Global Water Partnership
South Asia
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RESEARCH PAPER

on

CLIMATE CHANGE ADAPTATION IN WATER MANAGEMENT FOR FOOD SECURITY:

RECENT DEVELOPMENTS IN SOUTH ASIA

(IN CONTEXT OF INDIA)

December, 2012

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CLIMATE CHANGE ADAPTATION IN WATER MANAGEMENT

FOR FOOD SECURITY:

RECENT DEVELOPMENTS IN SOUTH ASIA

(IN CONTEXT OF INDIA)

Prepared by:
Prof .Santosh Kumar
&
Dr. Veena Khanduri

Layout & Design by:
Mangla Rai

December, 2012

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Preface

The Regional Hub (RH) of Asia Pacific Adaptation Network (APAN) functions as a knowledge centre and provides technical assistance for adaptation. The RH assists and collaborates with its sub-regional Nodes (SRN) and thematic nodes to implement the APAN activities. There are SRNs in Pacific and Central, North-east, South-east and South Asia. The three thematic nodes represent Agriculture, Mountain and Water. In 2011, GWP South Asia was selected as the APAN's Thematic Node for Water in South Asia and India Water Partnership (GWP-India) is one of the Country Water Partnership under GWP-South Asia along with the others like Bangladesh Water Partnership, Bhutan Water Partnership, Nepal Water Partnership, Sri Lanka Water Partnership and Pakistan Water Partnership, which are working on climate change knowledge, research and awareness.

GWP-India along with the other Country Water Partnerships is working with APAN on climate change adaptation issues since 2011. Under Phase-I of the assignment, IWP identified the national implementing partners and major issues and challenges faced by India in a consultation on "Water, Agriculture and Climate Change" organized on 9th February, 2012 at Institute for Human Development, New Delhi. The consultation was attended by Govt. of India officials (Planning Commission, ICAR, National Rainfed Area Authority, Central Water Commission, National Institute of Disaster Management), research institutions, lead Universities of Delhi, prominent Delhi based partner NGOs of IWP.

Under Phase-II of the APAN assignment, a draft Research Paper on "Climate Change Adaptation in Water Management for Food Security: Recent Developments in South Asia (in context of India)" prepared jointly by Prof. Santosh Kumar, Head, Policy Planning & Cross-cutting Issues, National Institute of Disaster Management (NIDM) and Dr. Veena Khanduri, Executive Secretary, GWP-India was discussed at length in a consultation organized on 22nd November, 2012 at NIDM Conference Hall, New Delhi under the Chairmanship of Prof. S R Hashim, President, GWP-India. In the consultation climate change experts from NIDM, Indian Council of Agricultural Research, University Grant Commission, Central Water Commission, The Energy and Resources Institute (TERI), GWP-India network partners, Dr. Akhilesh Gupta (member of India's core negotiating team on Climate Change for several meetings of UNFCCC and IPCC and member of National Coordination Team which drafted India's National Action Plan on Climate Change in 2008). The suggestions of the experts and the participants have been incorporated in this Research Paper. Brief report on the consultation is given on page no. 38

We extend our sincere thanks to Prof. S R Hashim, President, GWP-India for sparing his valuable time and chairing the consultation. We are also thankful to Dr. Akhilesh Gupta for providing his views and suggestions on the Draft Research Paper.

We convey our sincere gratitude to the experts who besides their busy schedule participated in the consultation and provided their valuable suggestions.

Finally we are thankful to all the participants who made significant contributions in the consultation due to which we have been able to finalize this Research Paper.

We hope that the useful information contained in the Research Paper would respond appropriately to mitigate impacts of the climate change in India and South Asia.

Veena Khanduri
Executive Secretary
GWP-India

Executive Summary

Climate change adaptation in water management for food security is the study undertaken by India Water Partnership (GWP-India) with its key objective to find out the initiatives taken so far in the country and also to study that how it has been challenging to translate into practice. The purpose of the paper has also been to identify and review recent policy developments in relation to climate change adaptation in India. The paper has tried to look into the major issues like food security, adequate water availability for agriculture, capacity development and awareness amongst communities for climate change adaptation. The study has also focussed on the examination of scientific/technological innovation in forecasting, decision support systems, information sharing and dissemination, infrastructure design techniques/ options and water saving technologies.

The study reveals that development, climate change, natural resource management and disaster risk reduction are seen in most of the cases as separate and in a isolated manner. When disaster strikes, it erodes development and developmental gains. There has been innumerable instances where all go hey-wire in case of disaster event. John Stuart Mill, the English philosopher and economist wrote in the year 1872, is still applicable in today's context that the "great rapidity with countries recover "-subsequently consuming at their earlier levels-what about the welfare of those affected? As economists typically look into individual income or a nation's output to measure prosperity, there is no dispute that income and output is important but they are not the perfect determinant of people welfare. So it is important to look into the factors which are responsible for income and welfare. Isolated interventions made by different sectors are important, but it is more important that they converge somewhere for better result. In many instances it has been seen that reducing risk is higher when it is addressed in a more integrated manner. Hence, adaptation, disaster risk reduction and development process should not be seen as an isolated category with each other. Each one intersect each other and hence DRR, Adaptation and development intervention be revisited for reducing vulnerabilities and ensuring sustainable development path.

The study also found that community practices and support of local government if both combine together it yield better result. The intervention should be designed in such a manner that it helps in community empowerment and in building capacity of local governance. Also, there is lot of information gap between the professionals and communities. At times every small single event is considered as climate change event and people combine it with both as act of God and manmade event. More public awareness and education and extension programmes are needed for awareness creation on CCA and disaster risk reduction

While agriculture's share in India's economy has progressively declined to less than 15% due to the high growth rates of the industrial and services sectors, the sector's importance in India's economic and social fabric goes well beyond this indicator. First, nearly three-quarters of India's families depend on rural incomes. Second, the majority of India's poor (some 770 million people or about 70 percent) are found in rural areas. And third, India's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes.(The World Bank). Agriculture is still the backbone of the economy for providing livelihood support to the millions (nearly 65 percent of the total popula-

tion) in India. Indian agriculture continues to be a fundamental instrument for poverty reduction and sustainable development. Promoting agriculture is imperative for meeting Millennium Development Goal of halving poverty and hunger by 2015 and continuing to reduce poverty and hunger for several decades thereafter. Agriculture production is important for food security because it is a source of income for majority of the rural poor.

It is estimated that the food demand by 2021 will be 276 Million tonnes against current production of 230 MT. Ensuring that agricultural growth responds to food security needs: The sharp rise in food-grain production during India's Green Revolution of the 1970s enabled the country to achieve self-sufficiency in food-grains and stave off the threat of famine. Agricultural intensification in the 1970s to 1980s saw an increased demand for rural labour that raised rural wages and, together with declining food prices, reduced rural poverty. However agricultural growth in the 1990s and 2000s slowed down, averaging about 3.5% per annum, and cereal yields have increased by only 1.4% per annum in the 2000s. The slow-down in agricultural growth has become a major cause for concern. India's rice yields are one-third of China's and about half of those in Vietnam and Indonesia. The same is true for most other agricultural commodities.

Millions of hectares are degraded through ravines, salinity, wind erosion, water logging, flooding, drought and haphazard grazing. Also use of fossil fuel, land use and agriculture are the key source of climate change in India. Also, with increasing extreme events and hydro-meteorological disasters, the challenges of food availability would be much more.

There has been a number of concern regarding the water sector; chiefly they consist of continuous depletion of ground water, agriculture sector continues to demand more water, aggravation of droughts and floods, water crisis and conflict within the states and communities and industrial sector for each one's own share and regional conflict for share in Brahmaputra, Indus and Ganga river basin. Water quality is affected by Industrial waste, agrochemicals, erosion, soil degradation, domestic pollution and wetland degradation.

Climate change is one of the main driving forces of change for water resources management, together with demographic, economic, environmental, social and technological forces. Climate change adaptation and disaster risk reduction needs to be implemented through the policies of other sectors, in particular, those of agriculture, water resources, health, land use, environment, finance and planning. Climate change will affect disaster risks in two ways: i) through the likely increase in weather and climate hazards and ii) through increases in the vulnerability of communities to natural hazards, particularly through ecosystem degradation, reductions in water and food availability, and changes to livelihoods.

The Sustainable Agriculture and Rural Development Policy of 1999 which focused on Sustainable Agriculture and Rural Development (SARD) is also essentially based on the policy on food security and alleviation of hunger. Soil and Water Conservation Programmes have been launched in response to the need for conservation and rehabilitation of degraded land for prevention of soil loss from the catchments. Promotion of multi-disciplinary integrated approach to catchment's treatment, improvement of land capability and moisture regime in

the watersheds and promotion of land use to match land capability is required in a more integrated and holistic manner.

National Water Policy (NWP) 2012 tries to recall water as an ecosystem service; however, neither provides adequate linkage with other environmental and natural resources policies nor with the disaster management policy. But, NWP-2012 recognizes the commercial aspects of water management and corporate involvement in policy implementation. The NWP-2012 also mentions that for pre-emptive and high profile uses of water for sustaining life and ecosystem for ensuring food security and supporting livelihood, the principle of differential pricing may have to be retained. This may have multiple implications for drought prone and dry areas, especially on agro-ecosystems, marginal farming, drinking water, people's health, power generation, irrigation, commercial development. Although, development of improved storage facilities, protection of surface water from evaporation, and introduction of drip irrigation system and animal husbandry activities are helping in mitigation with the use of improved and scientific methods. Nevertheless, impact of climate change in terms of variability in rainfall and temperature, it firmly indicate that these patterns will change. Increasing competition for water between industry, domestic use and agriculture has highlighted the need to plan and manage water on a river basin and multi-sectoral basis. As urban and other demands multiply, less water is likely to be available for irrigation. Ways to radically enhance the productivity of irrigation ("more crop per drop") need to be found. Piped conveyance, better on-farm management of water, and use of more efficient delivery mechanisms such as drip irrigation are among the actions that could be taken. Incentives to pump less water such as levying electricity charges or community monitoring of use have not yet succeeded beyond sporadic initiatives. . Underground water aquifers provide the best possible storages, available almost everywhere. Thus, massive plans for recharging underground aquifers in variety of ways, including through water harvesting systems, and recharging using the flood waters are required to be prepared and implemented.

There are major technological advancements have taken place and innumerable projects are being implemented in the country still there is a knowledge gap in the existing technology. There seems to be a major mismatch between water supply and water demand for agriculture in India. Some persisting problems are, poor land availability due to very high pressure on land, very little additional land that can be brought under irrigation, high degree of land fragmentation, poor public investments in rural infrastructure including irrigation and electricity, ecological constraints due to floods and overall lack of institutional and policy reforms in agriculture sector. Other key priorities may include (i) modernizing Irrigation and Drainage departments to integrate the participation of farmers and other agencies in managing irrigation water; (ii) improving cost recovery; (iii) rationalizing public expenditures, with priority to completing schemes with the highest returns; and (iv) allocating sufficient resources for operations and maintenance for the sustainability of investments.

Over-exploitation of ground water in the absence of appropriate pricing policy for its optimal use is absent. In fact, on the other extreme, the price structure of ground water use for irrigation is ad-hoc, irrational and perverse. In spite of a model bill for ground water use suggested by the Government of India, no meaningful progress has been made at the State (sub national) level to enact proper laws for use of ground water.

In addressing such issues, role of women may be revisited and be mainstreamed in water, agriculture and climate change management. A gender specific and gender based strategy must be the central focus in planning and implementation. Their perspectives and needs are often not heard in processes leading to policy formulation.

It has been observed that individuals and communities have steadily become more and more dependent on the government. There needs to be some reflection as to how policy shift can be brought about to bring change from this dependent syndrome to empowerment approach.

Community-driven development approaches will be critical to build social capital in the poorest areas as well as to expand savings mobilization, promote productive investments, income generating opportunities and sustainable natural resource management. Direct support to self-help groups, village committees, user's associations, savings and loans groups and others can provide the initial 'push' to move organizations to higher level and access to new economic opportunities. Moreover, social mobilization and particularly the empowerment of women's groups, through increased capacity for collective action will provide communities with greater "voice" and bargaining power in dealing with the private sector, markets and financial services. As decentralization efforts are pursued and local governments are given more prominence in the basic service delivery, the establishment of accountability mechanisms becomes critical. Local governments' capacity to identify local priorities through participatory budgeting and planning needs to be strengthened. This, in turn, would improve the rural investment climate, facilitating the involvement of the private sector, creating employment opportunities and linkages between farm and non-form sectors

Abbreviations

IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
NAPCC	National Action Plan for Climate Change
NWP	National Water Policy
NFP	National Forest Policy
NEP	National Environment Policy
PESA	Panchayats (Extension to the Scheduled Areas) Act
GDP	Gross Domestic Product
GoI	Government of India
NDMA	National Disaster Management Authority
TERI	The Energy and Resources Institute
RCM	Regional Climate Model
INCCA	Indian Network on Climate Change Assessment
NAIP	National Agricultural Innovation Project
GEF	Global Environment Fund
WOTR	Watershed Organisation Trust
NABARD	National Bank for Agriculture and Rural Development
YGL	Young Global Leaders
MoEF	Ministry of Environment and Forests
CCA	Climate Change Adaptation
DRR	Disaster Risk Reduction
CCM	Climate Change Mitigation
ADPC	Asian Disaster Preparedness Centre
ACCCRN	Asian Cities Climate Change Resilience Network
FDI	Foreign Direct Investments
WDR	World Development Report
IGP	Indo Gangetic Plains
CWC.	Central Water Commission
UNITAR	United Nations Institute for Training and Research
NGO	Non Government Organization
AFPRO	Action for Food Production
IGSSS	Indo Global Social Service Society
FORRAD	Foundation for Rural Recovery and Development
ACA	Additional Central Assistance
NWDPRA	National Watershed Development Project for Rainfed Areas
DPAP	Drought Prone Area Programme
ARGTDW	Artificial Recharge to Groundwater Through Dug Wells

ICDS	Integrated Child Development Services
IAY	Indira Awas Yojana
SSA	Sarva Shiksha Abhiyan
TSC	Total Sanitation Campaign
PMGSY	Pradhan Mantri Gram SadakYojana
BRGF	Backward Region Grant Fund
RKVY	Rashtriya Krishi Vikas Yojana
NRSC	National Remote Sensing Centre
NDVI	Normalized Difference Vegetation Index
CSIR	Council of Scientific & Industrial Research
ICMR	Indian Council of Medical Research

1. Background

India is a growing economy with more than 8 percent growth rate. On the other hand, India also has to take care of high population growth. India's population in 2011 was 1220 million which may stabilize at 1.6 billion by around 2050. Food security, livelihood and housing are a challenge which the country has to meet at standards which are much higher than in the past. Urban population of India at present is about 31% which will touch 50 % by 2050. Fast growth phase of urbanization generate pressure of various types including those on land, housing, water supply and industrial activities. Growing urbanization has great impact on agriculture. As the economy gets stronger, pattern of demand changes – more directly the demand pattern for food will change requiring changes in agriculture systems, cropping patterns, etc.

The natural resource base, including land and water, that support and sustain the livelihoods of masses is degrading at accelerated rates. The situation is likely to worsen in the water scarce regions in terms of severe drought and floods. Such conditions are likely to disrupt the balance in the pattern of water supply and demand for water across agriculture, domestic and industry sectors. This will lead to reduction in the choice of crops and cropping system, posing threats to food security and increasing frequency of water induced disasters.

Climate change has a profound effect on irrigated agriculture due to floods, droughts and rise in temperature. Therefore climate change needs to be updated to work out adaptation and mitigation strategies. The impact of climate change and adaptation strategies has to be considered in the backdrop of certain other concerns and challenges faced by India.

The IPCC Fourth Assessment Report of the Working Group II "Impacts, Adaptation and Vulnerability"[1] draws a formidable picture of the effects of climate change especially in the case of extreme events. The major areas that are going to be affected are, i) water, ii) food, iii) industry, society and settlement, iv) health[2]. The ISDR report states that climate change will affect disaster risks in two ways, firstly through the likely increase in weather and climate hazards, and secondly through increases in the vulnerability of communities to natural hazards, particularly through ecosystem degradation, reductions in water and food availability, and changes to livelihoods. Thus Climate change adaptation and disaster risk reduction, are two sectors whose importance cannot be denied neither their integration. These are not sectors in themselves but must be implemented through the policies of other sectors, in particular, those of agriculture, water resources, health, land use, environment, finance and planning[3].

According to the ISDR Briefing Note, by mid-century, water availability will likely to decrease in mid-latitudes, in the dry tropics and in other regions supplied by melt water from mountain ranges. A fact which is significantly important in the context of this paper considering a large proportion of the country's population is sustained

[1]IPCC Fourth Assessment Report, Working Group II Report
http://195.70.10.65/ipccreports/ar4-wg2.htm.
[2]Briefing Note 01: Climate Change and Disaster risk Reduction
www.unisdr.org/we/inform/publications/4146
[3]Briefing Note 02 : Adaptation to Climate Change by Reducing Disaster Risks: Country Practices and Lessons

by rivers fed by mountain systems. It also states that in the lower latitudes, especially in seasonally dry and tropical regions, the increases in temperature and the frequency of droughts and floods are likely to affect crop production negatively, which could increase the number of people at risk from hunger and increased levels of displacement and migration. In India the combined pressure of urbanization, economic development and industrialization would also be intensified by the risk of climate change. It will hamper the progress in sustainable development and constrict natural resources, one of the most precious being water, unless rigorous and long term remedial measures are not taken on priority basis.

Adaptation and mitigation should be considered jointly since climate proofing and vulnerability reduction goes hand in hand to reduce vulnerability to natural disasters. Examples of mitigation actions include more efficient furnace systems, developing new low-energy technologies for industry and transport, reducing consumption of energy-intensive products, and switching to renewable forms of energy, such as solar and wind power. Examples of adaptation include preparing risk assessments, protecting ecosystems, improving agricultural methods, managing water resources, building settlements in safe zones, developing early warning systems, instituting better building designs, improving insurance coverage and developing social safety nets (ISDR).

Climate change is one of the main driving forces of change for water resources management, together with demographic, economic, environmental, social and technological forces. If conceived in isolation, solutions to the major challenges that these driving forces create may become self-defeating. Decision-makers and policymakers in other disciplines have the solution to many water management problems. They need to recognize that all major decisions should take into account the potential impact on water, recognizing water as the lifeblood. While tackling these issues, decision-makers should think beyond their own sectors and consider the wider ramifications of their decisions on water availability and the forces affecting it, and should adopt a balanced, integrated and coherent approach.

It has already been said in so many ways that the extremes of climate change will make the poor grow poorer, in other words the more vulnerable in the society would be the first to be affected and also food crisis is as much a crisis of land in water-rich regions, as crisis of water in semi arid and arid, water-scarce regions (Dinesh Kumar, Sivamohan, Narayanmoorthy, 2010). So, clearly there is a need to examine the relevant national policies and mull over the features that concern our current topic.

2. Current Policy Analysis

2.1 National Action Plan for Climate Change

The National Action Plan for Climate Change was announced in 2008 by the Government of India. It was supposed to be comprehensive in its extent and was scaffolding for achieving the final objectives. It had 8 missions which converge directly or indirectly in certain sections which is inevitable.

National Solar Mission-The NAPCC aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar competitive with fossil-based energy options. It also includes the establishment of a solar research centre, increased international collaboration on technol-

ogy development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

National Mission for Enhanced Energy Efficiency: The NAPCC recommends mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-saving certificates, financing for public–private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings, and agricultural sectors, and energy incentives, including reduced taxes on energy-efficient appliances.

National Mission on Sustainable Habitat: The NAPCC also aims at promoting energy efficiency as a core component of urban planning by extending the existing Energy Conservation Building Code, strengthening the enforcement of automotive fuel economy standards, and using pricing measures to encourage the purchase of efficient vehicles and incentives for the use of public transportation. The NAPCC also emphasizes on waste management and recycling.

National Water Mission: The NAPCC sets a goal of a 20% improvement in water use efficiency through pricing and other measures to deal with water scarcity as a result of climate change.

National Mission for Sustaining the Himalayan Ecosystem: This particular mission sets the goal to prevent melting of the Himalayan glaciers and to protect biodiversity in the Himalayan region.
Green India Mission: The NAPCC also aims at afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23 to 33% of India's territory.

National Mission for Sustainable Agriculture: The NAPCC aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.

National Mission on Strategic Knowledge for Climate Change: To gain a better understanding of climate science, impacts, and challenges, the plan envisions a new Climate Science Research Fund, improved climate modeling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds. (Pandhve, 2009)

There is a national as well as international consensus that the impetus on hydropower and bio-fuel generation might have adverse affects on fresh water ecosystems which might cause decrease the ecosystem resilience of the regions affected by climate change. India has proposed a disparate range of climate change response measures that do consider water, but the implications for greater water consumption and other impacts on freshwater ecosystem services from the hydropower and bio-fuel targets would be negative and integration mechanisms are not proposed. There is an impending need to increase energy efficiency. Small details like increasing fuel efficiency in agricultural machines or operating them with renewable energy like solar or wind

goes a long way in increasing overall efficiency and also making agriculture more sustainable. The political impetus behind the plan is unclear. There has been left little scope for decentralization except for some mere instances. Also there is one advisory committee reporting to the Prime Minister and the Ministry of Environment and Forests delegated to coordinate implementation across Union Government agencies. So there needs to be seen how the monitoring of implementation can be done at state levels.

Also we have to consider the factors like increasing urbanization, globalization, greater demand for (quality food) and competition for natural resources from so many other sectors along with climate change as causing both water and food constraint. There should be focus on short term actions on adaptation and mitigation. Certain sectors of the National Mission for Sustainable Agriculture and the National Water Mission need to be converged according to the emerging needs. There needs to be more focus on small details like bridge between crops, enhancing livestock productivity, exploiting the manure and irrigation potential of treated waste water and sustaining growth in fisheries.

The National Action Plan on Climate Change provides a direction for changes at the national level in policy, planning, and public-private partnerships, and lays out a global vision for modifying longer time trends for sustainable development (Dev and Sharma, 2010).

2.2 National Water Policy

The National Water Policy (NWP), 2002 of India has taken into account the problems faced by drought (and flood) prone areas and have set concerned parameters (section 1.5). Under the Water Resource Planning (section 3.1 and 3.2) emphasized on non-conventional methods for utilization of water such as through inter-basin transfers, artificial recharge of ground water and desalination of brackish or sea water as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting. NWP sheds light on reforestation and prioritizing water resource management. Section 19.2 is regarding relief works for the drought afflicted masses. The new proposed version of National Water Policy 2012 tries to recall water as an ecosystem service; however, neither provides adequate linkage with other environmental and natural resources policies nor with the disaster management policy. But, the new version NWP (2012) recognizes the commercial aspects of water management and corporate involvement in policy implementation. This may have multiple implications for drought prone and dry areas, especially on agro-ecosystems, marginal farming, drinking waters, people's health, power generation, irrigation, commercial development, etc. Emphasis of the NWP on watershed based practices is of direct relevance to this topic besides other means of water conservation and management for drought risk mitigation and drought proofing.

2.3. National Forest Policy

The National Forest Policy (NFP) of 1988 dwells multiple references on degraded and barren lands and calling concern to the calamities of drought and floods. Strategic importance has been laid on afforestation, social-forestry and farm-forestry. This policy is aimed towards maintenance of environmental stability through preservation and restoration of the ecological balance and conserving the natural heritage of the country by

preserving the remaining natural forests and checking soil erosion and denudation in the catchment areas of rivers, lakes and reservoirs.

2.4. National Environment Policy

The National Environment Policy (NEP) of 2006 bestows importance on forest and maintenance of forest cover and there are certain features regarding drought which coincide in both NEP and NFP. Section 5.2.3 refers that large scale forest loss would lead to catastrophic, permanent change in the country's ecology, leading to major stress on water resources and soil erosion, with consequent loss of agricultural productivity, industrial potential, living conditions, and the onset of natural disasters, including drought and floods. In addition to messages on forest degradation it has given legal recommendation for instance, giving legal recognition to the traditional entitlements of forest dependent communities taking into consideration the provisions of the Panchayats (Extension to the Scheduled Areas) Act (PESA). This would remedy a serious historical injustice, secure their livelihoods, reduce possibilities of conflict with the Forest Departments, and provide long-term incentives to these communities to conserve the forests. Measures given for management of desert ecosystem are of relevance for drought. Section 5.2.2 states the measures of intensive water and moisture conservation through practices based on traditional and science based knowledge, and relying on traditional infrastructure, Enhancing and expanding green cover based on local species and reviewing the agronomic practices in these areas, and promoting agricultural practices and varieties, which are well adapted to the desert ecosystem.

3. Climate Change and Food Security in India

India is considered to be the second largest producer of wheat and the national productivity of wheat is about 2708 kg/ha. In Haryana, night temperatures during February and March in 2003-04 were recorded 3°C above normal, and subsequently wheat production declined from 4106 kg/ha to 3937 kg/ha in this period. According to a study done by the Indian Agriculture Research Institute, the impact of climate change with increased temperature and decreased radiation will lead to decrease productivity in rice in the North Eastern region. Sometimes sudden events for example the floods in Thar desert in 2006 or relatively slow events like the incursion on sea water into inland Orissa over the last two decades has caused stress in regional food production. Already the global use of water exceeds the renewable supply, with 15-35% of total water withdrawals for agriculture estimated to be unsustainable. The onset of the summer monsoon in India is getting delayed and disturbed. This affects crop cycles and cultivation in rainfed areas. Monsoon delays and failures inevitably lead to a reduction in agricultural output, thereby deepening food insecurity (Ranuzzi and Srivastava, 2012).

Food security under the changing global climate in India needs to be considered in the contexts of food production, job creation and income generation and conservation of the ecological base for sustained agricultural production (Sinha, Rao, Swaminathan, 1988).

The Steering Committee Report on agriculture for the Eleventh Plan (GoI, 2007a) has identified the possible reasons for slow down in agriculture since the mid-1990s. According to the report, the major sources of agricultural growth are public and private investment in agriculture and rural infrastructure including irrigation,

technological change, diversification of agriculture, and fertilizers. It seems that progress on all these fronts has slowed down since the mid-1990s.

A large public distribution system, supplemented by arrangements for moderating prices in the open market and concerted efforts for achieving self - sufficiency in foodgrains, coupled with measures for maximising procurement from surplus areas, have been the twin objectives of food policy in modern India, ever since the Bengal famine of 1943. These objectives have held sway over the last 55 years, though with changes in emphasis and varying degrees of rigidity, from total control to total decontrol, depending upon the prevailing situation and assessment at each point of time" (GoI, 2000).

Immense importance is being laid on the building of buffer-stock since the frequency of floods and drought have increased in the recent past thus putting a strain on food security. One major reform needed in the agriculture sector relates to reduction in subsidies and increase in investments. Public investment declined from 3.4 per cent of agricultural GDP in the early 1980s to 1.9 per cent in 2001-03. At the same time subsidies increased from 2.9 per cent to 7.4 per cent of agricultural GDP (GoI, 2007). Public investments in R&D to infrastructure for increasing climate adaptation in the agriculture sector needs to be improved.

As the National Commission on Farmers mentions, there is a knowledge gap in the existing technology. Therefore, extension becomes crucial for improving agricultural productivity. In view of the high variability in agro-climatic conditions, particularly in unfavourable areas, research has to become increasingly location specific (Dev and Sharma, 2010).

There is major mismatch between water supply and water demand for agriculture in India. Eastern India extending over Bihar and eastern UP, which is part of the Gangetic alluvium, is abundant in both surface water and groundwater. This region continues to be a net importer of food grain (Amarasinghe et al., 2004), and is agriculturally very backward (Evenson et al., 1999). This limit mainly comes from poor land availability due to very high pressure on land; very little additional land that can be brought under irrigation; high degree of land fragmentation; poor public investments in rural infrastructure including irrigation and electricity; ecological constraints due to floods; and overall lack of institutional and policy reforms in agriculture sector (Dinesh Kumar, Sivamohan, Narayanmoorthy, 2010).

There needs to be a detailed evaluation of the technologies and procedures employed for assessment of geological or hydrological conditions. For example the current district-wise assessment of groundwater development does not take into account the long-term trends, as the latest methodology suggests. A region might have experienced long term decline or rise in water levels; but a few years of abnormal precipitation (either drought years or wet years), may change the trends in the short run. Hence, assessment of over-draft conditions should integrate hydro-dynamics, i.e., the way groundwater levels behave (Dinesh Kumar, Sivamohan, Narayanmoorthy, 2010).

The potential future impacts of groundwater over-exploitation in a particular region on India's food security depend on: the relative contribution of well irrigation in that region to India's food security; the degree of over-exploitation of groundwater in the region; and the degree of vulnerability of the region (Dinesh Kumar, Sivamohan, Narayanmoorthy, 2010).

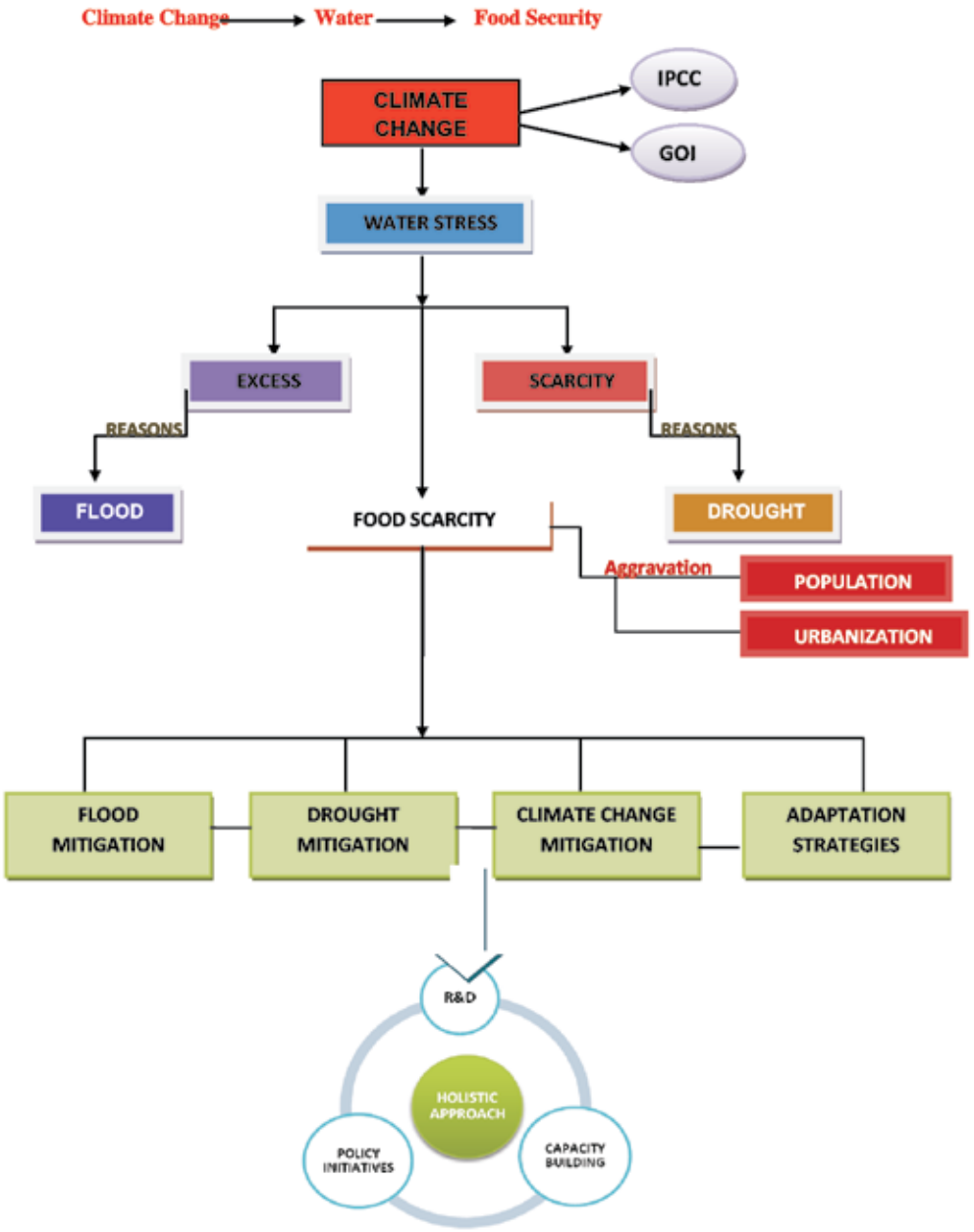


Fig.1 : Climate Change Mitigation and Adaptation Strategies

4. Scientific Innovation and Projects Involved

4.1. Projects being implemented

There are a number of efforts by different bodies and organization, both governmental and non-governmental working on Climate Change Adaptation and Disaster Risk Reduction. One objective of this initiative would be a study of the different endeavours, the diffrent technologies being used in the project and their respective perspective which would further fortify the base for a discussion on the topic of climate science and policy interaction.

I. The North East Climate Change Adaptation Programme which is to be a Detailed Planning of Adaptation Measures to contribute to the NAPCC and the State Action Plan on Climate Change

II. The National Cyclone Risk Mitigation Project under the aegis of NDMA and funded by World bank, seeks to minimize vulnerability in the cyclone hazard prone States and Union Territories of India and make people and infrastructure disaster resilient, in harmony with conservation of the coastal eco-system.

III. TERI in partnership with UK Met Office is conducting a research study to Assess the climate change vulnerability and adaptation strategies for the state of Maharashtra

The study will formulate sector specific policy recommendations in the adaption framework for climate change risk reduction. Specific research outputs of study which are listed are Regional Climate Projections, Impacts Assessments, Vulnerability Index, and Adaptation Options. The project employs high-resolution regional climate model (RCM). RCMs are dynamical downscaling tools with provisions for region specific topography to provide accurate regional climate projections at the state level. High resolution (25X25Km) regional climate projections for the state of Maharashtra for the time periods of 2030's, 2050's and 2070's will be used In the project detailed impact assessment will be carried out on the sectors of Agriculture, Human Health, Coastal Urban Systems, Water, Ecosystems. Vulnerability assessment of the state at district level will be carried out. A district level vulnerability index, based on select indicators that cover the elements of exposure to communities to various climatic hazards, sensitivity and adaptive capacity will be constructed at two levels, scoping level and detailed assessment level(Tahsil/ Taluka level). Climate change hotspots will then be identified based on the index, which in turn would aid in preparation of case studies. Based on the vulnerability index, climate change hotspots will be identified which, in turn will be used to draw adaptation plans and strategies. The outputs of the case studies will aid in the identification of case specific adaptation options. The index will further aid in the prioritization of adaptation options.

Sources:

(http://www.ccmaharashtra.org/index.php?option=com_content&task=article&id=7).

(http://www.ccmaharashtra.org/index.php?option=com_content&task=article&id=6)

(http://www.ccmaharashtra.org/index.php?option=com_content&task=article&id=8)

IV. Climate change and India: A 4x4 assessment (A sectoral and regional analysis for 2030s), by INCCA under MOEF (Assessment Report)

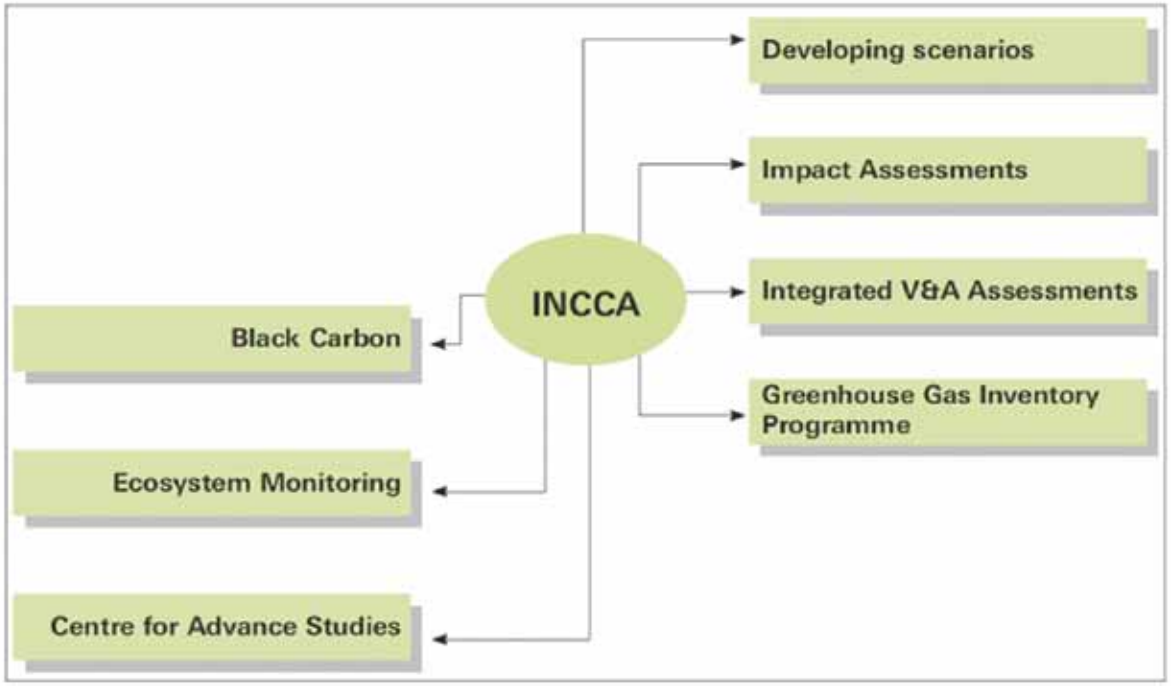


Fig 2. Programmes envisaged under INCCA

V. The German Federal Ministry for Economic Cooperation and Development (BMZ) commissioned a project entitled Climate change adaptation in rural areas of India for the term 2009-2014 and the Lead executing agency being the Ministry of Environment and Forests (MoEF)

VI. A NAIP-World Bank/GEF project on Adaptation to Climate Change and livelihood with specific objectives of identification of current and future risks to livelihoods due to climatic variability, development of drought indices, capacity building and Developing community based sustainable rural livelihoods

VII. A project by WOTR – SDC Partnership on Climate Change Adaptation whose main site location is Maharashtra with Nation-wide outreach with the main partners being NABARD and WOTR.

VIII. The Asian Development Bank has approved a number of infrastructure and capacity building projects on environmental sustainability. Some such are Karnataka Integrated and Sustainable Water Resources Management Investment Program, Advanced Project Preparedness for Poverty Reduction- Capacity Building and Institutional Strengthening for the Assam Urban Infrastructure Investment Program,

IX. The YGL Initiative on Indo-Pak Cooperation on Climate Change and Disaster Risk Reduction: Managing risks, sharing benefits.

X. The project Strengthening Adaptation Capacities and Minimizing Risks of Vulnerable Coastal Communities in India (AdaptCap) financed by the European Commission under the programme Thematic Programme for Environment and Sustainable Management of Natural Resources, including Energy aims at increasing knowledge, planning and adaptation capacities of coastal communities concerning climate change adaptation (CCA), disaster risk reduction (DRR) and climate change mitigation (CCM) in Andhra Pradesh and Tamil Nadu, India.

XI. The Asian Disaster Preparedness Centre (ADPC) has an ongoing project Climate Impact Reduction and Resilience in Support of the Asian Cities Climate Change Resilience Network (ACCCRN) - Phase 3 which provides On-demand technical assistance for Asian Cities Climate Change Resilience Network (ACCCRN) partners during city-level project design and implementation phases in Thailand, Indonesia, Vietnam and India.

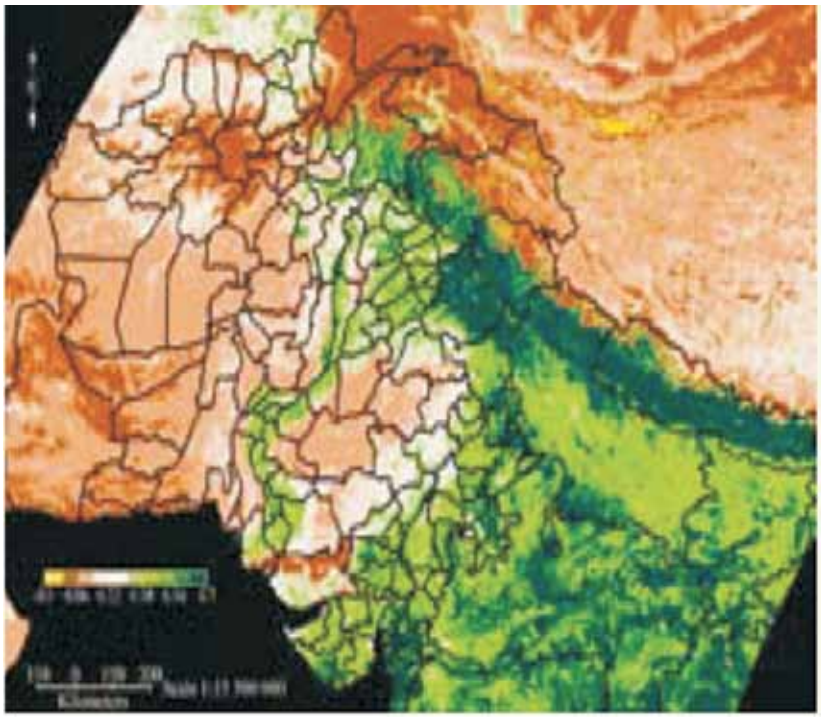
XII. The BASIC - Project which works towards linking national and international climate policy: capacity building for challenges ahead for Brazil, China, India and South Africa sponsored by The Environment Directorate General of the European Commission

XIII. The Indo Swiss Collaboration in Bio-Technology whose main aim is to develop products and biotechnological processes which have an impact on poverty reduction and sustainable management of natural resources in India and to build capacities of Indian institutes and to promote R&D partnerships between Swiss and Indian institutions and private companies with strong economic, social, and ecological relevance.

XIV. The Emmanuel Hospital Association has several regional projects in the country whose main aim is to initiate adaptation and DRR work.

XV. The ACCCRN has projects in cities of Gorakhpur, Surat and Indore to strengthen urban climate change resilience and the lead facilitation partner is ISET.

XVI. START Project-Towards Integrating Disaster Risk Reduction and Climate Change Adaptation: Understanding Flood Risk and Resilience in Eastern India to improve understanding of the systemic factors contributing to flood resilience under changing climate conditions in Gorakhpur district.



Drought Monitoring and Early Warning. South Asia Drought Monitor is an evolving drought monitoring tool developed by IWMI. It uses freely available satellite data to monitor ground vegetation as an indication of drought progression. Reporting in near real time, the system currently covers Afghanistan, Pakistan and western parts of India. With further improvements, including building in weather forecasts, this could provide an effective early warning system for droughts, allowing early action to reduce impacts. (Climate, agriculture and food security: A strategy for change, CGIAR, 2009)

Fig 3. Drought monitoring and early warning

Although a national grid at the present time seems unfeasible, what can happen and might become more common, is the transfer of water within company areas and across local boundaries. This approach has the benefit of utilising the existing infrastructure (possibly with some local reinforcement) to help meet future demand. (Source: http://www.water.org.uk/home/policy/positions/national-water-grid)

Climate change impact assessment and adaptation studies require predictions from climate models. To plan for adaptation some important changes are required in the features provided by current climate models (Kavi Kumar, Shyamsundar and Arivudai Nambi,). For example climate predictions are needed at finer spatial resolutions than are currently available from the global climate models. Also, future scenarios of climate need to go beyond predictions on temperature and precipitation. Along with these primary variables, the impact and adaptation community would benefit from knowledge on secondary variables such as heating degree days that combines information on available temperature range over the growing period of agricultural crops, heat index, starting and ending days of seasonal monsoon rainfall, storm surge etc. (Patwardhan, 2010)

5. Capacity Building

In general, the improvement in adaptive capacity refers to either increment in financial resources, reduction in poverty, provision of diversified income sources, better governance, social and political capital and even equitable flow of resources etc (Smithers and Smit, 1997; Yohe and Tol, 2001).

The challenge is to disseminate a sufficient quantity of fundamental research and useful technologies in time for adaptation to develop. The information necessary will be very different depending on the regions and sectors considered. There should be a good understanding and convergence between the public sector and the private sector. The first should disseminate general information on climate scenarios, impacts and adaptation at a minimal cost since this information can be considered as a public good. The second (with the eventual collaboration of public institutions) could provide more detailed analyses by region or by sector, since these analyses require a specific effort and have a significant marginal cost (Hallegatte et al., 2011).

Institutions are pivotal to implementing adaptation strategies. The ability to produce well-balanced arrangements is critical since existing institutions may be subject to increasing pressures as a result of climate change. For example, water distribution among users may become even more conflictual in the future than it is today (Hallegatte et al., 2011). Responsibilities should be properly defined so that there is no confusion in undertaking adaptive actions among different institutions. To avoid such situations prior consultation among each other is advisable and every detail should be discussed thoroughly.

Perception can be viewed as a process of transforming inputs (e.g. flood warning) to output (e.g. public mitigation response) (Burn, 1999). People who perceive that they are vulnerable are more likely to respond to warnings and undertake protective measures (Michael and Fasil, 2001).

When designing an adaptation plan, it is therefore necessary to distinguish marginal disturbances that require a simple adjustment of practices, and structural changes made necessary by climate change. Public action and transition support will be especially necessary in these latter cases that should be carefully identified (Hallegatte et al., 2011).

The strategies should be so dynamically formulated that in a way they can be manoeuvred accordingly even in the distant future taking into account latest information and technologies Within this framework, in addition to determining what must be done, we must, above all, determine when it must be done, taking possible time arbitrages into account, and who is responsible for doing it.

6. Access to Markets and Food Security

If the access to international food markets is improved the country will benefit not only in the natural resources sector but only the national food security situation can be enhanced. Some policy actions can be taken in this direction. Although food import is not a big issue in India even then improvement can be incurred in the acquiring processes. There can be decisive ways of tendering the imported food. These include electronic tendering and bidding and advanced credit and hedging products (source: WDR). One big step the country is already taking is relaxation of laws to usher in the FDI which will facilitate the multinational procurement, though every decision made should be cautiously done so as to avoid any abreaction. Another necessity is a well managed food reserve to dole the country out of emergency situations.

A small physical food reserve could allow a smooth response to food emergencies. An international coordinated global food reserve could reduce pressures to achieve grain self-sufficiency. And an innovative virtual reserve could prevent market price spikes and keep prices closer to levels suggested by long-run market fundamentals without putting the coordinated global reserves at risk.

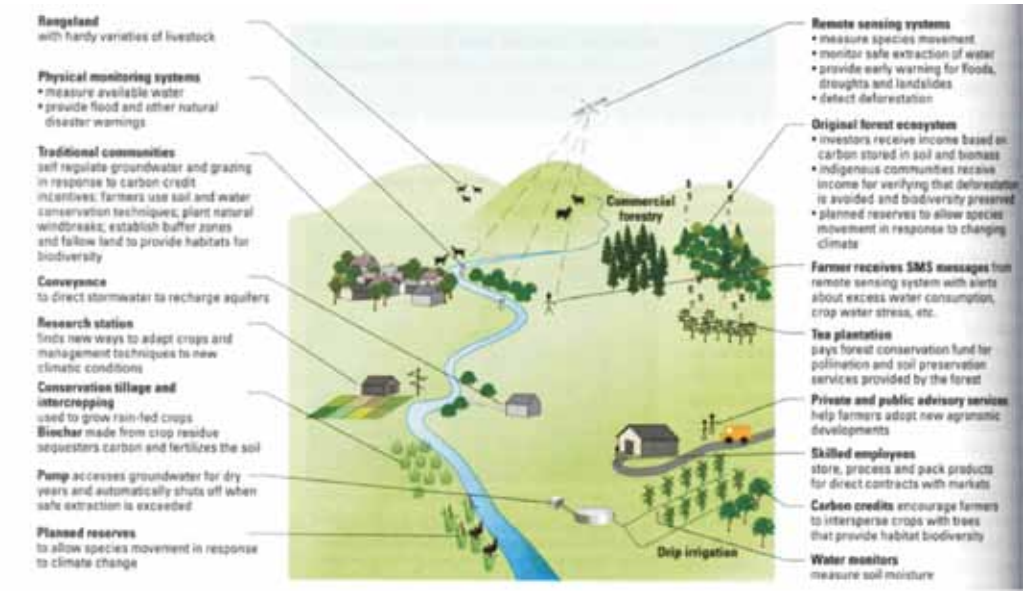


Fig. 4. An ideal climate smart agricultural landscape of the future would enable farmers to use new technologies and techniques to maximise yields and allow land management to protect natural systems with natural habitats integrated into agriculturally productive landscapes (source: WDR)

7. Disaster Management Strategies in River Basin Management- A Case Study Of Indo-Gangetic Basin

Should there be rivers in the land which drain off from the ground the stagnant water and the rain water, then the people will be healthy and bright. But if there be no rivers and the water that people drink be marshy, stagnant and fenny, the physique of the people must show protruding bellies and enlarged spleen.-Hippocrates

In India, the Indo-Gangetic basin extends from Punjab to Assam and the total basin area is 225.2 million ha & the net cropped area is 114 million ha. The most intensively farmed zone in the country, wheat being the major crop in the western part and rice is grown in the eastern section. Rapid change in land use, cropping and water use patterns, partly as responses to changing demographics and consumption patterns, and partly as responses to changing investment scenarios and economic growth. Some of the largest cities are expanding to low lying areas which are preserved as wet lands and drainage channels acting as buffering zone for floods. The river banks and drainage areas have some of the biggest and most polluting factories and plants which result in degradation of water quality as a lot of waste is dumped into the water and it affects population living downstream. The most effective disaster management mitigation can come about by a multi-pronged river basin management strategy. The Major Problems which are existent are Flood, Drainage congestion, Erosion, Water quality degradation, uneven distribution of rainfall.

i) Methods

- Micro-irrigation-As means to save water in irrigated agriculture.

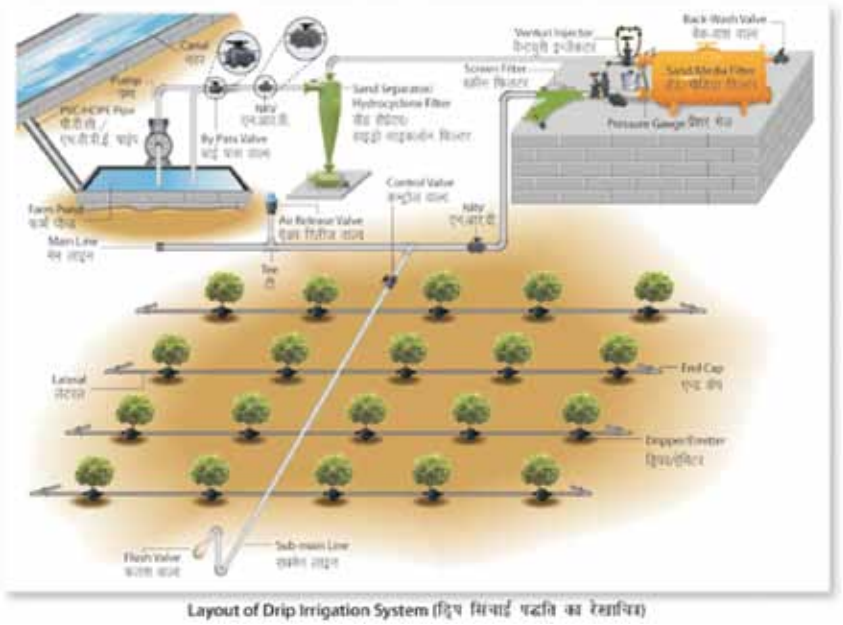


Fig. 5 Drip Irrigation System

- Water-Shed Management (Micro and Macro level)-It is important for the improvement and maintenance of good water quality. In the recent years the water quality standards have come under stress due to increasing population, depleting water resources, bad management practices.

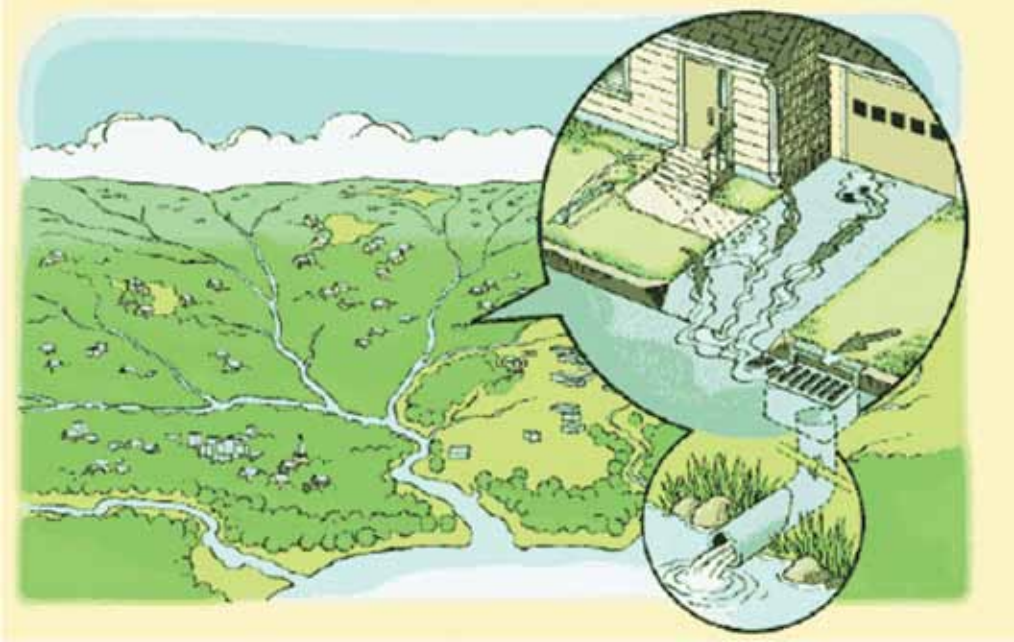


Fig. 6. Water Shed

- Embankments- Provide a reasonable amount of protection against small and medium sized floods. Shifting of river courses checked

Fig. 7. Embankment

- Afforestation- 1) Minimize soil erosion 2) Decrease Soil sediments
- Flood Plain Regulation- Regulation of land use in flood plains thus decreasing the chances of disaster.
- Flood Proofing- 1) Raising of villages 2) Quick drainage facilities
- Flood Insurance- yet to be implemented

ii) Present situation

The Government of India launched the Integrated water-shed Management plan in 1980-81 for the Indo-Gangetic Basin. There has been a lack of coordination among federal and provincial governments, research institutes, and national and international organizations; conventional farming and irrigation methods used by farmers; limited attention to reclamation and saline agricultural approaches; and lack of resources are identified as some of the reasons for the low success rate.

iii) Results of studies funded under GAP

- 75 per cent of the pollution load was from untreated municipal sewage
- 88 per cent of the municipal sewage was from the 25 Class I towns on the main river.
- Only a few of these cities had sewage treatment facilities (these were very inadequate and were often not functional)
- All the industries accounted for only 25 per cent of the total pollution (in some areas, such as Calcutta and Kanpur, the industrial waste was very toxic and hard to treat).
- Multiple uses of water are gaining importance in the Indo Gangetic Basin. It has been undertaken at experimental farms, watersheds and farmers field.
- Under GAP a total of 261 sub-projects were sought for implementation in 25 Class I (population above 100,000) river front towns.
- Importance was given to generating awareness through intensive publicity campaigns using the press and electronic media, audio visual approaches, leaflets and hoardings, as well as organising public programmes for spreading the message(for GAP).

Fig. 8. Integrated Rice-fish system

iv) Discussion

In Indo Gangetic plains (IGP) simple seed priming technique soaking chickpea seeds in water and micronutrient solution for six hours and drying in shade could establish good chickpea crop in rice fallow areas and increase crop production and incomes by using residual soil moisture. This technology can be

applied in 12 m ha rice fallows in India spread in MP, Orissa, Jharkhand, West Bengal and Chhattisgarh. Bank erosion by the Ganges& its tributaries has become a matter of serious concern and erosion control works are very expensive. Several capital towns situated on riverbanks have been provided protection against 100-years' floods and are fully protected by embankments. Adverse effects of Embankments:- Induced drainage congestion and water-logging behind the embankments and Enhanced flood problems in unprotected area between the embankments. To regulate flood-plain use, the land has been divided into three categories: Prohibitive river channel and floodway of design flood (100-years' flood); Restrictive extent to which inundation is caused by design flood (50-years' flood); and Warning extent to which the largest flood spreads (25-years' flood). Villages mainly raised in Uttar Pradesh, West Bengal and Haryana in the Gangetic basin. Flood forecasting was brought into operation in 1969 by the Central Water Commission (CWC).

8. Bundelkhand- A Case Study

Since crop production, livestock rearing and seasonal outmigration provide more than 90% of rural income in the Bundelkhand region (Samra, 2008) the effect of recurrent drought on this region is palpably devastating. The NRAA report on Drought mitigation in Bundelkhand mentions climatic changes as a reason for increased frequency of drought occurrences. It goes on to state that climatic changes have increased frequency of extreme weather events during past 15 years and raised the vulnerability and risk. Since 2004-05 the region has been plagued by increased frequency of drought occurrence. Studies have tried to analyze the problem of less water availability and usually the reasons are wide variations in seasonal availability of water, as a result of perennial water sources becoming seasonal due to high levels of run-off, reduced ground water recharging, over exploitation of groundwater and neglect of traditional water harvesting structures. Added to these is the wasteful use, even when the water is available. Water use in agriculture is highly inefficient with water intensive crops being grown using the wasteful flood irrigation method. With growing water scarcity, institutions such as the Water Users' Associations are witnessing increasing incidences of conflicts. There are encroachments on private properties, Panchayat lands and even village ponds for tank-bed cultivation. Within WUAs, there is favoritism towards farmers with large land – holdings and those at the head reach of the command area. According to the MP Right to Food Campaign and the MP Apda Niwaran Manch, coalitions of civil society groups working in the region, the MP side of Bundelkhand reported nearly 45 percent dip in foodgrain production during 2003-07. In 2003-04 Bundelkhand region produced 2.45 million tonnes of foodgrain which came down to 1.13 million tonnes in 2006-07. The decline in production of all grains during this period was around 43 percent. The production capacity has come down from 1,035 kilograms (kgs) per hectare (Ha) in 2003 to 806 kgs/Ha in 2007. The tribulations affecting the water and food scenario in this region can be used as model in other circumstances in the country.

i) Present Situation

Ironically, this once rich region has now become one of the poorest parts of the country. Except for Sagar and Jhansi districts, around 60 % of main workers in Bundelkhand are engaged in agriculture

as cultivators or labourers, showing a higher reliance on agricultural land compared to other parts of rural India. Industrialization has been sporadic and this in turn has led to low levels of urbanization. Living conditions are harsh especially for the rural poor who depend mainly on agricultural incomes for sustenance, and are therefore highly vulnerable to drought and failure in cropping systems and loss of employment and incomes. With recurring drought and failure in agriculture, the level of poverty in rural (Tendulakar Committee Report, 2009 & Economic Survey, 2009-10areas has increased since a large number of farmers depend on rain fed agriculture. According to the inter-ministerial central team report (Samra,2008), even though about 45 % of net sown area in Bundelkhand is irrigated, the water supply is not adequate.

The failure of the monsoons has severely affected the available water in river systems. The resulting diminishing water available in surface water sources as well as depletion of groundwater tables has not only decreased the availability of drinking water for people and domestic animals, but also impacted the natural vegetation and growing grasses (crucial as fodder). Most tribal population inhabiting forests areas adjacent to rivers have no choice but to continue to exploit forests for survival and cause further over exploitation of resources. The repetitive crop failures and depletion of natural resources has led to widespread and increasing trends of migration to urban areas. With the collapse of monsoons and arrival of successive dry years, the inhabitants of Bundelkhand are now facing scarcity of water in almost every season. Urban areas are no better off than rural areas. The expense of securing water has been raised and the resource is treated as a commodity. Most urban municipalities supply water in the urban areas of Bundelkhand only twice or thrice a week.

A number of projects, both governmental and non-governmental have been implemented in the region dealing with vulnerability reduction and mitigation of the effect of drought. A project of UNITAR entitled RISK COMMUNICATION FOR ADAPTING TO CLIMATE CHANGE – Communicating risk to policy makers and vulnerable community for assisting planning process in adaptation strategy to climate change at district level was implemented in Bundelkhand. The NGO Development Alternative has a Climate Change Adaptation Group works with policy-makers, foresters, scientists, research institutions, non-governmental organizations, government and rural communities in Bundelkhand. AFPRO along with funding partners CRS, OXFAM, IGSSS-Lucknow and FORRAD, New Delhi formed a consortium with the common goal of development of natural resources for three villages in Bundelkhand. The project, Bundelkhand Consortium Watershed Development Programme, is being provided socio-technical support by AFPRO. The Bundelkhand package, A GOI initiative, is being implemented in 7 districts of Uttar Pradesh and 6 districts of Madhya Pradesh states with total approved cost of Rs. 7466 crore comprising Rs.3606 crore for Uttar Pradesh and Rs.3860 crore for Madhya Pradesh. It is envisaged to provide Additional Central Assistance (ACA) to the tune of Rs. 3649 crore (49%) for implementing the package. A number of development schemes are being implemented by the government and vulnerability analysis studies are being carried out.

ii) Water Scarcity in Bundelkhand

For most of the year, the residents of Bundelkhand experience acute scarcity of water for agricultural and domestic use. Water sources are varied and often seasonal, ranging from ponds, tanks, lakes and streams to open wells, bore wells and irrigation canals radiating out from large-scale dams. Most agriculture is of the single-crop variety and rain fed, with supplementary water from open wells. Thus, a large number of farmers are highly dependent on the monsoon rains to recharge these wells.

Agriculture: A hopeless proposition

The Bundelkhand area in MP is reporting more than double food grain production decline in comparison to the state figure. What is worrisome is the drop in yield; it is around four times that of the state

District	Decline in food production (%)	Reduction in yields (%)
Chattarpur	58.06	35.35
Tikamgarh	76.81	48.48
Panna	28.02	10.41
Sagar	30.75	2.58
Damoh	15.94	10.51
Datia	44.18	18.31
Budelkhand	44.67	22.13
M.P	13.86	6.41

Source: MP Right to Food Campaign, May 2008, Bhopal

iii) Capacities: Mitigation and development

Bundelkhand region is characterized as a hot semi-arid eco-region and the agriculture depends on rainfall. The J S Samra committee report on drought mitigation strategy for Bundelkhand has suggested that historically drought came every 16 years, which rose threefold during 1968 – 1992 to once every 5 years and became a recurring annual feature since 2004. Rampant poverty in the region has forced the population to exploit the environment. For instance, collection of fuel-wood through unsustainable tree-felling and reckless mining is the only activities left for the survival of local people's livelihood. The environmental problems in the region have a very complicated relationship with climatic conditions, variability and different aspects of the population.

In Bundelkhand there is also the problem of massive discrimination against certain sections of the society, which aggravates the already festering problem of discontent. The lack of proper implementation of government schemes further aggravates the problem of backwardness and environmental degradation

iv) Traditional knowledge

Traditional technologies have evolved to fit the environmental and social context of the region and that is why they are so very effective. Systematic integration of cultural heritage and appropriate traditional technology, skills and local knowledge systems within present day developmental efforts, can provide effective means of reducing the impact of disasters. In view of the desertification and land degradation processes in Bundelkhand, learning from traditional knowledge and mitigation strategies comprises tapping a wide range of accumulated experience to manage natural resources in farming, grazing, landscape restoration as well as the institutional and organizational arrangements required. The ancient knowledge and technology of Bundelkhand incorporates wisdom instilled through millennia of experimentation and trial and error.

Bundelkhand had a vast number of traditional irrigation methods and environmental friendly methods of storing water from the time of the Bundela Rajputs. An example is the talabs or natural ponds called pokhariyan at Tikamgarh, which were used for drinking and agricultural purpose. Incidentally when these would dry, the beds were used for cultivating rice. Another system of irrigation was the pat system in which the specificity of the terrain was taken into account and water was engineered to flow from swift flowing hill streams into channels. This was possible due to the presence of gullies and ravines in the area. Stone check dams called bandhas were

built across streams and gullies to capture the monsoon run-off for irrigation. These check dams also helped in increasing the fertility of the soil by facilitating silt deposition due to the checked water. Chandela tanks are unique reservoirs of the region which get their name from their origin during the rule of the Chandela kings. The main structure used to be earthen embankments supported by partitions made of rough stones. These were built to catch rainfall run-off flowing through gullies as streams. These tank structures have a width of 60m or more and have survived so many centuries since they are constructed with lime and mortar. The only problem which these tanks are facing is siltation of tank beds. The region also has bigger more elaborate Bundela tanks with a flight of stairs leading to the water. They were symbols of power and glory of royalty and were usually accompanied by orchards and other grand decorations. They were costlier to build than Chandela tanks and maintenance was also expensive.

Jhansi is the “Gateway of Bundelkhand” and is an important destination of the Bundelkhand region. Its greatest claim to fame is huge water harvesting ponds of the period of Bundela and Chandelas. These have been encroached upon and demolished by the local and/or influential people. The Government cannot solve entire problem; it is ultimately up to the people become familiar with their local water resources. Trees and plants should be preserved now in order to prevent soil erosion and promote infiltration water into the soil and ultimately, the aquifers. Civil society institutions need to be educated and strengthened to respond to water quality problem quickly. This is possible through better knowledge and information about the nature of the ground water contamination, potential sources of threats to ground water quality in their region and degree of vulnerability, the ill effects of using contaminated water and the possible preventive measures.

However the original irrigation systems have been largely ignored for the last couple of decades as a result of the emergence of green revolution that swept the whole country, with its associated surge in the implementation of bore wells and submersibles. This has resulted in water being abundantly extracted without appropriate counter-mechanisms to recharge the removed water. The traditional Chandela and Bundela tanks have been largely neglected and population has encroached on these structures. There needs to be proper and scientific exploitation of water from rivers to help rural areas located near rivers and renovate the thoroughly neglected canal system. There is a huge scope for improving available water resources by proper repairing of these tanks; as well as provide employment to the rural population through the restoration of these structures and construction of check dams.

Other examples of traditional wisdom are windbreaks, made of trees or stones and built at right angles to the prevailing winds or as obstacles at an angle to the wind so as to force it to change direction for simply spreading water on land after ploughing; this stabilizes the fertile components of the soil by increasing soil cohesion. In traditional cultivation methods, crop production and fertility of soil is improved by application of ash to plants, application of dilute urine to plants and seeds in order to clean them and give protection against diseases and pests; and harvesting of spontaneous fodder and burning of land to promote re-growth.
One should remember Native American Proverb “We do not inherit the earth from our ancestors; we borrow it from our children”.

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v) Development Schemes in Bundelkhand

For mitigating the impacts of drought and improving the livelihoods of people, the central and state governments have implemented a number of schemes in the area, whose activities are facilitated further by the involvement of NGOS and other non-profit organizations.

Swajaldhara

This water sector reforms project was launched in December 2002 as Swajaldhara to improve the availability of drinking water especially in rural areas. Swajaldhara Project is ideally suited for small village based self-sufficient schemes. There was a general recognition that a transformation from a target based, supply-driven approach which pays little attention to the actual practices and/or preferences of the end users, to a demand-based approach, where users get the service they want and are willing to pay for, was urgently required. Implementation of a participatory, demand driven approach under Swajaldhara was expected to ensure that the public obtained the level of service they desired and could afford to pay part of the capital cost and full operation and maintenance cost.

National Watershed Development Project for Rainfed Areas (NWDPRA)

Launched in 1990-91 at the block level for the benefit of areas where the assured means of irrigation is less than 30% of total cultivable area, the main guiding principles NWDPRA's are: conservation of natural resources, integrated development of natural as well as social resources, in-situ moisture conservation, sustainable farming system, adoption of ridge to valley approach, production enhancement activities for land owners and livelihood support for landless families.

Integrated Wasteland Development Programme (IWDP)

The Integrated Wasteland Development Programme (IWDP) of the Government of India was started in 1989-90 and seeks to develop government-owned wastelands and common property resources (CPRs), on the basis of village-level or micro-watershed plans.The focus is on cultivable wastelands, since uncultivable wastelands are not generally considered for treatment, as such lands are often so degraded that the cost of treatment is very expensive and the lands are far from villages, making management of projects difficult.

Drought Prone Areas Programme (DPAP)

DPAP seeks to reduce effects of drought by funding projects for developing watersheds, water resources and pastures/afforestation projects in identified 'drought prone' blocks; the DPAP list includes blocks of Jalaun, Banda, Chitrakoot, Hamirpur and Mahoba districts.

Artificial Recharge to Groundwater Through Dug Wells (ARGTDW)

ARGTDW supports recharging groundwater resources by collecting rain water and diverting it to existing open wells that are dry or almost dry. Recharge pits with desilting chambers have to be constructed near the open well; desilted water is led from the pit to the bottom of a well by a PVC pipe. The total cost involved is estimated to be Rs 4000 per installation.

Integrated Child Development Services (ICDS)

ICDS seeks to provide supplementary nutrition, health care and pre-school education to children below the age of six. Under a Supreme Court order of December 13, 2006 in the Right to Food case, all settlements that have at least 40 children under the age of six have to set up Anganwadis within three months of the rural communities and slum dwellers making such a demand.

Mid-day Meal Scheme

The Mid-day Meal scheme is the result of a November 28, 2001 order of the Supreme Court in the Right to Food case, directing state governments to provide cooked mid-day meals in all government and government-assisted primary schools.

Swarnajayanti Gram SwarozgarYojana (SGSY)

SGSY is meant to promote entrepreneurship among rural poor by organizing them in self help groups (SHGs), and providing income-generating assets through a mix of bank credit and government subsidy, so that the poor rise above the poverty line.The central government provides 70% of the funds for implementation of the scheme in a state; the state government provides the rest.

Accelerated Rural Water Supply Programme (ARWSP)

ARWSP supplements efforts of state governments to provide safe drinking water in all rural habitations. Panchayati Raj institutions have to be involved in selecting locations of supply points, spot sources, operation and maintenance and fixing of water tariff.

Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT)

UIDSSMT partially helps small and medium towns get over chronic resource problems. UIDSST provides funds for water supply, sewage and solid waste management schemes; re-development of old congested areas and construction of roads and parking spaces. The central government provides 80% of the funds for projects appraised by a state-level implementing agency.

Pradhan Mantri Gram SadakYojana (PMGSY)

PMGSY provides 100% funds for constructing all-weather roads to unconnected habitations in rural areas. The scheme also funds construction of necessary culverts and drainage structures

Backward Region Grant Fund (BRGF)

BRGF, set up in 2006 under the Union ministry of Panchayati Raj, provides a good opportunity to identify challenges and opportunities in backward districts and make realistic plans with involvement of people and elected representatives up to the district level.

Rashtriya Krishi Vikas Yojana (RKVY)

RKVY, launched in 2007, provides 'additional central assistance' to Central government and state schemes related to agriculture. Among the projects funded by RKVY is region-specific agriculture research and preparation of district agriculture plans, taking into account local needs and conditions.
(sources :Swajaldhara guideline, Ministry of Rural Development, Bundelkhandinfo.org)

vi) Drought-Proofing

Conceptually, drought proofing means the capacity to meet the basic material and physical needs of the local population - human and animal - in a drought period so that there is minimal distress (Chopra, et al., 1995). As a process, drought proofing is a continuing one that spans lean and normal years. The nature of drought-proofing works and activities during the two periods can be quite different. For example, in normal years, land and water management must focus on enhancing the biomass on lands of marginal farmers and on landless people. During droughts, they must be targets of employment generation programmes. In India, policy approaches to handle drought and drought proneness rely on three aspects: rainfall, soil moisture and irrigation. Soil moisture and water balance lie at the heart of how we understand the related concept of dryness and dry lands. Soil moisture depends on several factors: rainfall, temperature, moisture retention and porosity of soil, run off of rainwater, vegetation, etc.

A range of diverse factors go into the making of a drought as disaster. These factors are based in the ecology, bio-production conditions, socio-economic conditions, etc. Rainfall deficiency (quantum, distribution and reliability) need not necessarily result in distress and shortages to the level of causing disaster. The effect of rainfall deficiency depends on the implications of policy, technology and land-ownership regime in the area and is an outcome of a complex interaction between socio-economic, agro-ecological and governance issues. The new policy interventions are driving the focus to address 'drought vulnerability' understood as the ability (or inability) of the land and people to withstand drought or soil moisture distress and experience lower crop failure, out-migration, land alienation, livestock distress, water shortage, hunger and starvation, poor health, and broadly the range of ecological services, etc.. Drought vulnerability expresses itself as shortfalls in food, fodder, fuel, water and livelihood.

Rainwater is retained at different rates on the plains and on the hills as soil moisture or groundwater. Hence, the eco-geo-physiographical condition of a location where the rain falls is important determining drought mitiga-

tion interventions. Rain shadow areas with investment in sound water management strategies and extensive irrigation may experience less crop failure or out-migration than higher rainfall sugarcane growing areas. High forest and vegetative cover will reduce fodder shortages and livestock loss and helps maintains resilience for ecosystem and agriculture recovery after the stress is over. Grain banks, fodder banks and a good network of the public distribution system may prevent hunger and starvation.

vii) Institutional Framework

A proactive response to any natural disaster calls for an efficient co-ordination and resourcefulness at every tier of the government. As discussed earlier there are a number of institutions under the aegis of the central government which are sufficiently capable of monitoring as well as acting in advisory capacity regarding the drought situation. Yet there seems to be a significant shortcoming in the management of the devastating scenario in Bundelkhand. The reaction of the Government from the moment it declares a drought should be swift and retrospective so as to avoid any major debacle and disastrous long-term conditions. The timing of the declaration of the drought is extremely vital to the subsequent development.

Sometimes there can be a co-ordination gap as a result of which the team may reach the area after a major portion of the crop had already been harvested which might result in inaccurate assessment. This can be prevented by collaborating with the experts in the premier Central Government as well as State Government institutions where a thorough study is carried out on the different indices like Normalised Difference Vegetation Index, Moisture Adequacy index, rainfall deficiency.

The occurrence of drought is unavoidable since it is a normal recurrent feature of climate and occurs in all climatic regimes. The National Drought Assessment and Monitoring System (NADAMS) established under the National Remote Sensing Centre (NRSC) maintain detailed monthly records of crop and seasonal situations. The states of Uttar Pradesh and Madhya Pradesh are covered under NADAMS and can declare drought by utilizing the data on NDVI that are made available. However, while proclaiming drought occurrence other parameters and indices should be considered instead of any one.

For a long time the main focus of drought management have been temporary relief measures. However, recently there has been a directional change towards stable and enduring mitigation strategies. The benefits of agro-forestry, as well as alternate crops like pulses, oilseeds, fodder crops and Jatropha sp. have already been considered. However, there need to be an appropriate method to introducing and cultivating these less water-intensive crops at a village level in the 13 districts of Bundelkhand. There are district agricultural plans but there is need for constant revision since both the climate and society is ever changing. There has been a massive allocation of funds through the Bundelkhand package especially to the Water-shed sector. However, there has been a meagre improvement in comparison to the generous amount of funding.

Along with proper functioning of the government institutional mechanism there is requirement of balanced community participation. The local population always has the wisdom required for formulating necessary adapta-

tion strategies. Benefits of alternative land-use models with community participation in the case of Sukhomajri in Harayana are well known, where watershed management was effectively carried out by the village people along with the government help to build a catchment area since the entire area was barren and degraded. This one model brings forth not only micro-level success example but also the success of Joint Forest Communities and women empowerment.

Continuous drought has disrupted not only the way of life but also the social structure of the entire community. Rainwater harvesting is a process whereby the rainwater falling to the earth is collected for later productive use. Development Alternatives with the help of Self help Group designed and demonstrated fifty rainwater harvesting structures covering 18 kuchha roofs and storing water in 42 storage tanks (the rest being recharged into the aquifers) covers an approximate 29,000 sq ft roof area. It turns the average 600 sq ft roof size into storage capacity of the 300 m3 installed tanks with the potential to harvest about 3500,000 litres of water. Rooftop rainwater harvesting in Bundelkhand is probably the first effort to ensure not only the water sustainability but also to protect the vulnerable communities against the ills of climate change (Sonal Kulshrestha, 2008).

viii) Opportunities and Limits

It is only reasonable that a fair conclusion to this retrospective analysis can be drawn by discussing the prospects that can be harnessed under the circumstances and the limitations present in achieving them. Earlier under the heading of Capacities: Mitigation and Development we have discussed the specifics of traditional knowledge, agro-forestry and alternative employment. These are vistas of opportunities in Bundelkhand under the present conditions. With the right intent, accurate information and sustainable technologies they have the capacity to flourish and provide resilience to the population in the region.

Chandela and Bundela rajputs who themselves seem to be wise disaster managers of their times built Indigenous tanks and water reservoirs. However, these tanks and reservoirs are currently in a state of neglect and degradation. The restoration of these structures will not only bring long term relief but also provide employment for the larger population. The government already has social sector schemes like NREGS which provide employment to the rural population. Incorporation of services like rejuvenation of these ancient irrigation systems into the schemes would increase the benefit for the masses. The Bundelkhand Package has already allotted a magnanimous proportion of funds to resurrect the water management in the area. A wholesome administration would improve the employment situation in this context. The haveli system of irrigation has few takers in Bundelkhand after the dawn of the green revolution.

This is a Bundelkhand geography and climate specific irrigation system which can bring relief to the farmers without putting strain on the depleting water level. The concept of drip irrigation is still confined to well to do farmers and agriculturally prosperous states. However, if a micro-level finance system can be contrived with the help of government subsidies and a percentage of interested native population then there is a chance that micro-irrigation will have quite a few takers in Bundelkhand. The importance of popularizing Jatropha curcas as a crop has already been considered, however there is a need for popularizing cultivation of a variety of

fodder crops. There is a large animal population in Bundelkhand which suffers the same fate as their human counterparts. Fodder crops are less water intensive and they are also commercially valuable. Along with this construction of animal husbandry facilities for cattle and goats can be highly profitable. There is a big market for dairy products in our country and a proliferating dairy industry which goes side by side with animal husbandry can be favourable to the people.

According to a report on small scale industries of Uttar Pradesh the percentage of Industrial units in Bundelkhand is only 1.5% as comparison to 51.3% in the Western region of UP. The stark contrast reflects the aggravated socio-economic scenario in the region. The report recommended that the new small scale and tiny units in 26 districts of eastern UP and 7 districts of Bundelkhand should be given capital subsidy[4] . The extent of small scale industries can be diverse ranging from micro-irrigation to bio-diesel and even manufacturing toys and pickles by the rural female community which would enhance not only the economy but also improve the conditions of women in Bundelkhand. Bundelkhand also has some of the country's most historically significant and beautiful architecture. The tourism industry in Bundelkhand has great potentials and can be improved many folds by environmental improvements, hospitality and market promotion.

Every dynamic opportunity presents itself with a number of hurdles. Bundelkhand is in a quandary not only because of an unfavourable climate but also an overtly feudal social system which exists even in these modern times. Although some of the districts in the region are chronically drought prone, but the economic demise and social tensions are spread throughout the whole region. Most of the suicides are related to debts that could not be repaid to the money lenders who levy a high interest rate taking advantage of the dire state of affairs.
It is important to mention that Bundelkhand region hosts a range of institutes of higher education and professional education in the field of natural resources, agriculture, environment, biotechnology, fisheries, engineering & technology, medical & ayurveda,

tourism and hotel management, sports, etc. There are a number of good NGOs promoting people centric endeavours to use technological knowledge like bio-gasification, handmade paper making, pickle and sauces industry, etc. The universities viz. Bundelkhand University and the newly established Agriculture University are feeding knowledge and skills into the youth of the region for professional advancement and employability. The ICAR institutions like Indian Grassland and Fodder Research Institute, National Centre for Agroforestry, Central Soil & Water Research and Training Institute, offer significant potentials for capacity development on various aspects of drought proofing. However, impact of these institutions at the ground level have not been realised to the level expected. CSIR and ICMR can also be approached for their regional research centres, whereas MoEF and Planning commission can help strengthen the process by locating their centres on climate-change adaptation research and planning and integrated land-use planning. As the region has been calling for a Central University to foster the growth of academic advances and with chain of research institutes to help

[4]Report: A study of the problems of sick small scale industries in Uttar Pradesh and suggested strat gies for their revival, University of Lucknow and Planning Commission

promote the natural resource management with inputs of affordable modern science and technologies as a blend to the traditional and local knowledge aiming at improving people's attitude, directing to right adaptations, livelihood and social security and cultural strengthening as the basic grounds of sustainability.

9. Gorakhpur Floods

Intervention made for the management of floods and livelihood

The key issues are addressed in the district of Gorakhpur, Uttar Pradesh

- Agriculture is the main source of livelihood, with the majority of farmers belonging to the small and marginal category. Average landholding is less than an acre.
- Flood destroys not only Kharif crop but also delays the cultivation of next crop due to water locking and water logging. People's interest and investment in agriculture is going down.
- Male migration has increased since flood/ drought have become a regular feature and put an additional burden of responsibilities on women.
- Women particularly the elderly eat and drink less to avoid going to toilet, which is for them one of the biggest problems during the flood.
- During flood the only source of drinking water i.e. local hand pumps and India Mark II get submerged in floodwater resulting into acute shortage of drinking water.
- The spread of water born diseases like cholera, dehydration, typhoid conjunctivitis and skin rashes are not uncommon.
- In the absence of effective measures to reduce flood impact, community seemed to have lost hopes and has accepted flood as destiny and resign to their fate.
- Over the year's people's dependence on relief assistance have increased. Fear of floods at one point of time, has converted into aspiration of relief assistance.
- Level of community initiatives has lowered so much that even during distribution of relief; people indulge in manipulation and corruption.
- The flood management in the state of UP has been governed within an age-old policy framework, which includes post flood response, relief and compensation and rehabilitation measures.

Brief about the project site

Uttar Pradesh is one of the most flood prone states in India in which 43.4 lakh hectare (14% of the total state area) areas is prone to floods. According to National Commission on Floods around 23.2 % of the total flood prone area in the country is located in Uttar Pradesh. Eastern Uttar Pradesh, which is situated along the foothills of the Himalayas, is traversed by numerous small rivers, and it comes in the catchments of rivers Ghaghra, Rapti, Gandak, Ganga etc. During monsoon these rivers cause floods in large areas of eastern Uttar Pradesh causing considerable damages to crops, property and loss of human & animal lives. This part being the most fertile is also densely populated and hence vulnerability to floods is comparatively high. During the last few years the situation has worsened due to some devastating floods in the years 1998, 2000, 2001 and 2007 breaking all previous records. Since the rural economy is predominantly based on agriculture, floods directly affect agriculture, thus the rural community engaged in farming activities suffer the most.

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Report on Consultation organized by India Water Partnership (GWP-India) on 22nd November, 2012 at New Delhi under Asia Pacific Adaptation Network (APAN) Second Phase Assignment on Climate Change Adaptation in Water Management for Food Security: Recent Developments in South Asia (in Context of India)

A consultation meeting was held by the India Water Partnership with the purpose of presenting a draft research paper on "Climate change adaptation in water management for food security: Recent developments South Asia (in context of India)" under APAN second phase assignment. The meeting held on 22nd November, 2012 at the Institute for Human Development, New Delhi was followed by a discussion which included comments and suggestions of the experts and participants.

The consultation was chaired by Prof. S R Hashim, President, India Water Partnership who was accompanied by Dr. Akhilesh Gupta, Adviser & Head, Climate Change Programme, Department of Science & Technology, Government of India and Mr. A D Mohile, Former Chairman, Central Water Commission, Govt. of India as the main panelists. The key presentation was delivered by Prof. Santosh Kumar, Head, Policy Planning & Cross Cutting Issues, National Institute of Disaster Management, Ministry of Home Affairs, Govt. of India.

Dr. Veena Khanduri, Executive Secretary, India Water Partnership in her welcome note thanked the experts and participants who had sent in their comments and suggestion for finalization of the research paper which was to be submitted to the Asia Pacific Adaptation Network (APAN). While providing the background to the consultation Dr. Khanduri noted that the United Nations Environment Programme (UNEP), in partnership with key UN and other international organizations facilitated the formation of Global Adaptation Network (GAN), in response to the recognition of the need for relevant and usable knowledge as a prerequisite for successful climate change adaptation efforts. The APAN was launched in 2009 as the first regional network under GAN. The Network aims at building capacity, facilitating policy, planning, access to finances and actions, and knowledge dissemination in climate change adaptation.

IWP along with the other Country Water Partnerships of GWP-South Asia is working with APAN on climate change adaptation issues since 2011, Dr. Khanduri stated. Under Phase-I of the assignment, IWP identified the national implementing partners and major issues and challenges faced by India in a consultation on "Water, Agriculture and Climate Change" organized on 9th February, 2012 organized at Institute for Human Development, New Delhi. The consultation was attended by Government of India officials (Planning Commission, ICAR, National Rainfed Area Authority, Central Water Commission, National Institute of Disaster Management), research institutions, lead Universities of Delhi and prominent Delhi based partner NGOs of IWP.

Under Phase-II of the APAN assignment, a research paper on "Climate change adaptation in water management for food security: Recent developments in South Asia (in context of India)" has been prepared and is being discussed. Dr. Khanduri noted that the research paper has been prepared based on the following issues:

a) Identify and review recent policy developments in relation to Climate Change Adaptation (CCA) in India, with special reference to water sector including an examination of the CCA policy already developed.
b) Major Issues in relation to CCA in India with reference to water sector based on Issue paper already developed and in discussion with the main institutions identify priority issues, classifying them based on National Action Plan for Climate Change and National Water Mission viz:
   - Ability to meet food production demands.
   - Ensuring adequate water availability for agriculture.
   - Mitigation of food scarcity related socio-economic impacts.
   - Increasing awareness and mobilizing communities for CCA.
c) Examine scientific/technological innovation in relation to aspects such as forecasting, decision support systems, information sharing and dissemination, infrastructure design techniques/ options, water saving technologies, cropping regimes etc.
d) Community empowerment and awareness creation on CCA with special reference to vulnerable groups such as rain fed farmers, Institutional arrangements for local level coordination, poverty and resilience/ risk management - especially use of local knowledge, recognition of role of community organizations and gender issues.
e) Addressing vulnerability, contingency plans and management challenges.
f) Internalizing CCA as an integral component in the development agenda of water institutions.
g) Importance of capacity building on CCA of water sector institutions.
h) Economics of adaptation
i) What are the gaps and constraints?
j) References/citations

The important focus is on what is being done in India and what needs to be done further? Since the scope of the study is very vast, it was decided to keep the research paper very focused, Dr. Khanduri stated.

Prof. S R Hashim in his introductory remarks added that the Regional Hub (RH) of APAN functions as a knowledge centre and provides technical assistance for adaptation. It assists and collaborates with its sub-regional Nodes (SRN) and thematic nodes to implement the APAN activities. There are SRNs in Pacific and Central,

North-east, South-east and South Asia. The three thematic nodes represent Agriculture, Mountain and Water. In 2011, GWP South Asia was selected as the APAN's Thematic Node for Water in South Asia and India Water Partnership (IWP) is one of the Country Water Partnership under GWP-South Asia.

Presentation by Dr. Santosh Kumar

Dr. Santosh Kumar in his presentation outlined the scope of the research paper. According to him it helped identify and review recent policy developments in relation to climate change adaptation in India, with special reference to water sector including an examination of the climate change adaptation policy already developed. The major Issues in relation to climate change adaptation in India with reference to water sector were – (a) Ability to meet food production demands (b) Ensuring adequate water availability for agriculture (c) Mitigation of food scarcity related socio-economic impacts and (d) Increasing awareness and communities for climate change adaptation.

There was also the need to examine scientific/technological innovation in relation to aspects such as forecasting, decision support systems, information sharing and dissemination, infrastructure design techniques/options and water saving technologies. He noted that community empowerment and awareness creation on climate change adaptation with special reference to vulnerable groups for poverty and resilience/risk management also needed to be reviewed. The paper also sought to addressing issues like vulnerability, contingency plans and management challenges.

Dr. Santosh Kumar noted that internalizing climate change adaptation was an integral component in the development agenda of water institutions. He highlighted the importance of capacity building on climate change adaptation in the water sector.

The methodology adopted for the research study comprised of secondary review and the time involved was two months. The key point that needed to be discussed was "what is being done in India and what needs to be further done?" he noted.

Dr. Santosh Kumar noted that agriculture is still the backbone of the Indian economy. Nearly fifty five percent of the population survives on climate sensitive agriculture with 70 per cent dependence for livelihood. Agriculture sector is the key driving force for gas emission and land use effects cause climate change. It is a significant user of land and fossil fuel particularly in activities like rice production and livestock raising. The use of fossil fuel, land use and agriculture are the key source of climate change. This has serious implications in India on its water supply, food production, livelihood and biodiversity.

Dr. Kumar noted that India's food demand would be 276 million tonnes by 2021 against current production of 230 million tonnes. Out of 329 million hectares of geographical area, 174 million hectares or 53 per cent is suffering from serious degradation. 144 million hectares are degraded through ravines, salinity, wind erosion, water-logging, flooding etc. Another 30 million hectare is getting degraded due to haphazard grazing. It is also estimated that there will be reduction of wheat production in future by 4-5 million tonnes due to increase in temperature by 1 degree. Food grain production have gone up from 56 million tonnes in 1967 to 240 million tonnes in 2007-8 but declined to 210 million tonnes in 2011 raising concern for food security.

As regards water, Dr. Santosh Kumar stated that the per capita availability of water has fallen by 70 per cent since 1950. Water supply per capita in 2002 was 1902 cubic meters and is now expected to decline to 1401 cubic meter by 2025. The average per capita availability of water estimated to be 1600 cubic meters per year is expected to decline by 1000 cubic meters by 2050 as per current population projections.

India is a low water efficient country which gets 1197 mm rains every year i.e. 4000 billion cubic meters. However, 3000 billion cubic meters are lost as runoff and only 1000 billion cubic meters is available. India has 200 cubic meters storage capacity per capita. There is increased demand of water due to increasing population, urbanization, industrialization, economic growth, insufficient water use, high pollution, heavy use of groundwater leading to depletion. Apart from that there is glacier retreat in Himalayas. There is continuous depletion of groundwater. Water quality is affected by industrial waste, agrochemicals, erosion, soil degradation, domestic pollution and wetland degradation. Agriculture sector continues to demand more water. Droughts and floods are aggravating the supply of water. There is water crisis and conflict within the states and communities and industrial sector for water share. Regional conflict for share in Brahmaputra, Indus and Ganga river basin are worsening the situation. There is weak enforcement of legislation and public policy leading to further conflict of water rights.

The major areas that are going to be affected by climate change are I) water, II) food III) industry, society and settlement IV) health V) spices and natural resources. Climate Change Adaptation and Disaster Risk Reduction needs to be implemented through the policies of other sectors, in particular, those of agriculture, water resources, health, land use, environment, finance and planning.

Climate change will affect disaster risks in two ways: i) through the likely increase in weather and climate hazards and ii) through increases in the vulnerability of communities to natural hazards, particularly through ecosystem degradation, reductions in water and food availability, and changes in livelihoods.

In India, the combined pressure of urbanization, economic development and industrialization would only be intensified by the risk of climate change. Adaptation and

mitigation should be considered jointly since climate proofing and vulnerability reduction goes hand in hand to reduce vulnerability to natural disasters. Climate change is one of the main driving forces of change for water resources management, together with demographic, economic, environmental, social and technological forces. If solutions are created in isolation major challenges that these driving forces create may become self-defeating.

On government policy and programmes, Dr. Kumar stated that there is a need to examine the relevant national policies. He began with an account of the National Water Policy, 2012 and 1987. The policy envisages strategies covering groundwater development, water allocation priorities, drinking water, irrigation, water quality, water zoning, water conservation, flood control and management. The NWP of 2002 of India has taken into account the problems faced by drought (and flood) prone areas and has set concerned parameters (section 1.5). The section on Water Resource Planning (section 3.1 and 3.2) has emphasized on non-conventional methods for utilization of water such as through inter-basin transfers, artificial recharge of ground water and desalination of brackish or sea water as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting. NWP sheds light on reforestation and prioritizing water resource management. The new proposed version of National Water Policy 2012 tries to recall water as an ecosystem service; however, neither provides adequate linkage with other environmental and natural resources policies nor with the disaster management policy. Emphasis of the NWP on watershed based practices is of direct relevance to this topic besides other means of water conservation and management for drought risk mitigation and drought proofing. The traditional water resource management systems should be revitalized which would need manpower provided by the affected population who would in turn find employment. The rural employment schemes can be converged with this aspect to improve the livelihood of thousands.

Dr. Kumar then discussed the sustainable agriculture and rural development policy. The Agricultural Development Strategy of 1999 focused on sustainable agriculture and rural development (SARD). The strategy is essentially based on the policy on food security and alleviation of hunger. Soil and water conservation programmes have been launched in response to the need for conservation and rehabilitation of degraded land. There is need for prevention of soil loss from the catchments and promotion of multi-disciplinary integrated approach to catchment treatment. Dr. Kumar also underlined the need for improvement of land capability and moisture regime in the watersheds and promotion of land use to match land capability. The Integrated Wastelands Development Project (IWDP) has been started by initiating area-specific projects taking into account land capabilities, site condition and local needs, and ultimately aims to promote optimal land use for both ecological and socio-economic needs.

Early warning of drought is an important requirement for tackling its adverse impacts. Currently the prediction or early warning of drought is carried out mainly based on following rainfall predictions: (i) Long range rainfall prediction of seasonal total rainfall by IMD using parametric and power regression models and dynamic stochastic transfer models; (ii) Medium range rainfall prediction by National Centre for Medium Range Weather Forecasting; (iii) Short range rainfall predictions by IMD based on Indian National Satellite (INSAT) data supported with weather and agro-met observations.

The Desert Development Programme (DDP) covers both the hot desert regions of Gujarat, Rajasthan, and Haryana and the cold desert areas in Jammu & Kashmir, and Himachal Pradesh. It is functional in 131 blocks of 21 districts in 5 States covering an area of about 0.362 million sqkm and a population of 15 million. The Drought Prone Area Programme (DPAP) was launched in 1973 in arid and semi-arid areas with poor natural resource endowments. The objective is to promote more productive dryland agriculture by better soil and moisture conservation, more scientific use of water resources, afforestation and livestock development. Some other programmes include - Food for Work Programme (FWP), National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programme (RLEGP), Integrated Rural Development Programme (IRDP), Accelerated Rural Water Supply Programme (ARWSP), Indira Awaas Yojana (IAY), Jawahar Rozgar Yojana (JRY), Employment Assurance Scheme (EAS) - to assure hundred days of employment during lean agricultural season in drought prone, tribal and hilly areas .

There is a need for improvement in agriculture through modifying cropping patterns and introducing drought-resistant varieties of crops. Management of range land with improvement of grazing lands, improved grazing patterns, introduction of feed and protection of shrubs and trees needs to be looked into. Dr. Kumar also noted that there was a need for development of water resource system with improved irrigation, development of improved storage facilities, protection of surface water from evaporation, and introduction of drip irrigation system. Animal husbandry activities could also help in mitigation with the use of improved and scientific methods, increasing outputs without destroying the eco-system.

The outcomes of climate change were highlighted by Dr. Kumar and he stressed the need for greater integration in research, specific programs and better infrastructure. He also discussed the areas where status quo continues like in unemployment, lack of early warning systems, high migration, high dropout rates in school and high incidence of droughts.

Dr. Santosh Kumar noted that there is a national as well as international consensus that the impetus on hydropower and bio-fuel generation might have adverse affects on freshwater ecosystems which might decrease the ecosystem resilience of the affected regions to climate change.

On climate change and food security in India, Dr Kumar cited a study by the Indian Agriculture Research Institute (IARI) which stated that the impact of climate change with increased temperature and decreased radiation will lead to decreased productivity in rice in the North Eastern region. Sometimes sudden events like the floods in Thar Desert in 2006 or relatively slow events like the incursion of sea water into inland Orissa over the last two decades has caused stress in regional food production. There is a knowledge gap in the existing technology. There is a major mismatch between water supply and water demand for agriculture in India.

Some of the persisting problems are (a) poor land availability due to very high pressure on land; (b) very little additional land that can be brought under irrigation; (c) high degree of land fragmentation; (d) poor public investments in rural infrastructure including irrigation and electricity; (e) ecological constraints due to floods; and (f) overall lack of institutional and policy reforms in agriculture sector.

Monsoon delays and failures inevitably lead to a reduction in agricultural output, thereby deepening food insecurity. The Steering Committee report on agriculture for the Eleventh Plan (GoI, 2007a) identified the possible reasons for deceleration in agriculture since the mid-1990s as deceleration in public and private investment in agriculture and rural infrastructure including irrigation, technological change, diversification of agriculture, and fertilizers.

Dr. Santosh Kumar talked about the key components of capacity development for adaptation. On access to markets and food security he said that there was a need to improve access to international food markets. The country will benefit not only in the natural resources sector but the national food security situation too can be enhanced. There is a scope for improvement in the acquiring processes like in electronic tendering, bidding, advanced credit and hedging products, according to Dr. Kumar. Another necessity is a well managed food reserve to dole the country out of emergency situations. An international coordinated global food reserve could reduce pressures to achieve grain self-sufficiency.

An ideal climate smart agricultural landscape of the future would enable farmers to use new technologies and techniques to maximise yields and allow land management to protect natural systems with natural habitats integrated into agriculturally productive landscapes, Dr. Kumar noted.

He also shared the case study of Indo Gangetic Basin in which disaster management strategies have been suggested in river basin management. The need to use micro-irrigation as a means to save water in irrigated agriculture was stressed. The need for coordination among federal and provincial governments, research institutes, and national and international organizations was highlighted. The strong linkages between climate change, disaster and development were also discussed. The 700 million rural population that depends upon agriculture for subsistence and livelihoods is a serious concern for India. We need to focus on climate sensitive sectors like agriculture, forestry and fishing.

It is an important finding that water scarcity is not just a matter of the amount of rainfall but the policy and practices of holding the water where and when it falls. With less than 100 hours of rainfall in a year in the country, the key challenge is to store, reduce the distribution leakages of this precious water for the dry season ahead. Individuals and communities have steadily given over their role almost completely to the state even though more than 150 years ago no government anywhere in the world provided water. We need to take a policy shift to bring change from dependent syndrome to empowerment approach.

At present 68.35 per cent of the land of India is a wasteland of which 50 per cent is non forest land and there is a possibility of conversion to fertility. There is a need for a policy to ensure water entitlement along with the food entitlement. Enforcement of groundwater users law needs to be done in the changing environment scenario. Drought and flood management programme need to be interlinked. There needs to be more focus on small details like bridge between crops, enhancing livestock productivity, exploiting the manure and irrigation potential of treated wastewater and sustaining growth in fisheries.

Dr. Kumar also talked about the need to have more gender sensitive interventions with specific gender budgeting approach for addressing the vulnerabilities.

Discussion

Dr. Akhilesh Gupta noted that for climate change adaptation the socio-economic part needs to be an imperative. Of the eight missions, four are on adaptation and that only goes to show how important adaptation is in a country like India. The crux of the national action plan is that India cannot afford to compromise on development and that economic growth needs to continue. At the same time we need to address the sustainability issue and the core country issues. We need to achieve higher human development index and all these things will be possible only through mainstreaming climate change with development process.

Climate change itself is an issue. We do not have to work on climate change in isolation. In the Xth plan, money allocated for climate change adaptation was 2.4 per cent while it is 4 per cent in the XIIth plan. This money is not directly visible. In climate change mission the allocation of money is not much. Adaptation itself is given very high priority in five areas – agriculture, water, health, environment and disaster management. All of them are important but agriculture and water are very important and linked. One per cent of GDP in India is lost every year owing to natural calamities. This is a huge amount for a country like India. This is a complex area and covers a huge range of issues not just financial/ organizational/ socio-economic issues but goes deeper into our practices and traditions. That makes it more complex and challenging. One adaptation practice applicable at a place cannot be adapted to the other.

Food security issue too is linked to so many things. We have increased our food production from 50 mt in 1950's to 240 mt at present. In the last six years there has been either stagnation or huge fluctuation year by year. Are we in a stage where we can say that production is linked to monsoons? Are we too dependent on monsoons? We found that to a large extent the country has been successful in becoming monsoon resilient. There are pockets in the country which will continue to have dependence on monsoons in the absence of other sources of freshwater.

We need to have proper crop management systems. Efforts are being made under the National Mission for Sustainable Agriculture wherein a lot of wheat and rice varieties are being developed. This may help in meeting the food production target.

The chance of extreme weather event is very high in states like Orissa, Chhattisgarh, Jharkhand, Bihar etc. Today early warning systems are there only for floods, droughts and cyclones. The plan is to introduce this for the entire range of disasters from next year onwards. There are a lot of losses due to landslides, cloudbursts, thunderstorms etc.

Water management is another important concern. How is the rise in population going to impact the per capita availability of water? Whether there is climate change or not, precipitation itself will be the major concern. Climate change is definitely going to affect the per capita availability of food. The per capita availability of food in India is 550 gm/ day as against 980 gm/ day for China and 2850 gm/day for the US. We consume very less. The Human Development

Index for India is 0.62 whereas that for the US is 1. We need to take a call on this and this is a very important area.

Agriculture and water are critical areas. All four national missions have water and agriculture somewhere. Government is fully aware of the fact that an issue like adaptation cannot be handled by it alone. There are five million NGOs in the country and without their help and support adaptation is not possible.

Mr. A D Mohile in his remarks stated that there is a very large scope particularly in eastern India for bringing in more land under irrigation. He said that the water sector in India faces many challenges. Most of them are drivers for change in the way we manage our water. The growing population, economic development and urbanization are three factors which are fast changing the qualitative and quantitative demand for water. Climate change is important but perhaps not as important as in developed countries where the abovementioned three factors are not as important and climate change takes the first place.

Now there is no doubt unlike 15 years back that global temperatures are rising; this is an accepted fact by all in the scientific community also. Even now the effect of climate change and other factors on hydrology and agriculture is a little nebulous.

We talk a lot about mitigation and adaptation but the link between the two is very thin. Adaptation or mitigation at the lowest level of the user is automatically being done. Our farmers are not fools – they know how to change crops. This has been taking place in other contexts if not due to climate change. In wheat dominated areas, temperature change may lead people to shift to rice or other kharif crops. This may lessen the blow of climate change.

Extreme events are a more serious concern and engineering & agriculture management strategies need to be changed. Our focus could be on these issues. Storage is a key issue. Importance of buffer stock will increase because of variations from year to year. One can get over a bad year if there buffer stock is available.

Mr. Mohile stressed the need for carry over storages which carry over water from one year to the next like Bhakra/ Aswan dam. Carry over storages are nothing but buffers of grain.

Our main focus in the context of climate change should be on income redistribution/ poverty alleviation in the face of climate change. Water transfer as mentioned in the national water policy is one such mechanism. It is a way through which income distribution takes place. In drier areas population density seems to be more than the capacity to sustain the population. In poor areas, this would alleviate poverty and give improved incomes. In the field of water management we were near about at the top till the early 1970s but lagged behind due to the IT revolution. Large use of GIS/ IT and real time management may be the key.

Mr. A D Mohile suggested that we should be very cautious about that we cannot depend on international market for food security. Food security very dear to us and we do not have a critical commodity like oil to ensure that people give us foodgrains.

On legal and institutional issues there is a need for bold decision making by the government; this is lacking because of weak governmental processes.

To conclude, water sector challenges are many. Climate change is one such challenge. The crux of solving these challenges including of the waters sector is to recognize the large linkages and interdisciplinary studies, improved technologies, continuous research, continuous policy modification.

Mr. R K Khanna, former Chief Engineer, Central Water Commission, Govt. of India stated that the National Water Policy is a good document but is advisory in nature. It is not backed by an act. The difference between MoWR and MoEF is that the latter is backed by acts and laws, while the MoWR is not. The NWP has been modified several times but still remains advisory in nature. The water resources bureaucracy takes the EIA notifications more seriously than the NWP. There is a lack of an institutional mechanism and coordination between Ministries/ Departments is absent. There is a need for an empowered mechanism backed by a law, Mr. Khanna stated. He gave the example of the Water Quality Assessment Authority that was constituted by the Government of India with the Secretary (Environment) as Chairperson and the MoWR as Secretariat. The idea was to improve coordination between the Ministries. This did not happen and both Ministries keep passing the buck to each other. Meetings are not held on time. The water sector is suffering because of lack of implementation and poor coordination. NGO involvement should be encouraged by the Government in a sincere manner.

Dr. Arun Sahdeo, National Institute of Disaster Management made a couple of points from the administrative, implementation and planning point of view. He said that food security cannot be considered in isolation of food production. Thirty to forty per cent of food is lost in the food chain in our country and that can be made available. On developmental paradigm, he said that we are moving from an agrarian based to manufacturing/ industrial development. Food security is important and not just food production in the market. Large number of people do not have access to food while we have food available in markets.

Climate change leads to internal refugees (displacement) of people. This may create social strife/ tension. In such scenario how food/ water/ internal displacement can be linked? Studies can be done on these aspects. Again, care should be taken to understand the water usage under the two different sets of farming – subsistence and commercial. Companies like Reliance are acquiring a lot of land nowadays; their water usage is entirely different than that of subsistence farmers. This will change the entire agricultural scenario as well as the usage of water in the agricultural sector, according to Dr. Sahdeo.

Ms. Suruchi Bhadwal of The Energy Research Institute (TERI) stated that a lot can be done on the demand side and not merely the supply side. In the case of adaptation, small scale pick pocketed projects cannot be effective and there is a need for large projects. Scalability will be an issue. There is a need to mainstream climate change adaptation into policy processes. At least in areas where some kind of technology can be implemented, scaling up should be done. More research is needed to identify which type of technologies/ projects will benefit whom.

There is an excellent array of policies/ programmes in our country. There is a need to study them and develop new ones. On usability of water resources, she said that field studies by TERI in West Bengal and Maharashtra indicate that there is a need for development of water grids analogous to inter basin transfers within the same state. In the agriculture sector, while drip irrigation is picking up, most parts of the country still use flood irrigation. The level of uptake of technology is quite low. There is a large scope that the government can incentivize such programmes.

In the national action plan on climate change, mitigation sectors are well defined/ well structured but that is not the case with the adaptation sectors. According to Ms. Bhadwal, mitigation is easier than adaptation.

Question of food availability is fairly complex, she noted. Projections of IARI and IFPRI suggest that enough food will not be available to the masses. There will be greater import dependency, food pricing will become an issue and poverty will increase. This will create a gap between those who have and those who do not have food. Role of women and its implications need to be understood as they play a major role in agricultural activities, according to Ms. Bhadwal.

Dr. Sanjay Bandopadhyaya of Indian Agricultural Research Institute said that there is no linkage of crop system/ soil system with water and agriculture management. There is a need to focus on early warning system for drought. The India Meteorological Department (IMD) has to be plugged into the system very tightly. We have to go agro-climatic/ agro-eco zone wise. What are the adaptive technologies available? What is the adoption rate? The amalgamation is not understood. People do not understand adaptive technologies well.

The entire water distribution network beyond the distributary level has collapsed in our canal systems, according to Dr. Bandopadhyaya. The losses from the distributary to farmers field is very high and stands at about 60-70 per cent. There is a need to put water efficient technologies to push water to the tail end of the canal systems.

Mrs. Kalpakam Yechury, President, All India Women's Conference said that women face the brunt of disasters as men go out in search of livelihoods. An integrated gender sensitive approach is needed consequently.

Dr. K J Anandha Kumar, National Institute of Disaster Management suggested that the problem is basically of implementation. Climate change is one of the problems; let us solve other problems. There is a lack of coordination between Ministries and policies are not implemented. Research is not of use to farmers.

He pointed to the issue of regional disparities. Groundwater development in states like Bihar, Orissa and Assam is just fifteen per cent whereas the national average is 70 per cent. Poverty is linked to groundwater development as poor states have low groundwater stage. Punjab and Haryana that are wealthier states have higher groundwater development (often over-exploited). Why do we not come up with policies to address these issues?

He also said that interlinking of rivers is already there and there should be inter basin transfers within states. The efficiency of irrigation is going down, 30-40 per cent in surface water and 80 per cent in ground water. There is a need to work on that.

India Water Partnership

India Water Partnership (GWP-India) is a non-profit organization with a goal of promoting Integrated Water Resources Management (IWRM). It is an accredited Country Water Partnership of Global Water Partnership (GWP) headquartered at Stockholm, Sweden. GWP-India started functioning as an informal body in 1997-98 first under the Chairmanship of Prof. S R Hashim (the then Member, Planning Commission, Government of India) and became a legal entity on 28th November, 2001 with its Memorandum of Association registered in Haryana under the Society's Act of India and was hosted by first Water and Power Consultancy Services Ltd. (WAPCOS), New Delhi as the National Host Institution.

GWP-India has been active in promotion of Integrated Water Resource Management (IWRM) principles and practices through IWP network partners to support national development priorities. Some of the core priority areas are; promoting IWRM approach effectively through workshops and consultations to address adaptation to climate change with the support of zonal water partners across the country; encouraging use of innovative low cost water saving technologies by the farming communities; sustainable natural resource management; integrated domestic water management; promoting Area Water Partnership (AWP) for river basin management; conflict resolution on water sharing; inter-state trans-boundary water sharing issues, gender mainstreaming, etc.

Asia Pacific Adaptation Network

The United Nations Environment Programme (UNEP), in partnership with key UN and other international organizations facilitated the formation of Global Adaptation Network (GAN), in response to the recognition of the need for relevant and usable knowledge as a prerequisite for successful climate change adaptation efforts. The Asia Pacific Adaptation Network (APAN) was launched in 2009 as the first regional network under GAN. The Network aims at building capacity, facilitating policy, planning, access to finances and actions, and knowledge dissemination in climate change adaptation.

The Regional Hub (RH) of APAN functions as a knowledge centre and provides technical assistance for adaptation. The RH assists and collaborates with its sub-regional Nodes (SRN) and thematic nodes to implement the APAN activities. There are SRNs in Pacific and Central, North-east, South-east and South Asia. The three thematic nodes represent Agriculture, Mountain and Water. In 2011, GWP South Asia was selected as the APAN's Thematic Node for Water in South Asia and India Water Partnership (IWP) is one of the Country Water Partnership under GWP-South Asia along with the others like Bangladesh Water Partnership, Bhutan Water Partnership, Nepal Water Partnership, Sri Lanka Water Partnership and Pakistan Water Partnership. IWP along with the other Country Water Partnerships is working with APAN on climate change adaptation issues since 2011.

India Water Partnership (IWP)
C/o Host Institution – Institute for Human Development,
3rd Floor, NIDM Building,
India Institute of Public Administration Campus, I P Estate,
New Delhi - 110002
Telephone: +91-11-23358166, 23321610
E-mail: iwpneer@gmail.com; Website : cwp-india.org

Dr. Abha Mishra, United Nations Development Programme stated that the issue of excess water is often overlooked. In Orissa, in particular there are lots of areas that are waterlogged for 4-5 months in a year and the peak agricultural period is lost because of that. Adaptation could also be a process of risk management or risk transfer; there are agricultural insurance policies that could help farmers. While looking at agriculture, we need to look at diversification of livelihoods for food security. ICAR is developing mixed farming practices and farmers need to be made aware of these. Food security is vital not just for humans but for livestock also. Dr. Mishra said that while developing adaptation approaches micro-analysis is required as within the same district there could be two problems – droughts and waterlogging. We also need to do micro-analysis at district level. We also need to see as to what kind of components can be taken up at the implementation level, Dr. Abha Mishra suggested.

Dr. Joseph Viruthiyel, Institute for Development Initiatives said that there is need to build climate resilient communities. He also suggested the need for incorporating good governance practices as cases in the research paper.

Dr. Veena Khanduri said that though we have captured many programmes, what we need to focus now is on where we are going to take up the lead. This is just a review of work done in our country on policy level and some implementation works. We came up with the insight that there is a lack of inter-sectoral linkage. She sought suggestions on how could adaptation work be taken up in a long term manner not just for project based implementation. Capacity building of community is required so that they can take this up in the long run.

Prof. S R Hashim noted that water use efficiency is vital when dealing with the topic of climate change, food security needs, water availability and needs of urbanization. In water use efficiency, there are technology and management related issues. The type of crops you grow is very important. Whether you grow more of maize/rice will make a lot of difference. In a water scarce situation, we can think of alternative cropping pattern and even alternative food habits. These are not the things that cannot change. Groundnut came to India in 1930s. Today large parts of the country depend on groundnut.

He also stressed on the need for a national perspective in light of the fact that states do not like to share water/data on water with others. Also, food security cannot depend on external source as this can be used for arm twisting as had happened in the 1960s, he said. Also the World market may not have the kind of foodgrains that is required at times; for example 5 million tons of food grains may not be available in the World market at short notice. So, available prices may shoot up. In case of food security there can be a network with neighbouring countries, Prof. Hashim said. We could think of a South Asian Food Bank.

Malnutrition and food insecurity can be caused by lack of awareness. Prevention of diseases and sanitary health problems are therefore also important.

Dr. Khanduri proposed the vote of thanks to the participants.