Inception Workshop on Mainstreaming Adaptation to Climate Change in Agriculture & Water Sectors

Climate Change Adaptation in the Agriculture and Water Sectors: Current Status, Issues and Challenges in India

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A.A. Nambi
M.S. Swaminathan Research Foundation, Chennai
anambi@mssrf.res.in

Outline

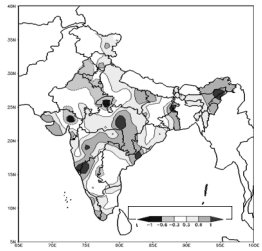
- **Overview of the current / future climate scenario**
- **Agricultural Issues**
- **Water Issues**
- **Major challenges & possible pathways**

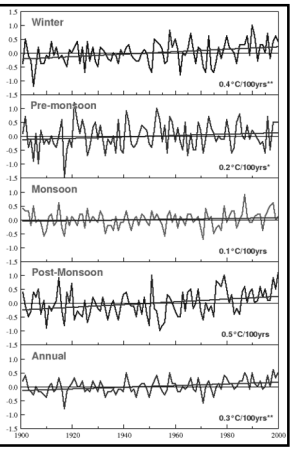
Climate Change: Current Scenario

***Temperature Changes*:**
- The mean annual surface-air temperature has risen by an average of 0.4°C in the last 50 years (1948 – 1998)
- The spatial distribution of temperature changes indicated a *significant warming trend.* This has been observed along the west coast, central India and interior peninsula and over north east India
- Cooling trend has been observed in north west and some parts of southern India.

***Variable rainfall patterns*:**
- At all India level, there is no trend in monsoon rainfall during last 100 years, but there are some *regional patterns and random variations*
- As much as *70% of the annual aggregate precipitation* is received in a short period from *June – September* during southwest monsoon
- Areas of increasing trend in monsoon rainfall are found along the west coast, north Andhra Pradesh and north-west India
- Decreasing trend over east Madhya Pradesh and adjoining areas, north-east India and parts of Gujarat and Kerala (-6 to -8% of normal over 100 years).
- There are *evidences that glaciers in Himalayas are receding at a rapid pace*.

All-India Observed Mean Surface Temperatures (1901-2000)





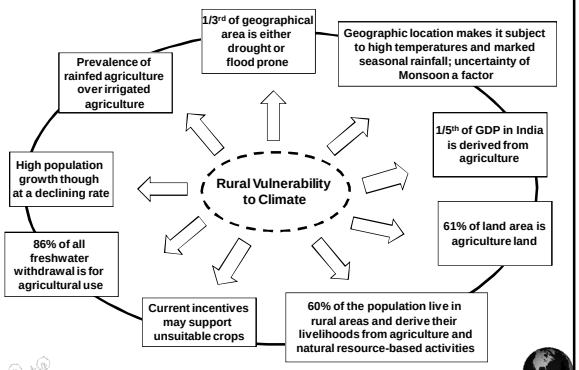
Current Trends

- Higher frequency of droughts:
  - Almost 20% of India's total land area is drought prone. The frequency of droughts has been increasing over time
- Increased frequency of floods:
  - The Ganges-Bhramaputra and Indus river systems are highly prone to flooding
  - The magnitude has *gone up from approximately 9 million ha. affected 50 years ago to 40 million ha.* in 2003, about 12% of the geographic area

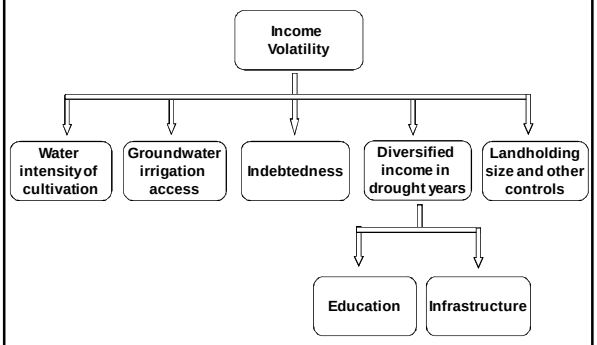
Climate Change: Future Scenario

- It is projected that by the end of the 21st century *rainfall will increase by 15 – 31%,* and the mean annual temperature will increase by 3°C to 6°C
- The warming is more pronounced over land areas, with the maximum *increase over northern India* and some parts of northwest India could witness a decrease in extreme rainfall
- The warming is also projected to be relatively greater in winter and post-monsoon seasons
- Glacial retreat caused by warming, though the extent remains uncertain
- A raise in sea level (40mm-80mm predicted in the next 3 decades) would threaten economic assets, coastal cities, and large coast-dwelling populations.

Elements of Vulnerability to Climate in Rural Areas of India



Determinants of Income Volatility



Drivers of Agriculture in an Uncertain Future

- **Agriculture in India is at present undergoing rapid transformation due to changing demands, markets and agricultural technologies**
- **Pace of these changes is likely to increase in near future**
- **Indian agriculture has become more global in its reach, more complex in trade and exchanges, more technologically grounded and ever *more challenged with balancing sustainability, productivity, profitability and inclusiveness***

Food Demand in India

Can India meet its food requirements?

Items (Food Crops)	Production (million tons)	Demand of food (million tons)	
	2000	2010	2020
Rice	85.4	103.6	122.1
Wheat	75.0	85.8	102.8
Coarse Grains	29.9	34.9	40.9
Total Cereals	184.7	224.3	265.8
Pulses	16.1	21.4	27.8
Foodgrains	200.8	245.7	293.6

Source FAO - 2001

Impacts of Climate Change on Agriculture

- Increase in temperatures, and increased variability of rainfall would considerably ***impact food production***
- Recent IPCC report and a few other global studies indicate a probability of ***10–40% loss in crop production*** in India with increases in temperature by 2080 – 2100
- Recent studies done at the Indian Agricultural Research Institute indicate the possibility of ***loss of 4 – 5 million tons in wheat*** production in future with every rise of 1°C temperature throughout the growing period
- Increasing climatic variability associated with global warming will nevertheless, result in *considerable seasonal/annual fluctuations in food production*. All agricultural commodities even today are sensitive to such variability
- Increasing glacier melt in Himalayas will affect availability of irrigation especially in the Indo-Gangetic plains, which, in turn, has large consequences on India's food production.

Impacts of Climate Change on Agriculture

- Small changes in temperature and rainfall could have *significant effect on quality* of cereals, fruits, aromatic, and medicinal plants with resultant implications on their prices and trade.
- *Pathogens and insect populations* are strongly dependent upon temperature and humidity. Increases in these parameters will change their population dynamics resulting in yield loss.
- Global warming could increase water, shelter, and energy requirement of livestock for meeting projected milk demands. Climate change is likely to aggravate the heat stress in dairy animals, adversely affecting their productive and reproductive performance. A preliminary estimate indicates that global warming is likely to lead to a ***loss of 1.6 million tones in milk production in India by 2020***
- Increasing sea and river water temperature is likely to *affect fish breeding, migration, and harvests.* A rise in temperature as small as 1°C could have important and rapid effects on the mortality of fish and their geographical distributions.

Results of Assessments of Climate Change Impacts on Crops in India

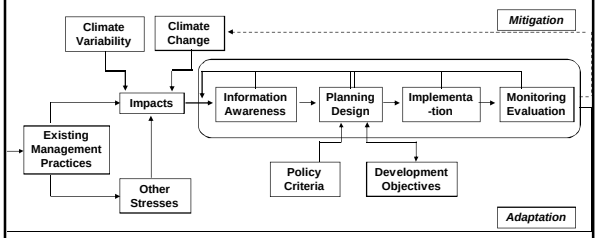
Temperature change	% change in net agricultural revenue per hectare	source
2^0C	– 3 to – 6	Sanghi, Mendelsohn, and Dinar 1998
2^0C	– 7 to – 9	Kumar and Parikh 1998
2^0C	– 8	Kumar and Parikh 2001
3.5^0C	– 20 to – 26	Kumar and Parikh 1998
3.5^0C	– 3 to – 8	Sanghi, Mendelsohn, and Dinar 1998

Adaptation Context

Adaptation is context-specific. Changing climatic conditions *will affect different populations and sectors in different ways*, **and adaptations to climatic changes must be appropriate to the needs and capabilities of those affected.**

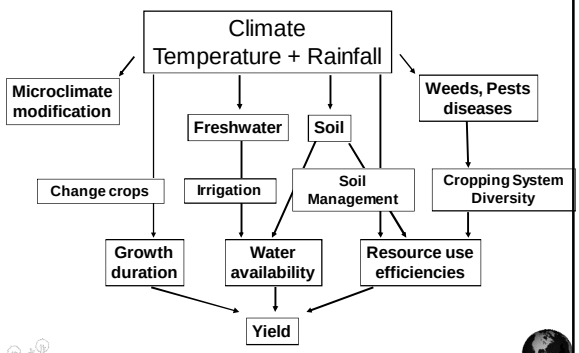
- **Not a Single Response – Portfolio of Responses**
- **Shared Responsibility that requires a framework of shared governance**
- **Links needs of today with the expected problems of tomorrow**

Iterative steps in planned Adaptation to Climate Change



- **The starting point for adaptation decisions is to have the information on the possible range of impacts to which one would need to adapt. This is a complex task in itself**

Adaptation



Adaptation of Indian Agriculture

- Use of biotechnology to formulate suitable gene constructs to impart drought resistance and heat and cold tolerance.
- Improved crop production techniques to enhance input use efficiency, use of resource conservation technologies, attain higher yields.
- Special efforts for coastal, hilly and other critical and fragile areas.

Adaptation options to Climatic Change

- **Changing varieties / crops**
- **Altering fertilizer rates to maintain grain or fruit quality and be more suited to the prevailing climate**
- **Altering amounts and timing of irrigation**
- **'Harvest' water**
- **Conserve soil moisture (e.g. crop residue retention)**
- **Use water more effectively**
- **Altering the timing or location of cropping activities**
- **Diversifying income including livestock raising**

Land use based interventions

- **Control of erosion losses –sloppy land treatment**
- **Weather based farming**
- **Development of cropping systems based on weather codes**
- **Testing of option sets (SRI, mixed cropping, varietal trials)**
- **Treatement of alkaline soils**
- **Kitchen gardens for nutritional security**

Knowledge Management

Water Crisis

Water Availability of River Basins - Issues

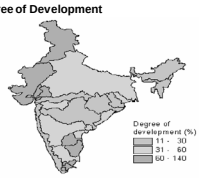
India's Water Resources	km^3
Surface water produced internally	418
Ground water produced internally	1220
Over lap	380
Flows from other countries	638
Totally Renewable Water Resources	1896

Source: FAO Aquastat

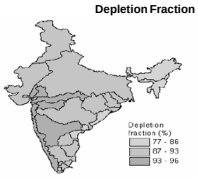
20% of World Population dependent on 4% of water

Indicators of water and food accounting in Indian river basins

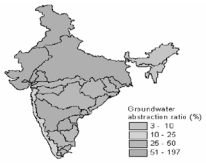
Degree of Development



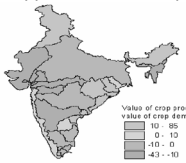
Depletion Fraction



Groundwater abstraction ratio



Ratio of value of crop production to value of crop demand

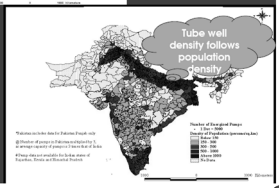


Source: IWMI_2003

Livelihood-supporting GwSEs have high population pressure on land, large agricultural population, semi-arid monsoon climate. India is a typical case.

One in four farming households in India owns an irrigation well; and the rest use purchased pump irrigation.

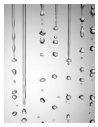
10% of India's GDP, 70% of its irrigated areas, 70-80% of its rural population, 60-70% of its farm output and incomes are linked to groundwater.



Institutional Arrangements

- Union Ministry of Water Resources is the nodal agency. NWRC, NWB, CWC, CGWB, CPCB etc.
- *Water is a state subject – responsible for financing, cost recovery, management.*
- Administration and functional responsibilities are unclear and spread over a number of institutions.
- *India has developed a relatively sound technical information base and expertise for resource development.*
- Regulatory mechanisms are inadequate to generate incentives to enhance water use efficiency.

Legal and Policy Frameworks



- **No separate and exclusive water law and legal framework specifying water rights**
- ***State has an absolute right over all lakes and rivers.***
- **Water charges are very low and energy costs for irrigation are subsidized**
- **Existing local and public institutions are too weak to address the complex emergent issues.**

Improving Institutional Capacity

- Enhance water storage capacity, especially in Himalayan region
- Improved design standards in disaster prone areas
- Enhance water productivity at all levels
- Invigorate the traditional institutions at local levels
- Promote private partnership in critical functions.

Adaptation to Floods

- Learning to live with the floods
- Improved flood forecasting
- Area inundation forecast
- Flood plain zoning, enforcement of regulations
- Community participation in flood management

Prevention and Management of Droughts & Floods

- Comprehensive, decentralized system of drought declaration and management
- Vulnerability-level based system of drought/flood response
- Shift in favor of robust and integrated system of livelihood opportunities
- Water harvesting at local, community and strategic level as a strategic intervention for mediating drought impacts

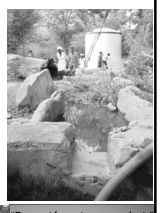
Integrated Ecosystem Management

Water harvesting and efficient use

Indigenous and advanced methods

Water based interventions

- **Lining of irrigation channels**
- **Reduction of irrigation intensity**
- **Groundwater monitoring**
- **Strengthening water harvesting structures / revival and restoration of traditional / community based water conservation measures**
- **Revival of traditional harren System**
- **Formation and revitalisation of water user groups**



Barriers in Indian Context

- Wide Geographical Area and huge diversity (physical, cultural)
- Political & Institutional Rigidity Persists
- Lack of information & knowledge
- Comprehensive, robust and accessible database
- Lack of information on adaptation costs & benefits
- Vulnerability Assessment
- Awareness of the issue at the Extension level is weak
- Land fragmentation
- Lack of focused research
- Lack of synergy among research institutes
- Lack of Resources
- Absence of a concrete plan for river linking

Adaptation Challenges

- ***Uncertainty*: Usage of macro models, no basic information on vulnerability of specific regions, Long time-frames. Different levels of certainty (projections, risk extremes, major events), poor research information on managing climate variability**
- **Irreversible losses such as agro-ecosystems / agro-biodiversity**
- **Policy action and legislation to be carried out at regional / local level by public / private sector and to be "stakeholder-led", rather than enforced**
- **Allocating costs**

Major Challenges in Mainstreaming Adaptation

Key Policy Question: **What do we need to do differently because of the expected adverse impacts of climate change?**

- **Relevance of Climate information for Agricultural development related decisions**
- **Uncertainty of Climate information**
- **Compartmentalization of Government Departments**
- **Segmentation & other barriers within Ministries**
- **Trade-offs between climate and development objectives**

National Policy on Climate Change Eight National Missions

1. **National Solar Mission**
2. **National Mission for Enhanced Energy Efficiency**
3. **National Mission on Sustainable Habitat**
4. **National Water Mission**
5. **National Mission for Sustaining the Himalayan Ecosystem**
6. **National Mission for a Green India**
7. **National Mission for Sustainable Agriculture**
8. **National Mission on Strategic Knowledge for Climate Change**

Possible Pathways

- **Clarify Central Government Policy Guidance**
- **Enhance efforts to Systematically incorporate climate information in decision processes**
- **Integrated management, vertical integration transcending different sectors**
- **Strengthen micro-level planning to facilitate adaptation**
- **Adaptation to long-term changes will require a combination of measures at National level and changes in the behavioral patterns at local levels**
- **Increase local government capacity (Panchayat Raj Institutions)**
- **Develop sound integrated assessment criteria**
- **Build capacities at different levels**
- **Identify appropriate research, technology policy options**
- **Develop climate sensitive research infrastructure.**