



Environment

Water Community



Food and Nutrition Security
Community



Solution Exchange for the Water Community Solution Exchange for the Food and Nutrition Security Community Consolidated Reply

Query: Climate Change Adaptation in Water, Agriculture and Coastal Areas - Experiences

Compiled by Gopi Ghosh, Resource Person and Ramya Gopalan and T.N. Anuradha, Research Associates

Issue Date: 31 December 2007

From [Preeti Soni](#), Energy and Environment Division, UNDP, New Delhi
Posted 27 November 2007

Climate change is likely to impact water resources, coastal areas and agriculture in India. While undertaking efforts to reduce the greenhouse gas emissions, there is also an urgent need to develop strategies to cope and adapt to these changes.

Following a programmatic approach to adaptation, the GoI and the GEF/UNDP project on "Climate Resilient Development and Adaptation" aims to work towards enhancing the resilience of the country's development by anticipating and adapting climate change related impacts. The project addresses key priorities in contributing toward the reduction of national and sub-national level vulnerabilities to climate change through the pursuit of specific outcomes including:

- Implementation risk reduction strategies and measures at pilot sites
- Integrating concerns into policies and planning processes at the state and national levels
- Strengthening technical capacity to integrate climate risks into management frameworks in agriculture, water and coastal regions
- Disseminating lessons learned to key stakeholders, both nationally and internationally

The project targets specific local interventions and broader enabling frameworks by linking demonstration activities directly to national and sub-national level policy making processes, and will help integrate climate risk reduction into planning, policies and programs in six sites with growing climate vulnerability: two drought-prone (in Rajasthan and Uttar Pradesh), two flood-prone (in Bihar and Uttar Pradesh) and two susceptible coastal areas (in Gujarat and Tamil Nadu).

In this regard, I would be extremely grateful if members could provide information on:

1. Findings from studies or experiences relating to sector-specific impacts of climate change on water management, agriculture practices and coastal area management
2. Adaptation strategies, experiences and lessons learned for climate resilient water, agricultural and coastal management practices, with a specific focus on livelihood diversification and capacity building

The experiences of members will contribute towards delivering benefits in the form of practical planning and implementation of risks reduction measures. Your inputs will indeed be a beneficial support to UNDP's project efforts.

Responses were received, with thanks, from

1. [P.K.Thampan](#), Peekay Tree Crops Development Foundation, Kochi
2. [Nupur Bose](#), A.N. College, Patna
3. [Anand Babu](#), ICRISAT India, Hyderabad
4. [T. P. Trivedi](#), Indian Council of Agricultural Research (ICAR), New Delhi
5. [Umesh Babu](#), Institute for Social and Economic Change (ISEC), Bangalore
6. [Vinod Kumar](#), Maithri, Palakkad
7. [Arin Basu](#), University of Canterbury, Christchurch, New Zealand
8. [Manish Kumar](#), Technology Information Forecasting and Assessment Council (TIFAC), New Delhi
9. [B.L. Menaria](#), Indian Institute of Forest Management (IIFM), Bhopal
10. [Bhaskar Goswami](#), Forum for Biotechnology & Food Security, New Delhi
11. [Manisha Alice Lakra](#), University of Edinburgh, Scotland
12. [Jyotsna Bapat](#), TERI, New Delhi
13. [Ramakrishna Nallathiga](#), Centre for Good Governance, Hyderabad
14. [Sajitha Joshy](#), Water and Sanitation Management Organisation (WASMO), Ahmedabad*
15. [G. Sarkar](#), Bidhan Chandra Krishi Viswavidyalaya (BCKV), Nadia, West Bengal*
16. [Seema Tripathi](#), Madhya Pradesh Water Resources Department, Bhopal*

* *Offline Contributions*

Further contributions are welcome!

[Summary of Responses](#)
[Comparative Experiences](#)
[Related Resources](#)
[Responses in Full](#)

Summary of Responses

In response to the query on climate change adaptation strategies in agriculture, water and coastal areas, members discussed the larger context of climate change, shared environmental impact findings and mentioned experiences with climate resilient water, agriculture and coastal

management practices. They also deliberated on mitigation strategies and recommended possible steps that communities could undertake towards climate change adaptation.

Discussants noted the undisputable **link between climate change and the increasing concentration of greenhouse gases**, particularly carbon dioxide, in the atmosphere. The amount of carbon dioxide in the atmosphere increased in volume from 0.028% during the immediate pre-industrial period to 0.034% in 1987 and now is nearly 0.038%. Members pointed out that the current annual rate of increase is 0.53%, making the projected atmospheric level of carbon dioxide by the middle of this century 0.055%. Both deforestation and burning of fossil fuels are largely responsible for the build up of carbon dioxide. Respondents also shared study findings showing that known carbon sinks are not fully absorbing the gases emitted from different sources. These factors have led experts to expect the world's temperature to exhibit an increase of about 4.5 degrees Celsius in approximately 50 years, which will likely result in unprecedented environmental hazards, opined members. They also noted currently there are insufficient global conventions/protocols and mitigation activities underway to effectively address the problem, and thus emphasized the need for serious adaptation efforts to focus on changes in local climates and terrestrial ecosystems, and counter threats to biota and human livelihoods.

Presenting sector **specific impact findings**, respondents explained climate is an important determinant of agricultural productivity. Since food and fiber production are essential for sustainable development and human welfare, agriculture is a central issue in any discussions on climate change. The impact of climate change on agriculture is dependent on two factors: first, the rate and magnitude of change in climate attributes and the agricultural effects of these changes; and second, on the resilience of agricultural production to adapt to changing environmental conditions. Moreover, the main climate change attributes- temperature, precipitation, atmospheric carbon dioxide content, the frequency of extreme events and raising sea level- all affect agricultural production and productivity.

Trees form the major terrestrial sink for carbon, members explained, sequestering and enriching carbon content in the soil, highlighting that one hectare of land with dense tree cover, can sink 7.25 tons of carbon annually (until the trees attain maturity). They thus recommended promoting agro forestry at the primarily level, as a way to prevent excess build up of carbon dioxide in the atmosphere. For example, farmers in [Kerala](#) planted different species of medicinal trees as intercrops in coconut gardens, which provided economic benefits along with protection in the form of carbon sequestration, conservation of the ecological farming base and biodiversity, and amelioration of the local climate. Other major sector impacts mentioned included:

- Fauna and flora in agriculture
- Useful insect species and pests in agriculture- climate change has altered their occurrence, space and time distribution, and population dynamics making their appearance unpredictable
- Crop pollinators and agriculturally useful microorganisms- increases or sharp falls in temperature, drought and rains affect their contribution.

Additionally respondents discussed rising carbon dioxide concentration increases the photosynthetic rate, which however with increased rate of photorespiration will reduce food production. Since certain plant species could disappear in drastically changed environment, they recommended the development and selection of crop genotypes appropriate for the specific agro-ecological situation.

Drawing from a study in [Bihar](#) members highlighted aspects of subtle and sudden change in agricultural production that need immediate monitoring to help stakeholders to adjust to the altering environment. Noting these impact findings, they recommended further impact analysis, and establishment of advisory and management systems dependent on the monitoring of abiotic and biotic factors involving various stakeholders. Another example highlighted was the dyke and

drainage system used to reclaim land in Mumbai's Back Bay in Bombay, shared as possible way to adapt to rising sea levels and subsequent urban flooding. In light of these changes, members urged that nations must urgently improve food and fiber production, establish environmental services and create rural livelihoods to improve food security, reduce poverty and provide an adequate standard of living for its growing populations.

Discussants also cited experiences of organizations in developing climate resilient mechanisms. Members presented a study by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), which shows empirical evidence on the vulnerability of the poor to various climate risks and shocks, as well as their diminishing capacity to access physical, financial and social resources and networks in the risky dry land areas. The water conservation techniques employed by a community in [Western Maharashtra](#) was also mentioned where an NGO improved climate change preparedness towards decreasing precipitation levels.

In addition, members suggested understanding local needs and scenarios, and documenting indigenous knowledge base of farmers as a pre-condition to address climate change impacts. Further noting the difficulties in conveying information to farmers and convincing them to go along with certain public decision and policies concerning climate change, they advised improving access to information, skills and knowledge on adaptation at the micro-level. Moreover, since adaptation strategies require strong capacity building and a good network among organizations, discussants emphasized the need for a reliable database, and a strong understanding of climate change at the regional and national level. Discussants also noted the need for climate change related public awareness programs in resource-poor settings to develop an understanding of the importance of developing early warning systems and other adaptation efforts.

Other **prevention and preparedness measures**, discussants recommended were to provide micro-insurance to vulnerable communities and generate awareness among people particularly the end users, decision makers and scientists. Members cited the example of Palakkad District, [Kerala](#) where volunteers are engaged in data collection and climate change monitoring systems. Additionally, they argued that since the impact of climate change on water, agriculture and coastal zones are interrelated, a high degree of coordination is necessary to frame an adaptation strategy and policy, as well as conduct a thoroughly planned multidisciplinary research and action programme.

A specific challenge remaining is how to link existing or improved practices and **coping strategies with long-term climate change** since the variability within seasons may also increase with climate change. Despite the complexity of the challenges, members opined there are many opportunities for leveraging the right kind of technologies, institutional arrangements, and policies to reduce potential losses and improve various livelihood options. On a concluding note, they stressed that research on the risk assessment is necessary in order to understand the potential of adaptation and mitigation measures have in risk reduction and sharing. As the recent [UNDP Human Development Report](#) points out, climate change is going to hold the key to human development in future.

Comparative Experiences

Kerala

Benefits of Tree Cover, Pattanakkad Block, Alappuzha District (from [P.K.Thampan](#), Peekay Tree Crops Development Foundation, Kochi)

Peekay Tree Crops Development Foundation is implementing a programme as part of an UNDP-GEF-SGP project in eight villages to plant various tree species of medicinal value as intercrops in

the coconut gardens of 2000 farm households. The objective is to plant about 50,000 selected tree species to cover 300 ha over a two-year period. Once they attain maturity they will bestow economic benefits on farmers involved and protective benefits upon the local communities

Climate Monitoring Programme through Volunteers, Eastern Palakkad District (from [Vinod Kumar](#), Maithri, Palakkad)

Maithri is developing a climatic monitoring programme with the support of PRIs, SDC CapDeCK and farmers since 2004. As part of this, volunteers are running several climatic data collection centres, to collect data about rainfall, temperature and humidity. They also compare patterns and initiate discussions among concerned communities. Additionally efforts are made to validate field data scientifically and monitor water quality in rivers.

Bihar

Impact Findings on Land Use Patterns and Water Resources (from [Nupur Bose](#), A.N. College, Patna)

Study aimed to find quantum of changes in land use in the region using image-processing techniques of IRS-WIFS Sensor satellite imageries of 1984 and 2004. Findings revealed a reduction in areas under crop cultivation, forests and wetlands and concomitant reductions in spatio-temporal surface water configurations and recession of Himalayan ice cover within the 20 year time span. Changes in river flow systems are attributed to Neotectonics and global warming.

Maharashtra

Drip Irrigation through Earthenware Pots (from [Jyotsna Bapat](#), TERI, New Delhi)

Locally produced earthenware pots that are not glazed are used as a form of drip irrigation, allowing water to slowly seep to the roots of the main fruit trees in the drought prone areas. The orchards growing pomegranates and figs have thus benefitted. Further it serves as a water conservation technique allowing for preparedness against decreased levels of precipitation.

International

Russia

Climate Change Adaptation Efforts, Lena Basin (from [Ramya Gopalan](#), Research Associate)

The Lena is one of the world's 10 largest rivers. Due to climate change, floods have become very severe in Lena and tributaries. Last five years recorded two floods of extreme severity affecting sixty-two towns and villages in 2001 and completely flooding Lensk town resulting in a direct economic loss of 250 Million US Dollars. The Lena Basin Dialogue was thus established for sustainable water management and generate awareness on the impacts of climate change.

Related Resources

Recommended Documentation

Climate Change: Linking Adaptation and Mitigation through Agroforestry (from [Anand Babu](#), ICRISAT India, Hyderabad)

Journal Article; by Louis V. Verchot et al; Mitigation and Adaptation Strategies for Global Change; Springer Netherlands; Volume 12, Number 5, June, 2007; Permission Required: Yes, paid publication, abstract available at <http://www.springerlink.com/content/88555762q0266186/>

Examines data on the mitigation potential of agroforestry in humid and sub-humid tropics and presents scientific evidence on the role of agroforestry in climate change adaptation

Climate Change Studies in Indian Agriculture (from [Bhaskar Goswami](#), *Forum for Biotechnology & Food Security*, New Delhi)

Article; by K.S. Ravi Kumar; Commentary; Economic and Political Weekly (EPW); VoL 42 No. 45 and 46; 10 November – 23 November, 2007

Available at <http://www.epw.org.in/uploads/articles/11226.pdf> (PDF Size: 336 KB)

A discussion of the existing literature on the effect of climate change on Indian agriculture, covering three strands of assessment – impact, vulnerability and adaptation

Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (from [Manish Kumar](#), *Technology Information Forecasting and Assessment Council (TIFAC)*, New Delhi)

Synthesis Report; Climate Change 2007; Intergovernmental Panel on Climate Change (IPCC)

Available at <http://www.ipcc.ch/ipccreports/ar4-syr.htm>

On the basis of climate change drivers, impacts and responses, evaluates possible development pathways and global emissions constraints to reduce risks of future impacts

From [Ramakrishna Nallathiga](#), *Centre for Good Governance*, Hyderabad

Analysing the Physical, Demographic and Vulnerability Profile of Indian Coastal Zone

Paper; by Ramakrishna Nallathiga; ISEE Biennial Conference; New Delhi

Available at <http://www.solutionexchange-un.net.in/environment/cr/res27110701.pdf> (PDF Size: 1 MB)

Attempts to depict the vulnerability profile of Indian coastal zone in terms of exposure area characteristics and the storm risk profile especially in relation to climate change

Human Development Report 2007/2008 - Fighting Climate Change: Human Solidarity in a Divided World

Report; UNDP Global; 2007/2008

Available at <http://hdr.undp.org/en/>

Examines impacts of climate change and ways to mitigate climate risks by integrating them into the development planning process

From [Ramya Gopalan](#), *Research Associate*

Impacts of Climate Change

Factsheet; by Centre for Science and Environment (CSE); New Delhi

Available at <http://www.cseindia.org/programme/geg/pdf/western.pdf> (PDF Size: 113 KB)

Records impact studies on agriculture, health, coastal areas and biodiversity as a result of climate change in western and central India

Vulnerability of Indian Agriculture to Climate Change and Globalisation

Study; TERI; New Delhi

Available at <http://www.teriin.org/coping/index.htm>

Uses a framework based on the 'double exposure' concept relating to dual impacts that some regions or social groups will experience due to climate change and globalization

Water Resources and Climate Change: An Indian Perspective

Review Article; by R.K. Mall *et al*; *Current Science*, Vol. 90, No. 12; 25 June 2006

Available at <http://www.ias.ac.in/currensci/jun252006/1610.pdf> (PDF Size: 195 KB)

Examines potential for sustainable development of surface and groundwater resources within the constraints imposed by climate change and future research needs in India

Climate Change Impact Assessment on Hydrology of Indian River Basins

Article; by A.K. Gosain *et al*; Current Science, Vol. 90, No. 3; 10 February 2006

Available at <http://www.iisc.ernet.in/currsci/feb102006/346.pdf> (PDF Size: 197 KB)

Presents a detailed analyses of two river basins predicted to be worst affected (one with respect to floods and the other with respect to droughts) as a result of climate change

Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries

Book; United Nations Framework Convention on Climate Change (UNFCCC)

Available

at

http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/txt/pub_07_impacts.pdf (PDF Size: 3 MB)

Outlines the impact of climate change in four developing country regions, highlighting their concerns and needs in adapting to the effects of climate change

From [T.N. Anuradha](#), Research Associate

Global Monitoring of Lakes and Reservoirs to Assess Climate Change

Paper; by Richard Robarts; UNEP GEMS/ Water Programme

Available

at

http://www.idswater.com/Common/Paper/Paper_147/Global%20monitoring%20of%20lakes.htm

Assesses the impact of climate change on the physical, chemical and biological attributes of lakes and reservoirs

Global Climate Change and Agricultural Production. Direct and Indirect Effects of Changing Hydrological, Pedological and Plant Physiological Processes

Book; FAO; Rome; Italy; 1996

Available at <http://www.fao.org/docrep/W5183E/w5183e00.htm>

Reports on the results of experiments to assess the effects of global climate change on the agricultural production of crops and livestock

Recommended Portals and Information Bases

SPOTLIGHT on India & Climate Change, SciDev.Net, London, UK (from [Manisha Alice Lakra](#), University of Edinburgh, Scotland)

<http://www.scidev.net/dossiers/index.cfm?fuseaction=specifictopics&dossier=4&topic=180&CFID=4346692&CFTOKEN=52741341>

Provides relevant articles, facts and figures, features focusing on development vs. climate change in India, India's emissions profile and pragmatic approach to climate change

Responses in Full

[P.K.Thampan](#), Peekay Tree Crops Development Foundation, Kochi

This has reference to Preeti Soni's query on the impact of climate change on different spheres of human life. My observation is confined to the needed efforts at the primary level for mitigating the hazards of climate change.

Climate change is linked to the increasing concentration of green house gases, particularly carbon dioxide, in the atmosphere. The concentration of carbon dioxide has increased from 0.028 percent by volume in the immediate pre-industrial period to 0.0348 percent in 1987, to 0.0353 percent in 1990 and to 0.0375 percent now. The current annual rate of increase in the concentration is 0.53 percent and at this rate the projected atmospheric level is 0.04 to 0.055

percent by mid 21st century. Both deforestation and burning of fossil fuels are considered responsible for the projected build up of carbon dioxide. The gas emitted from different sources has not been found fully absorbed by the known carbon sinks. It is anticipated that in another 50 years or so the world's temperature is likely to exhibit an increase by about 4.5 degree Celsius resulting in many unprecedented environmental hazards.

Trees form the major terrestrial sink of carbon. Trees not only sequester carbon in the woody biomass but also enrich the carbon content of the soil occupied by them through the regular addition of organic debris. Properly established mixed tree plantations are expected to yield not less than 15 tons of biomass per ha per year. This is equivalent to 6.75 tons of carbon that has been assimilated through photosynthesis and sequestered in the tree parts. In addition to the sequestered carbon in the biomass, the carbon storage of soil under the mixed tree species is also likely to increase by an average of 0.5 ton per ha. Thus, the annual increase in carbon storage in one ha of land under a dense tree cover could be 7.25 tons until the trees attain maturity. At this rate planting of tree species in about seven million ha of land could contain the net carbon release, about 50 million tons, linked to deforestation in India.

At the primary level agroforestry is a viable approach for preventing excess build up of carbon dioxide in the atmosphere. Agroforestry is the planting and nurturing of tree species of economic importance along with herbaceous plants in arable fields for deriving both productive and protective benefits.

In this direction Peekay Tree Crops Development Foundation is implementing a programme as part of an UNDP-GEF-SGP project in eight village Panchayats of Pattanakkad Block, Alappuzha District of Kerala, to plant in 2000 farm-households different tree species of medicinal value as intercrops in coconut gardens. The objective is to plant about 50,000 selected tree species to cover an effective area of about 300 ha over a period of two years. These trees on maturity will bestow economic benefits on the farmers involved and protective benefits upon the local communities in the forms of carbon sequestration, conservation of the ecological base of farming, amelioration of local climate and biodiversity conservation. The estimated carbon sequestration is around 2,000 tons annually from 300 ha until the planted trees attain maturity.

[Nupur Bose](#), A.N. College, Patna

The densely populated fluvial plain of Bihar is sustained by its agro-based economy. Its land use patterns are largely determined by its abundant fresh water resources augmented by monsoon rainfall.

Our study was aimed to find the quantum of changes in land use in the region, and identifying the visible, recorded physical causes for these changes. The methodology was based on image processing techniques of IRS-WiFS Sensor satellite imageries of 1984 and 2004. Comparative analysis of areas under major land use types was done to corroborate the findings with ground realities. There was significant reduction in areas under crop cultivation, forests and wetlands, while plantation cover increased by almost 20%. Fallow lands registered a sharp increase. Sandy stretches, bereft of any significant plant cover, also had larger aerial spread.

The study revealed concomitant reductions in spatio-temporal surface water configurations and sharp recession of Himalayan ice cover within the time span of 20 years. Though neotectonics have been attributed to changes in the river flow systems, the stark evidence of global warming in the form of gradual shrinking of the perennial sources of water of the region's drainage system cannot be ignored. This aspect of subtle and sudden changes in agricultural production need immediate monitoring to help the stakeholders in adjusting to the altering environment.

Anand Babu, ICRISAT India, Hyderabad

Nations are going to bear the brunt of climate change and suffer most from its negative impacts. Global conventions are not sufficiently effective to halt the increase of atmospheric greenhouse gases (GHG) concentrations, and we now accept that the primary drivers of climate change are not going to stop. Mitigation efforts will therefore only provide a partial softening of the effects of climate change. Local climates and terrestrial ecosystems will change, threatening biota and human livelihoods. Yet, even as climate changes, food and fibre production, environmental services and rural livelihoods must improve, and not just be maintained. Nations are faced with urgent needs for development, to improve food security, reduce poverty and provide an adequate standard of living for growing populations. (Kindly refer Journal Article by **Louis V. Verchot et al (2007)**. "Climate change: linking adaptation and mitigation through agroforestry." Mitigation and Adaptation Strategies for Global Change. April 28, 2007)

Climate change is occurring amidst global economic, demographic and social change, resulting at times in unexpectedly uneven outcomes on rural livelihoods. Few earlier studies by International Crops Research Institute Semi-Arid Tropics (ICRISAT) through its Village Level Studies (VLS) conducted since 1975 provide empirical evidence on the vulnerability of the poor to various climate risks and shocks, as well as their lack of capacity to access physical, financial and social resources and networks in the risky environments of the drylands.

The specific challenge that remains is how to link existing or improved practices and coping strategies with long-term climate change since variability within seasons may also increase with climate change. Therefore, despite the complexities that climate change poses to the agricultural sector, ecosystems in India (Asia and rest of the world), there are a lot of opportunities for leveraging the right kind of technologies, institutional arrangements, and policies that reduce the losses and contribute in improving the livelihoods of millions.

T. P. Trivedi, Indian Council of Agricultural Research (ICAR), New Delhi

The impact of climate change on fauna and flora in agriculture has been subject of concern .The occurrence, distribution in space and time, population dynamics of useful insect species and pests in agriculture ecosystem has not been predictable due to erratic change in abiotic factors. The role of pollinators in crops has been for some time affected due to increase or sharp fall in temperature, drought and rains. The load of agriculturally useful microorganisms is some time adversely affected. Therefore, the impact analysis, advisory and management should be dependent on monitoring abiotic and biotic factors by various stakeholders.

Umesh Babu, Institute for Social and Economic Change (ISEC), Bangalore

This is a good study for upcoming issues like climate change at global, national and local level. The river basin climate change papers will help you in water management and agricultural management. Krishna, Mahanadi and major river basins climate change papers are available in website for national level. Mekong and Colorado river basin climate change papers for international level. Coastal area management studies can look at Arctic climate change studies.

Vinod Kumar, Maithri, Palakkad

Maithri is developing a climatic monitoring programme in the eastern part of Palakkad District in Kerala with the support of Panchayati Raj Institutions, SDC CapDeck and farmers since 2004. As

part of this, there are several climatic data collection centres run by volunteers (farmers, teachers etc.), who are collecting data about rainfall, temperature and humidity. They are also comparing the patterns and initiating the discussions among the concerned communities. Apart from this, there are efforts to validate the field data in a more scientific manner along with an attempt to monitor the quality of water in the rivers. With this background, we are putting forward the following suggestions.

1. It is very difficult to convince a local farmer or common person about climatic change. Best results were obtained when they took part in a monitoring or data analyzing exercise. So suitable processes should be developed according to the local conditions.
2. It is much more difficult (almost impossible) to convince the local planners or decision makers about climatic change.
3. People do not have ideas about tackling it. Last month we had lost a major part of 50000 hectares of paddy due to untimely rains during the harvesting period. There are areas where the second crop was lost for 13 consecutive years. There were four droughts during the last ten years. Few years back, at the end of the monsoon, the reservoir of a major dam was half-empty. However, the authorities allowed to start the paddy cultivation in the entire command area. Then they tried to irrigate it. The result was to loss of entire crop and there was not even sufficient water for drinking.
4. At the micro level information, skill and knowledge for adaptation is lacking. In a drought year, at the end of the monsoon, the water position should have been known. But a typical farmer with few acres of land, will start paddy in the entire area and will continue to irrigate it until all his water and crops are dried up. The humidity and temperature is having unprecedented swings and the pest attack is becoming more intensive. The average person is helpless about all these.
5. Whatever spontaneous response we have is in the wrong direction. For example, here the farmers are simply stopping paddy cultivation and converting the land for cash crops with irreparable damage to the local environment.
6. Each locality is different. Even in a Panchayat with a 30 sq km area, we have to adopt different strategies.

Arin Basu, University of Canterbury, Christchurch, New Zealand

Vinod's mail is an eye opener. Based on the observation in his organization, they have tried to convey the message about the impact of climate change and observed that it was difficult to convince the end-users (farmers) and the middle tier users of information (policy makers), I'd probably ask:

1. How was the message about linkage between climate change and the end results conveyed (audience, medium, presenter issues, etc)?
2. How was the information presented (what was used: stories, narrations, charts, graphs, high-end knowledge, shared experiences)?
3. How are we, the so-called information vendors or "experts" convinced that the change in the crop patterns and the environmental events related to climate changes (what's our source of information -- peer reviewed research, techno talks)?
4. Is the language that we, the so called "experts" speak and understand, comprehensible to people like farmers, tillers of the land, and the policy makers and public opinion leaders? If not, what can we do to make it more comprehensible to them? Also, "must" we make it comprehensible?

5. What have we tried to learn from the experiences or indigenous knowledge-base of the farmers, tillers, etc vis-a-vis climate change impacts? Where and how are they documented?

A lot about the effectiveness of climate change related public intervention programs in resource-poor settings will depend on how these questions are answered, IMHO.

[Manish Kumar](#), Technology Information Forecasting and Assessment Council (TIFAC), New Delhi

Your query is very interesting and most debatable issue at the moment. The Climate Change issue has created a great awareness & impact on every segment of the globe after getting coveted Nobel Peace Prize. Everybody is talking about adaptation due to climate change but how, remains a question? Here I am not mention climate change impact on water, agriculture and coastal areas, it is available on net through Regional Climate Models (RCM) and Global Climate Models (GCM) and phenomenon of change is well understood with varying level of confidence. Please refer fourth Technical Assessment Report published of Working Group II recently by IPCC, which is posted on IPCC site. The report is divided into different chapters covering all the areas of ecosystem.

Climate change experts are still conflicting over the issues of climate change mitigation and adaptation. Which is best? Mitigation or adaptation as both is a costly affair. If you see the number of CDM projects going on in India and China, it is much more than any other European Country. Cost involve in CDM project in India is roughly about 2% of GDP, which is a significant amount. If you see the different reports on Climate Change, it projects that the adaptation cost will be much more than the mitigation cost. Adaptation needs strong capacity building and good network among national and state level agencies/organizations, which is quite a difficult task. It cannot be implemented until and unless we have a reliable database, good understanding of climate change at regional or national level. Only on the basis of thorough understanding of the local situation (climatic, social and political) adaptation strategy will be helpful.

In case of Bihar and Uttar Pradesh especially Bihar peopled are experiencing flood since time immemorial and now adapted to it, they think flood is their third crop and they get lots of central and external funding in the name of flood. This mentality and attitude has made them not to think on mitigation and to develop an early warning system. Therefore, here the case of Bihar is different.

Impact of Climate Change on water, agriculture and coastal zones are interrelated, hence a degree of understanding from all aspects is needed to frame an adaptation strategy and policy.

For more reading, please refer IPCC report.

[B.L. Menaria](#), Indian Institute of Forest Management (IIFM), Bhopal

Climate is an important determinant of agricultural productivity. As food and fiber production is essential for sustainable development and human welfare. In this regard, agriculture has been a major concern in the discussions on climate change. There are number of Conventions/conferences on Climate Change has been put and pointed out the adverse effect of climate change and motivate community. The impact of climate change on agriculture depends upon two factors: first, the rate and magnitude of change in climate attributes and the agricultural effects of these changes, and second, the ability of agricultural production to adapt to changing environmental conditions. Further, the temperature, precipitation, atmospheric carbon dioxide

content, the incidence of extreme events and sea level rise are the main climate change related drivers, which impact agricultural production and productivity.

Bhaskar Goswami, Forum for Biotechnology & Food Security, New Delhi

K.S. Ravi Kumar's paper published in the 10 Nov 2007 issue of EPW examines existing literature on the effect of climate change on Indian Agriculture. The link for the paper is below:

Climate Change Studies in Indian Agriculture

K.S. Ravi Kumar, Commentary; Economic and Political Weekly (EPW) VoL 42 No. 45 and 46; 10 November – 23 November, 2007

<http://www.epw.org.in/uploads/articles/11226.pdf> (Size: 336 KB)

A discussion of the existing literature on the effect of climate change on Indian agriculture, covering three strands of assessment – impact, vulnerability and adaptation

Manisha Alice Lakra, University of Edinburgh, Scotland

Please check the following portal website for information... Hope this is useful.

SPOTLIGHT on India & Climate Change

SciDev.Net

<http://www.scidev.net/dossiers/index.cfm?fuseaction=specifictopics&dossier=4&topic=180&CFID=4346692&CFTOKEN=52741341>

Provides relevant articles, facts and figures, features focusing on development vs. climate change in India, India's emissions profile and pragmatic approach to climate change

Jyotsna Bapat, TERI, New Delhi

I am aware of drip irrigation practiced using earthenware pots in Western Manarashtra. Using locally produced earthen ware pots that are not glazed allows for water to slowly seep to the roots of the main fruit trees in the drought prone areas of Maharashtra. The fruits grown are Pomegranates and Figs. These orchards are doing good business. These kinds of water conservation techniques will allow us to be prepared of decrease in precipitation that we in our part of the world are most likely to face due to climate change.

Alternately, dykes and drainages that allowed for land reclamation of the Back Bay in Bombay is a way out for resisting sea level rise and water flooding urban settlements. Rising sea levels, flooding low-lying costal cities is the other issue. We have found solutions for that in India too by building wave breakers and dykes. We may need pumping out of water during high tides as additional precaution.

Livelihood suitability through micro insurance of vulnerable communities is some thing towards which efforts are made by DMI against flooding and other natural disasters.

All these fall under prevention and preparedness measures as against post disaster mitigation. I believe in resilience and creativity of human societies and faced with a challenge we have always found solutions and we will find some for these issues as well.

Hope these inputs are of use.

Ramakrishna Nallathiga, Centre for Good Governance, Hyderabad

The HDR rightly pitched that Climate change is going to hold the key to human development in future, which is at best looked down at worst not understood by many political and policy making circles in India. Even before embarking on adaptation and mitigation strategies, the risk associated with the climate change impacts on various sectors is itself less understood in a large country like India.

Among the sectoral studies the study by Jyoti Parikh and Kavikumar (1999) (World Bank publication) and that of IARI, Delhi in Agriculture are the only strong references. TERI (2003) study on sea level risks to coastal regions is also one such, but the storm vulnerability aspects are not much discussed in it.

The following link gives an account of general relative vulnerability of the coast to cyclonic storms, but the risk associated with climate change need to be ascertained.

Analysing the Physical, Demographic and Vulnerability Profile of Indian Coastal Zone
<http://www.solutionexchange-un.net.in/environment/cr/res27110701.pdf> (Size: 1 MB)

Research on this front - risk assessment - is itself lacking and centres like IITM, IITs and IISc have to promote the same in order to gain insights of the same. It is then that the potential of adaptation and mitigation measures in risk reduction and/or sharing can be well understood. For the specific study regions / states proposed, Central Arid Zone Research Institute, Jodhpur and National Institute of Ocean Technology, Chennai can be useful centres to establish tie-ups.

Sajitha Joshy, Water and Sanitation Management Organisation (WASMO), Ahmedabad

As we are discussing Climate Change, something interesting came up in Ahmedabad, Gujarat. G. Sarkar, xxx, xxxThe Global Climate Campaign was held on 8th December 2007. As a part of which there were a series of events at CEPT Campus, Ahmedabad to create awareness and involve local people in the most concerning issue of this time, 'Global Warming.'

G. Sarkar, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Nadia, West Bengal

Thank you very much for your query on Climate Change Adaptation in Water, Agriculture etc. This is a very serious matter from agricultural, including allied subjects point of view and needs immediate attention of the agricultural scientists in particular as well as awareness among all people in this issue in general.

As a result of climate change, the temperature and concentration of CO₂ plus other green house gases in the atmosphere will increase, which have serious impact on the agricultural (food) production in the coming years. Due to rise in CO₂ concentration the photosynthetic rate of will increase but due to rise in temperature, the rate of photorespiration will also be enhanced reducing food production to about 30-35%. Many plant species may not adapt to this changing situation and may be abolished. Therefore, development and selection of crop genotypes according to agro-ecological situation suitable for such changing climatic condition is the urgent need of the day to feed our ever increasing population. A well planned multidisciplinary research programme is needed to be undertaken. Simultaneously, awareness among the people about this and to reduce the causes of climate change may be taken up. If your esteemed organization undertakes any such project in this regard in West Bengal, we will participate in this programme, if you desire so.

Seema Tripathi, Madhya Pradesh Water Resources Department, Bhopal

Climate change is an alarming issue. Rio Summit, Kyoto Protocol and this year at Bali, Scientists are raising this issue continuously. Now it is our time to think over this problem and take it to the grass roots level. As for my concern, I am working in water resources department. Impact of climatic change is very dangerous to water resources, which ultimately leads to destruction of agricultural products.

To conserve water we are promoting construction of ponds, small dams and series of dams. Rainwater if tapped may prove to be a boon for the society. Roof water harvesting is another tool to tap rainwater from urban areas. Plantation of coconut plants may prevent coastal areas from disastrous climatic change impacts. I am thankful to the solution exchange for raising such crucial issue.

Many thanks to all who contributed to this query!

If you have further information to share on this topic, please send it to Solution Exchange for the Water Community in India at se-wes@solutionexchange-un.net.in and/or Solution Exchange for the Food and Nutrition Security Community in India at se-food@solutionexchange-un.net.in with the subject heading "Re: [se-watr][se-food] Query: Climate Change Adaptation in Water, Agriculture and Coastal Areas- Experiences. Additional Reply."

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