

## **THEMATIC SESSION B1: CLIMATE CHANGE**

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### **ABSTRACTS**

#### **CLIMATE CHANGE AND NATURAL DISASTERS: IMPACTS AND MITIGATIONS**

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In the pre-science era disasters were looked as punishment or “acts of the divine”. With the advent of 19th Century we started getting more scientific explanations of the causes of these disasters. During the global climate system era, (post 1970) with the help of satellites we started understanding the climate system. Global monitoring, computer models revealed climate change and potential impacts on the natural ecosystems. Current era of change and uncertainty pose a threat to the entire society locally and globally as well. Natural disasters are purely in natural but climate change may exacerbate it.

Climate change may not be the major reason for natural disasters but it could be a major threat. Almost five-fold rise in disaster have been observed over 1960s -1990s and most of those are of hydro-meteorological origins. Growing disasters are the sign of unsustainable development. Disaster mitigation and preparedness are necessary for a sustainable growth of any society. It has also been observed that the numbers of people killed due to disaster are more in the places where human development is low. Data also show that it's the hydrometeorological disasters which cause more damages than the disasters which are of geophysical nature. Climate

change and natural disasters should be dealt with mutually and not exclusively.

Not all impacts of climate change could be linked to climate variability. Changing trends and irreversible processes pose new challenges to us. For these impacts, it is generally less clear whether suitable technologies for adaptation exist. Here, climate change presents a new challenge, which requires further analysis to identify technology needs. A good starting point is to focus on enhancing adaptive capacity. A systematic approach towards disaster mitigation is the need of the day. Since disasters are human phenomenon, we can change our ways to reduce our risks. Shifting of focus from hazards to risk management could make our life safer.

## **IGNORING LOCAL ECOLOGY, INVITING DISASTER RISK**

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Local ecology of a place deserves utmost importance in its own right. The diverse nuances of the play of ecological factors, the topography, the microclimate, the soil variation, the natural streams, the nallahs, the ponds and lakes, the rocky surfaces, even the desertic patches. All of these harbors a phenomenal mosaic of natural habitats, ecological communities and a strange balance in the ecosystem. Each of our cities and urban areas has its own natural heritage. But the development processes have had scant regard for the natural ecology.

Our inhuman attitude towards the local ecology has taught us some lessons in the cases of disasters occurring of late. The destruction of mangroves in Orissa in the recent years brought about a huge devastation during the Orissa supercyclone. The absence of mangroves in Nagapattinam resulted in similar misery, the worst humankind had witnessed, while Pichavaram and Andamans were saved where mangroves still existed and where the sand dunes were not mined. Disregard and disconnectedness from the local hydrology resulted in the unforgettable Mumbai flood disaster of July 2005. The local streams and nallahs which carried away bulk of the rainwater have in recent times mysteriously disappeared. Meethi Nadi, Mumbai's stream now houses slums, expansions of factories and other built up structures.

Delhi and its environs and an innumerable Indian towns and cities in deep slumber need to wake up and introspect, before a huge calamity strikes.

The Yamuna floodplain known to be vulnerable to earthquakes is growing vertically with increasing construction activity for extremely high density multistory apartment complexes.

It is imperative for the “Development Process” to recognize and understand ecological limits to evade unimaginable destruction. This paper explores detailed case studies from Tsunami 2004 and Mumbai floods to raise the issue of the importance of local ecology to avert disasters. Thereafter Delhi’s case is studied in detail to understand local ecological ignorance and related risks and vulnerabilities.

## **RECENT TRENDS IN CLIMATE AND IMPACT OF CLIMATE CHANGE ON FOOD SECURITY OF NORTH WEST INDIA**

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North West India is part of the food bowl of the country contributing to its food security and rice-wheat cropping system, among others, is the major production system followed. Besides ecological, technological and socio-economic drivers, climate change/variability has become an important determinant of crop yields in this region. In this study, an attempt has been made to (a) quantify the recent climatic trends and climate variability in North West India, (b) develop sensitivity models of crop yield to climatic elements and (c) using these models for impact assessment of future climate change. The homogenous monthly rainfall and maximum (Tmax) and minimum (Tmin) temperatures for past 40 years were used to determine climatic trends/variability. Using regression techniques, linear trends were fitted to the time series of weather variables at monthly, seasonal (Kharif & Rabi) and annual time scales. The slope of the trend gave the annual rate and direction of change. For trend in climate variability, changes in maximum and minimum values and coefficient of variation (CV) for each five-year period were computed. Using district level historical rice yield and monthly rainfall, Tmax and Tmin for seven stations, multiple linear regression models of yield sensitivity to climatic variables were developed after segregating the effect of technology. These models were used with future climatic anomalies as per six IPCC SRES Scenarios for 2020, 2050 and 2080 generated by Hadley Centre global climate model HadCM3. The required climatic anomalies forecast were input into the crop sensitivity model for each station and the impact on

yield was calculated in terms of change in crop yield from technological determined yield level. Both Tmax and Tmin showed increasing trends at annual, kharif and rabi time scales with different rates. The rate of increase is significantly higher during kharif than during rabi for Tmax and vice-versa for Tmin. The variability of Tmax, in terms of CV, increased for both kharif and rabi seasons, whereas variability of Tmin increased for kharif and decreased for rabi season. At annual and seasonal scales, rainfall did not show any significant trend but at monthly scales during monsoon, it showed significant increasing trend during June, no change during July, and a significant decreasing trend during August and September. The results of the climate change impact assessment showed that in general rice and maize yields will be adversely affected in future in this region. The range of rice yield reduction from technological determined level may range from 7% in 2020 to 25% in 2080. No significant impact would be there on wheat yields and may be beneficial for sugarcane.

## **CLIMATE CHANGE AND ITS IMPACT ON HIMALAYAN-GANGA ECOSYSTEM: PAST, PRESENT AND FUTURE**

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According to a 2001 Report of the Intergovernmental Panel on Climate Change (IPCC), scientists estimate that surface temperature could rise by 1.4° C to 5.8° C by the end of twenty-first century. The increase in the global temperature in the twentieth century was observed as  $0.6^{\circ} \pm 0.2^{\circ}$  C. This has started to affect the glaciers all over the world. Around the world, glaciers are thinning and retreating and sea levels are rising. The phenomena of global warming have already started showing its effect on the Himalayan glaciers. In the present study, Himalayan-Ganga Basin i.e. upper part of river Ganga has been identified for detailed analysis.

Mountains are the main hydrological and climatological triggers of the water cycle by presenting complex meteorological patterns such as the production or inhibition of rainfall. In terms of their role as water towers, mountain regions form an important supply of snow and/or rain-fed water to the lowlands. Gangotri glacier, the headwater of river Ganga, is receding at a rate of about 18 metres every year, due to a variety of reasons ranging from global warming to local factors. A large part of the discharge in the Ganga comes from the glacier rather than the monsoon rains. If the Gangotri glacier, which is among the biggest glaciers in the Himalaya, continues to recede at the present rate as per remote sensing analysis, severe ecological disasters like flooding in short term and water scarcity in the long term may occur. Such situation will bring great challenges to our food security. The purpose of this paper is to understand complex linkages

between climate change and hydrological disasters in order to prepare risk mitigation strategy for the Himalayan-Ganga basin.

Almost all the glaciers of Himalaya and Karakoram are receding with varying rate. Gangotri glacier, source of river Ganga is receding at alarming rate, which has adverse impact in Himalayan Ganga basin. As the glacier retreats back from an area, newly deglaciated terrain is commonly subject to rapid change as fluvial, slope and aeolian systems relax towards non-glacial equilibrium status. Exposed area near the snout is prone to numerous glacial geohazards like rockfalls, landslides, avalanches etc. Some of the most devastating effects of glacier meltdown occur when glacial lakes overflow and thus the phenomena of Glacial Lake Outburst Floods (GLOFs) take place, inundating the lowland areas. In addition, changes in sediment and water supply induced by climatic changes and glacier retreat have altered channel and floodplain patterns of rivers draining high mountain ranges. Loss of ice because of global warming has perturbed alpine geomorphic systems and created conditions that favour ice avalanching, slope failure, debris flow, catastrophic failures of moraine and glacier dams, it has also produced significant changes in the regime and platform of some rivers. In order to control and minimize the extreme events, it is necessary to analyse these geohazards. The first rational step must be to identify the hazard and to estimate risks and its consequences. Once the hazard has been identified, it is possible to adopt response strategies to control the hazardous processes. After selecting hazard-reduction strategy, it has to be implemented effectively. It is essential that we act now to mitigate the climate changes and thus its effects on hydrology.

## **MAINSTREAMING ADAPTATION TO CLIMATE CHANGE IN PLANNING/PROJECTS**

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Climate change is no longer is a matter of scientific debate but a reality. Climate change is likely to threaten food production, increase water stress and decrease its availability, result in sea level rise that could flood agricultural fields and coastal settlements and increase the occurrence of diseases such as malaria. Therefore, adaptation to change becomes inevitable. However, since the beginning of the climate change debate the global community highlighted the importance of mitigation, adaptation to climate change was not in the limelight. It is only during eighth conference of the parties (COP 8) of the UNFCCC held in New Delhi in October 2002, the adaptation agenda got the global focus and was highlighted in the Delhi Declaration of COP 8.

The planning commission and the government of India have not so far internalized climate change concerns and its impacts in development plans and projects. Mainstreaming would need a considerable data from a large number of case studies spread over various climatic zones of India such as - flood prone, drought prone, cyclone prone areas. Lessons learned from such large number of case studies may form the basis for formulating a national policy and mainstreaming adaptation to climate change. However, adaptation to climate change will incur considerable costs to India.

These costs have to meet by some international mechanism such as UNFCCC / GEF. India would find it difficult to divert such huge funds at this stage of development for implementing different measures for mainstreaming adaptation to climate change. The lessons learned will provide the necessary background and data for formulating a national policy.

Mainstreaming adaptation would need various measures at the country level (Planning etc.), state level, and district and panchayat levels, (Implementation). Enhancing adaptive capacity would involve national efforts such as promotion of sustainable development for social well being, economic well being, environmental protection and conservation and technological innovation and development. Further mainstreaming adaptation would also involve considerable research on education training and public awareness, sustainable livelihood practices, cooperative efforts, insurance, technological interventions and capacity building at the national, state and district levels to implement the national policy for mainstreaming adaptation to climate change. While mainstreaming adaptation into the country's development plans it is very essential also to find out from the people what they need for their development. This bottom up process needs to be integrated with the national planning.

India has already initiated a number of activities/case studies in this regard since CoP-8. Giving resources including finance, India would be able to come up with solutions for effectively mainstreaming climate change adaptation concerns in all development activities at national, regional and local levels. Once a national policy is thus formulated for mainstreaming it would need to be tested on ground before actual implementation all over the country. Such a study has to be an all India coordinated study

involving a very large number of institutions/NGOs and civil societies both at the national level, grassroots levels to formulate an effective national policy on mainstreaming adaptation to climate change.

**ADDRESSING VULNERABILITY TO CLIMATE VARIABILITY  
AND CLIMATE CHANGE – AN INTEGRATED MODELLING  
SYSTEM DEVELOPMENT**

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The Earth's Climate is Changing. Human-induced climate change is one of the most important development issues facing society worldwide. Future changes in the Earth's climate are inevitable as the atmospheric concentrations of greenhouse gases continue to increase. India has experienced an increase in the average annual surface temperature of about 0.4°C over the last century, with most of the warming occurring in the post-monsoon and winter seasons. All global climate models project a marked increase in average annual surface temperature, ranging from 2-6°C across India. India is vulnerable to climate variability and climate change. Global warming caused by enhanced green house effect is likely to have significant effects on hydrology and water resources of India. Climate change in the future would have implications on water resources availability in India. Present study is aimed to address "How is climate projected to change at the regional level and what are the projected impacts on water resources and agriculture?" An attempt has been made to quantify the impacts of climate change and climate variability on water resources at regional level by applying new regional level climate change HadRM3 data to Pennar basin of India. Model resolution is based on major driver of this study is HadRM3 (climatic data outputs) – The Hadely

Center Regional Climate Models resolution, which is 0.44 x 0.44 degrees (approx 50km cell-size) on ground covering an average size of typical Indian districts/sub-basins.

Under this study the present water resources and agricultural crops are being assessed with an emphasis on land and water management to clarify its baseline vulnerability. The assessment includes following components: 1) Baseline climatology and meteorology, 2) Under global warming HadRM3 derived project climate change scenarios, 3) Water Resources (Hydrological) analysis including irrigation water and 4) Agro-meteorological simulation. Modeling framework used in this study establishes an identified links between these components that are Regional Climate Model (RCM) HadRM3 climate data, which flow as an input to both hydrological and agro-met simulation models. This includes database and models designed to aid water resources and crop modeling under climate variability and climate change scenarios. Simulation runs include both control (base) runs and IPCC SRES A2 and B2 scenarios. The use of new climate change RCM data as input to hydrological and agromet model demonstrates substantial changes in extremes that will have adverse impacts on water and agricultural crops of the region. Final results quantifying an impact of climate will be presented during symposium.

**ADDRESSING VULNERABILITY TO CLIMATE VARIABILITY  
AND CHANGE THROUGH AN ASSESSMENT OF ADAPTATION  
ISSUES AND OPTIONS**

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A World Bank funded ongoing study that identifies issues and opportunities that enhance coping strategies of communities in dealing effectively with extreme climatic events such as droughts and floods was embarked on by TERI in April 2005. The objectives encompass, a review of current coping responses and measures adopted by communities to cope with and adapt to climatic extremes; an assessment of the efficacy of these measures; identification of lacunae and suggestions for enhancement of adaptive capacities.

The geographical focus of the study includes three river sub-basins: Pennar basin in Andhra Pradesh (districts of Chittoor and Anantpur), Mahanadi in Orissa (districts of Jagatsinghpur and Puri) and Godavari in Maharashtra (districts of Ahmednagar and Nasik). Selection of these basins is congruent with locations of drought and flood affected regions in the country; Andhra Pradesh and Maharashtra experiencing drought conditions and Orissa being plagued by floods. Field surveys were conducted for the collection of primary data in 17 villages spread across the above-mentioned districts. The villages were selected on the basis of two indexes, i.e. on irrigation and infrastructure. The institutional and field based surveys provided a harvest of information on the intensity of the problem of droughts/floods, change in climatic conditions over a period of time (rainfall, temperature), the crops grown in the region, change in cropping patterns, irrigation, livelihood options and migration,

infrastructural development, availability of financial services and schemes and the importance of insurance.

Also a Cost Benefit Analysis (CBA) of certain select options is being investigated. In this case, the four options chosen are: Insurance, Credit/ Loan mechanisms, Crop Diversification/ use of tolerant varieties and schemes promoting Income diversification for farmers. The study is bound to come up with interesting results through the statistical/ econometric analysis of the primary data, aiming to look at the variations in coping measures being employed, given different underlying influential factors that exist across the villages, districts and states selected.

## **ENVIRONMENT AND CLIMATE CHANGE INDUCED DISASTERS**

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Rising levels of green house gases together with sulphur dioxide (SO<sub>2</sub>) and suspended particulate matters such as dust, etc. in the environment of our living planet i.e. earth are expected to cause climate change. By absorbing infrared radiation, these gases control the flow of natural energy through the climate system. Among the Green House Gases, Carbon dioxide (CO<sub>2</sub>) is currently responsible for over 60% of the “enhanced “Green House Effect, which is responsible for climate change. This gas occurs naturally in the atmosphere, but anthropogenic sources and Human activities i.e. Deforestation or Depletion of Land resources are adding much more of this gas into the atmosphere. Current emissions amount to over 7 billion tones of carbon, or almost 1% of the total mass of carbon dioxide in the atmosphere. CO<sub>2</sub> produced by human activities enters the natural carbon cycle. Many billions of tones of carbon are exchanged naturally each year between the atmosphere, the oceans and land vegetation. Global warming results from an increase in the temperature of the Earth’s lower atmosphere. And global warming may lead to climate changes result from alterations to regional climatic events such as rainfall patterns, evaporation and preventive measures. Climate induced natural disasters (CINDs) like drought; flood and cyclone become serious problems to coastal areas. CINDs are of regular occurrence particularly in coastal areas of Orissa and have become the part of normal life. The changes in climate due to global warming, lead to induce the chances of different types of natural disasters such as Drought, Floods, Cyclones and Forest fire and man made disasters

like Ozone depletion, Environmental acidification etc. IPCC of UN in its report has confirmed the global warming trend and projected that the globally averaged temperature of the air above earth's surface would rise by 1.4-5.8<sup>0</sup>C over the next 100 years. India is highly vulnerable to climate change as its economy is heavily reliant on climate-sensitive sectors like agriculture and forestry and its low-lying densely populated coastline is threatened by a potential rise in sea level. It appears that progress in climatology and in the development of numerical models not only enables scientists to relate extreme weather events such as floods and droughts, with climate variations, but they can give some insight to climate change scenarios due to global warming such as sea level rise and changes in frequency, strength and geographical distribution of extreme events. These results should be of great help in taking the right measures and in building up the adapted policies. The Eighth session of the Conference of Parties (COP-8) to the UN convention on Climate Change (October 23 to November 01,2002), New Delhi, ended here with a Delhi Declaration has successfully resolved the technical parameters necessary for the Implementation of the Kyoto Protocol (1997) on Green House Gases reductions. The Delhi Declaration gave primacy for the implementation of the clean development mechanism in the climate change process.

## ENVIRONMENT AND CLIMATE CHANGE INDUCED DISASTERS

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depletion, Environmental acidification etc. IPCC of UN in its report has confirmed the global warming trend and projected that the globally averaged temperature of the air above earth's surface would rise by 1.4-5.8<sup>0</sup>C over the next 100 years. India is highly vulnerable to climate change as its economy is heavily reliant on climate-sensitive sectors like agriculture and forestry and its low-lying densely populated coastline is threatened by a potential rise in sea level. It appears that progress in climatology and in the development of numerical models not only enables scientists to relate extreme weather events such as floods and droughts, with climate variations, but they can give some insight to climate change scenarios due to global warming such as sea level rise and changes in frequency, strength and geographical distribution of extreme events. These results should be of great help in taking the right measures and in building up the adapted policies. The Eighth session of the Conference of Parties (COP-8) to the UN convention on Climate Change (October 23 to November 01,2002), New Delhi, ended here with a Delhi Declaration has successfully resolved the technical parameters necessary for the Implementation of the Kyoto Protocol (1997) on Green House Gases reductions. The Delhi Declaration gave primacy for the implementation of the clean development mechanism in the climate change process.

## **INTEGRATED CLIMATE RISK MANAGEMENT**

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Over the last few years, a general consensus has emerged among the scientific community regarding the fact that the earth's climate is changing due to anthropogenic factors. It is being recognized that the reductions in emissions over the next several years are not likely to be achieved at a rate that is sufficient to greatly reduce the rate of change. Hence increasing attention is now being given to enhance adaptive capacities of populations at risk. Referred to as “adaptation” within the climate change community, work in this area has gained prominence over the last five years. However, it is still very unclear as to how exactly adaptation will work at the local level. There is also a lack of clarity as to what kind of national policies will support the enhancement of adaptive capacity of the poor people.

In such a context, the key point that an integrated climate risk management approach makes is that adaptation to climate change can be viewed as an on-going exercise in risk management. A focus on risks of negative outcomes over a variety of time scales allows a linkage to be made between present-day concerns about the alarming increase in climate-related losses and more nebulous but very real concerns about potential losses in the future when climatic averages are expected to have shifted and possibly frequency and severity of climate extremes increased. This approach sets the stage for the argument that reducing vulnerability to climatic hazards today is a cornerstone of the effort to build resilience for the future.