarat, of which drought makes up 57 percent, cyclone and storm surge 12 percent and inland flooding 5 percent, over a 100-year time horizon (GSDMA/TARU, 2005). This assessment breaks new ground by disaggregating risk to economic output and capital stock separately for urban and rural areas. This is one of the most detailed sub-regional risk assessments in the world that percolating down to *talukas* (i.e., sub-district level) for eight crops, animal husbandry, fisheries, industry, services and critical infrastructure (roads and bridges, power, ports and airports). Yet, even though completed in 2005, it does not take into account increased hazard risk due to climate change, because of the low awareness of climate risk exposure in India.

A similar national and state-level estimate of gross domestic product (GDP) or gross state domestic product (GSDP) compression would need to be generated as a priority based on disaggregated district-level analyses to enable actionable intervention sets. A fundamental challenge will be the locus of such an effort. Conventional discipline and hazard-based approaches (e.g., earthquake, drought or cyclonic storms) are currently situated across a high fractured institutional environment ranging from the Ministries of Science and Technology, Environment, Agriculture and Home Affairs. This is a sure means of ensuring that little strategic perspective and no coordinated action takes place, especially because states, urban local bodies (ULBs) and communities are where the adaptation and mitigation action will take place. Given the significant national development and security implications of climate change, this could be best situated in the Cabinet Secretariat of the GoI. This apex arrangement can help coordinate a large network of institutions that will need to be mobilised across India, to address climate change adaptation and mitigation.

The urgency of the problem lies in the fact that vast sections of the Indian population continue to be deprived of basic amenities and even necessities. India is improving on many critical demographic indicators. The average life expectancy at birth has gone up from 32 years in 1951 to over 60 years today. The Total Fertility Rate (TFR) has declined during 1982-1992 resulting in the reduction of almost one child per woman. The TFR is projected to decline further from 3.13 during 1996-2001, to 2.52 during 2011-2016. The Infant Mortality Rate (IMR), a sensitive indicator of health status as well as of human development, has also declined considerably for both males and females. The average literacy rate has gone up from less than 20 percent in 1951, to more than 65 percent in 2001 (Natcom, 2004). The poverty level has gone down to 26 percent of the total population in 2000 from 51.3 percent during the 1970s.

Yet, despite these achievements, India continues to face the persistent challenge of population and poverty. Around 74

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percent of the population lives in rural areas, in about 5.5 lakh villages, many with poor communications and transport facilities. Reproductive health and basic health infrastructure require considerable strengthening, despite commendable achievements in the last 50 years. Nearly a 100 million people live in urban slums, with limited access to clean potable water, sanitation facilities and health care services. In addition to this, there is the issue of a large-scale migration of people from rural to urban areas.

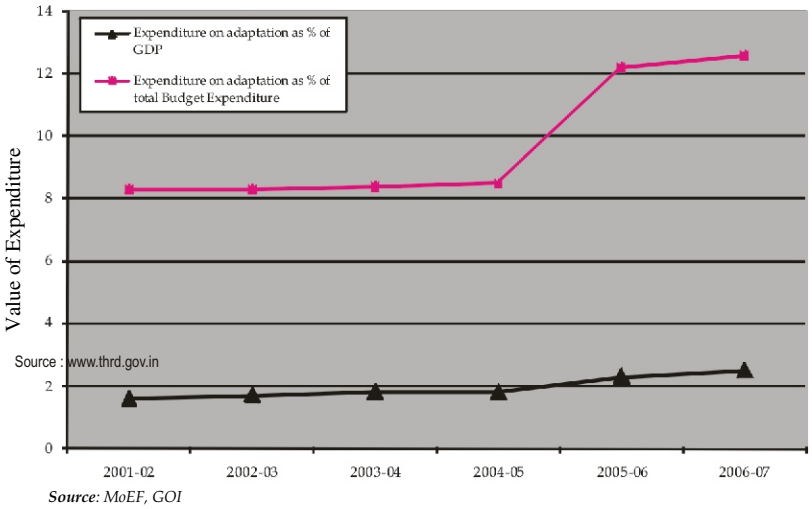
Almost every sector of the economy, be it agriculture or health, faces a silent (or sometimes not so silent) crisis today due to a complex mix of reasons. Climate change risks will accentuate these crises, and the issue remains whether adopting a business as usual approach, as is often evident in national development programmes, will enhance the adaptation capacities of the poor or enable disaster risk reduction.

On the face of it, the Indian government is aware of these issues and is acting to change things. One example is that in 2006-07, India used 2.17 percent of its GDP, compared to 0.6 percent in 2000-01, on projects that would help communities adapt to climate change and reduce their vulnerability to climate change, as disclosed by the joint secretary in the MoEF on September 15, 2007 (TOI, New Delhi, 16/9/2007). The Ministry reached this figure by back calculating and claiming that there are several government programmes that address the key factors increasing vulnerability to climate change; these are, 22 programmes in crop management, 19 in drought proofing, 19 in health, 6 in risk finance, 6 in disease control, 12 in forestry and 30-odd in poverty alleviation (ibid.).

A publication available on the ministry's website gives the following graph to further illustrate the above, and adds that along with agriculture, water resources, health and sanitation, forests, coastal zone infrastructure and extreme weather events are specific areas of concern.

All this data notwithstanding, there is enough evidence to show that lack of accountability and transparency is a serious issue, and that without these it is not possible to attain the goals of intervention processes, no matter how well meaning they may be. The above figures were contested almost as soon as they were released (TOI, 16/9/2007). In the course of the present study an attempt was made to validate the calculations but to no avail. The issue here is not so much the authenticity of the data and the inclusion or exclusion of programmes that have been considered, but that of the lack of transparency.

Figure 2 : Expenditure on adaptation programs in India



Source: MoEF, GOI

The Urban Scenario

India will experience one of the most dramatic settlement transitions in history over the next 40-odd years as its urban population grows from about 300 to over 700 million (Hughes and Hillenbrand, 2006). Unlike most

other regions of the world, South Asia has been marked by a low level of recent urbanisation, although it was one of the most urbanised pre-colonial regions of the 18th century (Banga, 2005; Revi, 2002). About 30 percent of India's population lived in urban areas in 2006 (Census, 2006), but given a 1.1 billion-plus population, its urban population exceeds that of Japan and the European Union (EU) and most other regions of the world, except the United States and China (UN, 2006).

In India, climate change risk should be seen in the perspective of an ongoing three-part transition: a demographic transition that will see India's population stabilising at about 1.6 billion in the 2060s; a simultaneous urban transition, which will see an addition of almost 500 million people in an estimated 7,000 to 12,000 urban settlements over this period; and simultaneously brown (e.g., water, sanitation and environmental health); grey (e.g., air and water pollution) and green (e.g., climate change) environmental transitions (McGrahanan et. al, 2007). This complex interplay of effects requires multiple strategies that are sub-regionally nuanced to respond to the climate crisis, drawing on considerable local experience of coping with uncertainty and far-from equilibrium systems.

A central challenge of Indian urbanisation over the early 21st century is that by 2050, there will be an almost equal number of people living in about 0.6 million villages as in 12-15,000 towns and cities. By 2025, an estimated 70 Indian cities are expected to have a population size of over one million. In addition, three mega urban regions Mumbai-Pune (50 million), the National Capital Region of Delhi (over 30 million) and Kolkata (20 million) will be among the largest urban concentrations in the world (Census, 2006; Dyson and Visaria, 2004; Revi, 2006).

India could, by mid-century, have both the largest national urban and rural populations of the time. This will have an important bearing on global climate vulnerability and the potential for mitigation and adaptation. Hence, the future direction of Indian urbanisation is not only an important domestic concern, but will be a major international opportunity to demonstrate the viability of a more sustainable development paradigm.

Urban India overtook rural India in its GDP share in the late 1990s, in spite of having less than 30 percent of the national population. This income skew has been accentuated by a recent rapid economic growth in the city-based services and manufacturing sectors. Urban per capita incomes are now over thrice that in rural areas (CSO, 2006; RBI, 2006). India's agriculture sector currently contributes only 18 percent of its GDP, but nevertheless provides livelihoods to close to 60 percent of the population, as well as the biomass and ecosystem services that enable the 'metabolism' of most Indian cities to function. The transformation of this metabolism towards more efficient and productive use of renewable energy (via biofuels and wind) and sustainable water management will be crucial not only to the sustainability of cities, but also the creation of 21st century livelihoods, in a culture that is still in touch with its peasant roots.

Climate change could, in unexpected ways, catalyse the ongoing agrarian crisis in rural India (Sainath, 2002) into a migratory rout, driven by an increase in frequency and intensity; expansion of endemic drought to more areas in the semi-arid peninsula; drought and flooding in the super-dense Indo-Gangetic and Brahmaputra plains; and coastal flooding and drought in the coastal plains (Gosain et al., 2006; Mall et. al., 2006; Ramesh et al., 2005). These

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scenarios have only been broadly articulated, but not systematically investigated with fine-grained GIS-linked models (GSDMA/TARU, 2005; Kumar et al., 2006). Hence, most projections on this count can only be seen as speculative at this point of time. Nevertheless, India's medium and long-term social and political stability will require a more nuanced and geographically explicit understanding of these risks as demographic dynamics alter the political representation of southern and western India in key democratic institutions, like the Parliament (De Vries et al., 2007).

A greater mobility of the more marginalized and vulnerable sections of society could, in time, alter the migration dynamics across demographically dominant northern and eastern India.

It is possible that drought and resource conflict induced by climate change may force the pace of rural-urban migration over the next few decades. Alternatively, severe stresses induced in urban areas due to a mix of water scarcity, environmental services breakdown, flooding and consequent water borne disease and malaria-like epidemics, combined with a rapid rise in health expenditures, could maintain the low current level of rural-urban migration. A greater mobility of the more marginalized and vulnerable sections of society could, in time, alter the migration dynamics across demographically dominant northern and eastern India. This indicates the potential for climate change (along with other driving factors) to induce bifurcation behaviour in migration and hence urbanisation trends questions that need more investigation.

Maintaining two-way flows of food, biomass, water, energy, livelihoods, products and services across the rural-urban (rurban) continuum will be crucial to India's 'development transition' and medium-term sustainability. Hence, climate change adaptation in both cities and their embedding countryside is an undiscovered near-term policy concern -- intimately connected with livelihoods and drought, biomass and energy security (Revi, 2006).

The other important post-2004 development is the reappearance of urban development, urban renewal and governance as a significant public policy agenda after a hiatus of over a decade. The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) was initiated in 2005 to target 60 of the largest and most important cities with a $10 billion challenge fund that addresses improvements in infrastructure development, urban poverty and urban governance. While this has taken off to a slow start, it is hoped that more rational urban infrastructure development with a strong pro-poor focus would help address some of the structural vulnerabilities of a number of million-plus cities and state capitals.

A large chasm exists between the official urban 'city building' development agenda and vulnerability reduction for those most at risk in these urban areas. A root cause is the ambiguity of the Indian state and its elites, in accepting the centrality of the poor and their informal settlements in the process of urban development and economic growth. This ongoing institutional and cultural failure has been documented for decades, but is now reaching a scale, along with recurrent demolitions and relocations, that has led to the compounding of vulnerability of a large section of urban residents. The most vulnerable populations and elements most at risk in a typical Indian city are:

- Slum, squatter and migrant populations residing in traditional and informal settlements, which are often located in the most vulnerable locations
- Industrial and informal service sector workers, whose occupations place them at significant risk to natural hazards, which is then accentuated by additional stressors such as climate change
- Buildings, especially traditional and

informal housing, that are especially vulnerable to wind, water and geological hazards

- Industrial units and their in-house infrastructure, plant, machinery and raw materials
- Lifeline public and private infrastructure, which includes roads, bridges, railways and ports
- Airports and other transportation systems; water, sewage and gas pipelines; drainage, flood and coastal defence systems; power and telecommunication infrastructure and critical social infrastructure such as hospitals, schools, fire and police stations, and first responder's infrastructure
- Ecosystems and the natural environment, especially wetlands, riverine, estuarine and coastal ecosystems, and surface and groundwater systems

Hence, the imperative of delivering entitlements of adequate services (water, sanitation, solid waste management, drainage, power) and equitable access to land and housing to the bulk of city residents is still a matter of contention. There is, however, currently no independent JNNURM sub-component that addresses either urban vulnerability or risk mitigation, and no climate change-related response in sight.

Risk adaptation and mitigation measures need to address particular populations and elements at risk within a rurban landscape to be effective in responding to a heterogeneous field of constraints and opportunities. Hence, decentralised adaptive management strategies that engage with a political, policy and implementation continuum from the neighbourhood, city, and region to national level have proved to be more effective than centralised top-down interventions (Moffat et al., 2003, cited in Revi, 2005). A coherent framework, within which public policy, private sector and civil society urban development and planning actions are taken, can reduce vulnerability and risk in a steady iterative manner, over a period of decades (Revi, 2005). This, in turn, requires a new set of incentives and structures that link short-run priorities with long-run strategic actions a major shift in the current urban management paradigm.

In the rest of this section programmes that relate specifically to adaptation or disaster risk reduction, insofar as they have the potential or are actually reducing the risks of the poor in rural areas to climate change, are discussed. However, it has to be noted that most of these programmes were not designed with the issue of climate change in mind.

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5.1 Government Programmes for Climate Change Adaptation[3]

The Government of India, as well as several state governments, has launched various programmes to conserve and develop water resources for agricultural and domestic sectors. These programmes, which aim at conservation and sustainable use of water resources, also reduce vulnerability to water stress as well as addressing eradication of poverty. Some of the important programmes are described below.

The centrally-sponsored scheme for soil conservation for the enhancement of productivity of degraded areas in the catchments of River Valley Projects (RVP) and Flood Prone Rivers (FPR) is being implemented on a watershed basis in 45 selected catchments throughout the

3 International Agencies such as the UNDP or the DFID have several programmes, including UNDP's DRM programme. However, most of these are implemented through Government Agencies. They are not discussed here as it is presumed that relevant information/evaluations are available with the agencies concerned. Similarly, there are many NGOs across the country implementing many programmes whose objectives are the same as the government ones. Some of them have yielded very good results, which will be discussed in the section on the states.

country. Other schemes include the Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP), National Watershed Development Programme for Rainfed Areas (NWDPRA), Soil, Water and Tree Conservation (Operation Soil Watch), operational research projects on Integrated Watershed Management, and the Jawahar Rojgar Yojana (JRY). All these programmes had definite objectives: improvement of productivity of catchment areas, optimum use of soil, land and water and their conservation, and employment generation.

" Overall national objectives of reducing the adverse impact of droughts, improving/stabilisin g the production of important rainfed crops like pulses and oilseeds, and controlling siltation of reservoirs, have not been achieved to a satisfactory level."

Watershed Development Programme

This programme has been in operation for nearly 40 years. It has emphasised the importance of soil and water conservation, and people's participation through Watershed Associations in planning and management.

As the Natcom notes, "Overall national objectives of reducing the adverse impact of droughts, improving/stabilising the production of important rainfed crops like pulses and oilseeds, and controlling siltation of reservoirs, have not been achieved to a satisfactory level." However, the impact of some of the watershed projects in reducing siltation, expansion of cropped area, increase in cropping intensity and grain/biomass yields has been very pronounced and visible on the ground. The watershed development programme has emphasised soil and water conservation efforts/methods, but not on productivity-linked best agronomic practices (Natcom, 2004).

Command Area Development Programme (CAD)

This programme has had a positive impact on irrigation water utilisation, irrigation intensity, agricultural productivity and soil and water environment. It has been felt that the main emphasis of CAD has so far been on hard resilience or physical works, such as construction of field channels and on-farm development work.

Crop Diversification

Crop diversification methods such as crop rotation, mixed cropping and double cropping, reduce the vulnerability of crop yields. Crop diversification has also been found to result in reduced erosion, improved soil fertility, improved crop yield, reduced risk of crop failure and enhanced water savings.

Source : GEAG Resource Centre

Expansion of Irrigation and Irrigation Water Management

Irrigation reduces the vulnerability of crop yields to the vagaries of rainfall. India has implemented a large programme to expand irrigation from diverse sources. However, about 60 percent of the net sown area is still under rainfed cropping.

Flood Control and Flood Management

Flooding is a major problem in the Himalayan rivers. About 40 Mha, which is close to one-eighth of the geographical area of the country, is vulnerable to floods. Flood protection works in the form of flood embankments and reservoirs have not proved very useful. It has been felt that it may not be possible to provide complete protection against floods. What is needed is a greater emphasis on the efficient management of flood plains, flood proofing, including disaster preparedness and response planning, flood forecasting and warning, and many other non-structural measures.

There are several bodies that have been set up expressly to deal with the problem of floods. The National Flood Commission (*Rashtriya Barh Ayog)* was set up in 1976 by the Government of India to review and evaluate the flood protection measures undertaken since 1954, and to evolve a comprehensive approach to the problem of floods. In 1996, the Government of India set up a Task Force to review the impact of recommendations of the *Rashtriya Barh Ayog* and analyse the strategies evolved so far for mitigating flood problems, and to suggest both short-term and long-term measures.

Though there is no dearth of critiques of the various development programmes, they rarely lead to any constructive outcome or positive change. Thus, despite the barrage of criticisms, the flood control and management measures have remained confined mostly to the construction of dams and embankments. Hence, the International Rivers Network (IRN) argued, in a 2007 report, that flood control based on dams and embankments failed to stop the rapid rise, severity and number of floods (IRN, 2007). Dams and levees can never be fail proof and when they do fail they can cause catastrophic damage. In addition, by creating a false sense of security, they encourage questionable development on vulnerable floodplains. Thus, in 2006, monsoon waters were released from the Ukai Dam in Gujarat to stop the dam breaching. At least 120 people were killed and many millions of rupees of damage were caused. At least 39 people were killed walking across the Sind River in Madhya Pradesh during a religious ceremony, washed away by sudden releases from the Manikheda Dam. These stories were repeated in many river basins across India in 2006, including the Mahi, Sabarmati, Chambal, Narmada, Krishna, Godavari and Mahanadi basins. Sudden high releases of water from dams were the prime reason for most of the flood damage in these basins.

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Similar releases of water from dams or the backwaters of reservoirs like the Massanjore Dam on the Mayurakshi River affect thousands of people annually, most of them tribals. In 1999, when the "super-cyclone" hit Orissa on September 30, the barrage upstream of Bhadrak town was opened, flooding large parts of the town, including the low-lying stream beds that had been occupied over the years by the poor. Though not directly cyclone affected, many lives were lost as a result.

In agriculture, despite the emphasis on the marginalised and the poor, and the stress on people's participation, farmer suicides seem to be on the increase. According to the eco-feminist Vandana

Shiva, the Indian government policies have already marginalised Indian small farmers and made them more vulnerable to climate change. "Policies driven by corporate globalisation are pushing farmers off the land, and peasants out of agriculture," said Shiva in April 2007, "This is not a natural evolutionary process; it is a violent and imposed process and the 150,000 farmer suicides are one aspect of this violence" (WGCCD, 2007:46)

Similarly, the DPAP and DDP too have come under intense criticism from several government appointed committees (see box).

BOX A critique of the GoI led drought proofing efforts

Systematic long term drought proofing efforts were launched by the GoI during 1973-74 (DPAP) and 1977-78 (DDP) to create assets designed to reduce the impact of drought. A Planning Commission sponsored study on Droughts in Gujarat (Roy and Hirway, 2007) shows that the results of these programmes so far have not been satisfactory.

Both programmes seek to:

- Minimise adverse effects on crop productivity, livestock, water and human resources;
- Promote economic development of the poorer sections through creation and equitable distribution of productive resources;
- Increase employment opportunities through sustainable livelihoods; and
- Reduce ecological degradation and desertification in perpetual drought regions.

But subsequent evaluations of these programmes, by as many as six committees, reveal that projects under the DPAP and DDP have not resulted in raising productivity and conservation of soil moisture to reduce the adverse impact of drought, and in checking desertification. Till 1994, the DPAP and DDP were being implemented on a sectoral basis where major activities like soil-moisture conservation, water resource development, afforestation and pasture development were taken up in a fragmented manner by different line departments. Isolated implementation of wide ranging sectoral activities over widely disjointed areas of very small sizes failed to bring about any noticeable impact, and programme objectives remained farfetched. In 1993 the Hanumantha Rao Committee suggested major policy changes. These included

(a) Development of lands, water and vegetative resources on a watershed basis in the area development programmes, including IWDP.

(b) The treatment for the watersheds should include all categories of land including private, village commons, revenue and degraded forest lands.

(c) A micro-watershed with about 500 ha may be taken up for management and development.

(d) Watershed development programmes should be implemented with the total participation of the beneficiaries.

(e) Awareness raising including dissemination of relevant information relating to the programme should be given priority.

(f) State and District Level Committees should be constituted to monitor the programmes.

(g) States should also contribute a suitable matching share in watershed development schemes.

(h) Training at various levels for the preparation of Watershed Development Plan should be arranged.

(i) For identification of blocks to be covered under the DPAP and DDP, the criteria of moisture index, three eco-systems - arid, semi-arid and dry sub-humid and area under irrigation may be taken into consideration.

(j) It is necessary to organise independent evaluation studies on a regular basis through reputed independent and autonomous organisations

Based on the above recommendations, uniform guidelines for all the three programmes, i.e., DPAP, DDP and IWSD, were formulated. Both sectoral and area development were given importance under these programmes. The Government attached utmost importance for development of waste and degraded lands by increasing their productivity following the principle of equity, transparency and community empowerment by adopting low-cost locally available technology and material. These guidelines were in operation for a period of over six years.

However, the performance under these schemes has so far not been satisfactory. This has been largely due to: a) lack of convergence of other rural and agriculture development programmes at the ground level, b) the projects were implemented in isolation and in a disjointed manner, c) management of projects failed due to lack of inter departmental coordination, d) projects under these programmes became, over the years, too large to handle, and e) large scale malpractice has been observed at ground level. Nonetheless, the projects under the supervision of NGOs and local CBOs have shown some good results in achieving the goals of integrated watershed development programmes, thereby reducing the impact of drought.

In fact, this was reflected in the S Parthasarthy Technical Committee of 2005, appointed to look into the nation's watershed programmes. The salient findings of the Committee were as follows:

- Dry-land regions of India have suffered due to a lack of attention
- Financial resources have been abysmal
- Implementation has been totally top down
- Rigid bureaucratic system of project execution
- Participation of grassroots agencies and local NGOs is needed
- Massive investment proposal for dry land development to the tune of Rs 10,000 crore annually for 15 years is required

The committee recommended the creation of a National Authority of Sustainable Development of Rainfed Areas (NASDORA). The NASDORA should be a quasi-independent authority with the mandate to manage the watershed programme, must be endowed with autonomy and flexibility to respond innovatively to local needs, and must have clear accountability for performance. This recommendation is yet to be implemented.

Yet all these interventions and programmes can still be adapted to adequately meet the challenges of climate change. The Public Distribution System (PDS), spread across every part of the country, could be useful but is very much in need of restructuring[4]. Programmes under the National Rural Employment Guarantee Act (NREGA) can be used to deal with the impacts of climate change in agriculture in rural populations by ensuring a safety net for those facing droughts and/or floods, or too little or too much rainfall. Climate proofing could be undertaken through judicious public works based on the principles of community based planning, which are embedded in the provisions of the act itself[5]. A major change that is needed is the way families are identified as being below or above the poverty line. Local politics plays a major role in this process almost all over the country. The NREGA has recently been expanded to all the districts of the country, but still the norms specify that employment (of 100 days a year) is available only to one person per family and not all those who demand work. Moreover, the selection of persons for employment is dependent on the local power elite, who have the backing of various political parties. In many areas, the norms prevent building of community assets and are restricted only to making *kutcha* roads (Mitra, 2007)[6].

Government sources recognise that water resources need to be managed efficiently so that wastage is minimised (Natcom, 2004). Management issues should include linkages with the farmers, command area development, water conservation techniques, participatory irrigation management and institutional reforms. All reforms must be backed by research and diagnostic analysis for optimal results. The efficiency of existing systems needs to be enhanced so that the savings in water are utilised to increase irrigation intensity. Irrigation consumes nearly 83 percent of water being used at present; it

is estimated that even in the year 2050 the requirement will continue to be about 79 percent of the total water consumption. Yet, even a nominal saving of 10 percent in irrigation water can result in an increase in the availability of water for domestic and industrial use by about 40 percent in the long term. Such an increase may also be used to offset the impacts of climate change in areas where reduction in water availability is projected (ibid).

Source : www.ruraldev.gujarat.gov.in

The fact remains that despite the numerous technological, managerial and institutional options available, the country's national programmes for agriculture, water or biodiversity do not adequately address developmental issues, in spite of the impending challenge of climate change. The same set of issues that mark most development programmes, such as lack of transparency and accountability or the participation of the people in the planning and implementation processes also mark the measures that are being sought for adaptation to climate change. One example given above is that of the spending on climate change adaptation programmes and its ratio to the GDP.

Several other issues are involved too. Just as the inter-linkages between various interventions, even in the same local area, are ignored, leading to several line agencies working at cross purposes or duplicating efforts, issues like education (both non-formal and formal) are often neglected. Health issues remain a major concern, with a weak and underdeveloped public health infrastructure, even in states like West Bengal. Sectoral issues apart, the major problem lies in the very approach itself. It is generally assumed that building up hard resilience will automatically lead to developing soft resilience. Sometimes, even the measures to build soft resilience are treated as though hard resilience structures are being built, with solutions arrived at mechanically, not taking into account the flexibilities required when dealing with human beings and social problematics. Some of these issues will be discussed in greater detail in the discussion on the states.

4 The PDS essentially seeks to give a certain amount of foodgrains, the amount varying from state to state, at very subsidized rates to those who are too poor to buy them in the open market. The entitlements are linked to whether one is below the poverty line (BPL) or above the poverty line (APL). What is needed is a change in the method of classifying families as BPL or APL.

5 http://www.nrega.nic.in

6 These are rough paths that are not paved, bricked or macadamized.