

FINAL REPORT for APN PROJECT

Project Reference Number: CBA2013-13NSY-VARMA

***Building Capacity for Adaptive Governance through  
Participatory Modeling:  
Rural and Urban Flooding in India***



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# Building Capacity for Adaptive Governance through Participatory Modeling: Rural and Urban Flooding in India

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Final Report submitted to APN

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## OVERVIEW OF PROJECT WORK AND OUTCOMES

### Non-technical summary

Global environmental change processes like climate change challenges the continuation of top down practices of resource and knowledge management. The complexity of multiple drivers of place based vulnerabilities to such global challenges along with the lack of preciseness of climate related risks at the local level creates an uncertainty on the type and degree of its impacts. There is an undeniable need of guidance of science for appropriate targets for long-term adaptation interventions, but equally important are the lessons from practice for its acceptability in localities. In the midst of complex linkages between society and ecosystems and future uncertainty, there is a need of creating a better fit between science, policy and practice by introducing principles of learning and flexibility in public policy process. This project is a capacity building exercise to usher the importance of shared vision by practicing co-management and offered hands-on training on participatory modelling to multi-disciplinary and multi-sectoral groups of stakeholders to delineate drivers of flood, design responses to it and negotiate for a solution. The exercise illustrated the relevance of deliberation, by not only enabling comprehension of impacts from natural processes but also feedbacks of human actions, for influencing mind-sets. The process led to the understanding of the role of key factors like diagnosis, co-ordination and trust for triggering change in management approaches.

### Keywords

capacity building, conceptual systems modeling, systems thinking, adaptive governance, flood, Assam, Bangalore, India

### Objectives

The main objectives of the project were:

1. Create understanding of principles of adaptive governance among policy makers, practitioners and researchers in Assam and Karnataka in India
2. Provide hands-on training on participatory model building techniques and systems modelling tools
3. Provide operational framework for implementation of the principles in resource governance in India

### Amount received and number years supported

The Grant awarded to this project was: US\$ 40,000 for Year 1

Years supported: 1 year

### Activity undertaken

1. **Design of methodology for the workshops-** All the members of the proposed advisory committee were contacted through email and informed about the aims and objectives of the project. From this stage itself, Professor Arabinda Mishra, TERI University, Professor Kanchan Chopra, TERI University, Professor S. Ravi Rajan, University of California and Dr. Vishal Narain, Management Development Institute (MDI), Gurgaon expressed initiative to

guide the project team. Dr. Jan Sendzimir in International Institute of Applied Systems Analysis (IIASA) also agreed to comment on the methodology developed for the workshop.

In December 2013 a workshop was held among the team members of the project in Bangalore office of TERI and some members of advisory committee members joined through skype. This curriculum workshop was coincided with consultations with different stakeholders in Bangalore to understand the context for the rural flooding case study.

2. **Guwahati workshop** – Since January 2014 consultations with relevant stakeholders in Lakhimpur district and Guwahati city in Assam were conducted. An ongoing study of the Principal Investigator on issues of villages in Dhokuakhana subdivision of Lakhimpur district was drawn as case study for rural flooding. Preliminary conceptual systems models were prepared with the information from this study along with the consultations for introducing participatory modeling in the group activities of the workshop. A land use land cover (LULC) analysis was performed to explain the trend of the problem in the workshop.

A 4-day workshop on the topic-“Systems Thinking and Adaptive Governance -The Context of Flood in Lakhimpur District, Assam” was organized from 28th to 31st January at TERI North Eastern Regional Centre, Guwahati. The workshop had a mix of panel discussion, lectures and introduced techniques of participatory systems modeling which helped stakeholders to understand issues of flood from different perspectives, learn about challenges posed by uncertainty and strategize accordingly. It provided an opportunity to learn theory and practice of systems thinking and network with peers from civil society, academia and government. Resource persons included Dr. Arup Jyoti Saikia from Indian Institute of Technology (IIT), Guwahati, Mr. Ratul Sharma, Former Chief Engineer, Water Resources Department (WRD), Government of Assam, Professor Sanjoy Hazarika, Center for North East Studies and Policy Research, Jamia Milia Islamia, New Delhi, Dr. Vishal Narain, Professor Ravi Rajan, Professor Arabinda Mishra, Dr. Parthajyoti Das, Aaranyak, Assam, Ms. Nandita Hazarika, Project Co-ordinator, Assam State Disaster Management Authority (ASDMA), Mr. Prasoon Singh, TERI and Dr. S. Maibangsa, Regional Agricultural Research Station, Assam Agricultural University, North Lakhimpur, Lakhimpur district, Assam. Participants included researchers and scholars from IIT, Guwahati, Lakhimpur College, representatives of student activist associations and non-governmental organizations like Rural Volunteers Cell (RVC), Aaranyak and Farm2Foods, government officials from extension offices of Revenue and Disaster management Department and WRD, Government of Assam.

3. **Bangalore workshop** – Through a literature review and consultations conducted in December 2013, preliminary conceptual systems models were prepared for flooding problem of Bangalore. A land use land cover (LULC) analysis was performed to explain the trend of the problem in the workshop.

A 2 day workshop on-“Systems Thinking and Adaptive Governance: The Context of Urban Flooding and Water Stress in Bangalore” was organized in TERI Bangalore from 24th to 25th April. The workshop had a lecture series spread across 2 days and introduced techniques of participatory systems modelling which helped stakeholders to understand linkages across

issues of water logging, water scarcity and infrastructure development and learn about challenges posed by uncertainty. Like Guwahati workshop, it also provided an opportunity to learn theory and practice of systems thinking and network with peers from civil society, academia and government. Resource persons included Ms. Ritu Kakkar, Director General, Environment Management and Policy Research Institute, Dr Veena Srinivasan Fellow, Centre for Environment and Development, Ashoka Trust for Research on Ecology and the Environment (ATREE), Dr. Vishal Narain, Dr Kala Sridhar Head, Public Policy Research Group, Public Affairs Centre (PAC), Mr D Kiran Kumar Research Associate, Sustainable Habitat Division, TERI, Dr Archana Patankar Senior Research Fellow, Regional Centre for Urban and Environmental Studies, All India Institute of Local Self Government, Dr H S Sudhira Gubbi Labs, Mr. Prasoon Singh, TERI and Professor S. Ravi Rajan. Participants included representatives of the Bangalore Metropolitan Region Development Authority (BMRDA), Bangalore Water Supply and Sewerage Board (BWSSB), Central Ground Water Board (CGWB), Environment Management and Policy Research Institute (EMPRI), Lake Development Authority (LDA), Administrative Training Institute (ATI) and State Institute for Urban Development (SIUD), Mysore, in addition to research and academic institutions like Ashoka Trust for Research in Ecology and the Environment (ATREE), Indian Institute of Science (IISc), Indian Institute for Human Settlements (IIHS), and Azim Premji University; and civil society organizations like Environment Support Group (ESG)

- 3. Delhi workshop** – The transcripts of the group activities involving participatory modeling, both from Guwahati and Bangalore workshop were analysed. After presenting the methodology and findings of the project in the international conference-Resilience 2014 held in Montpellier, France and communicating a manuscript in sage publication-Vision, a final workshop was conducted on August 20<sup>th</sup> in TERI, New Delhi. This workshop–“Policy dialogue on Operationalizing Adaptive Governance in India” introduced the findings to a wider group of stakeholders from the national level and held a brainstorming on questions framed around 5 common themes- “Misdiagnosis, Communication, Labelling and Mistrust” that were diagnosed as barriers for shared vision for management of floods in both rural and urban contexts in India. Participants included representative from National Institute of Disaster Management (NIDM), Central Water Commission (CWC), TERI University, IIT-Delhi, South Asian Association for Regional Cooperation (SAARC) Disaster Management Cell, National Water Development Agency (NWDA), TERI and also 3 participants of Guwahati workshop i.e. from IIT-Guwahati and WRD, Government of Assam and 3 participants from Bangalore workshop i.e. EMPRI, ATREE and Town and Country Planning, Government of Karnataka. Resource persons included Dr. Ashok Jain, Advisor to Planning Commission, Water Resources Department and Rural Development Department, Government of India, Dr. P.G. Dhar Chakrabarty, Distinguished Fellow, TERI and Former Executive Director, NIDM and Professor Arabinda Mishra. A policy brief was circulated among the participants and resource persons and also a pen drive with workshop resources of both contexts as well as literature on systems thinking, resilience and adaptive governance and training modules on conceptual systems modelling.

## Results

- The project provided opportunity to 24 participants in Guwahati and 34 participants in Bangalore, ranging from PhD scholars, researchers from think tanks, faculty members of colleges, government officials of different levels i.e. subdivision, district and State to civil society members, for hands-on training of conceptual systems modeling using causal loop diagrams and also introduced Vensim software for modelling systems dynamics
- Trends of land use land cover (LULC) since 1990s to 2014 was derived for the vulnerable cluster of 4 villages in Dhokuakhana subdivision of Lakhimpur district of Assam and from 1970s to 2014 for Bangalore city.
- Findings presented in international conference-Resilience 2014 in Montpellier in France, organized by the French node of Resilience Alliance
- Paper titled- "Climate Change, Disasters and Development- Testing the waters for Adaptive governance in India" submitted to special issue on governance and public policy of sage publication- Vision- Journal of Business perspectives
- Policy brief (see appendix) with ways forward circulated in New Delhi workshop, among resource persons in both contexts and outside the project scope but within TERI network like International Centre for Integrated Mountain Development (ICIMOD) in Nepal, Bangladesh Centre for Advanced Studies (BCAS) in Bangladesh and Pakistan Agricultural Research Council (PARC).

## Relevance to the APN Goals, Science Agenda and to Policy Processes

The project has come at a time when different states of India are finalizing their State Action Plan (s) for Climate Change and the National Disaster Management Agency is undergoing through internal changes. Interactions among and between representatives of state government departments, national agencies like CWC and NIDM in the workshops illustrated nuances of policy planning and implementation to civil society and academia while also informed government representatives of complex issues of contexts.

By bringing together researchers from national and international institutes with policymakers and other stakeholders at the sub-national level in India, the training programme directly contributed to Goals 1 and 2 of the APN Third Strategic Plan (i.e. Goal 1: Supporting regional cooperation in global change research on issues particularly relevant to the region; Goal 2: Strengthening appropriate interactions among scientists and policymakers, and providing scientific input to policy decision-making and scientific knowledge to the public).

By focusing on flood management under climate change, the proposed activity addresses two priority areas of the APN's Science Agenda, viz. "Climate Change and Climate Variability" and "Resources Utilisation and Pathways for Sustainable Development". It aligns with the APN science agenda through its inter-disciplinary approach, which promotes science-policy interactions through multiple technical workshops, group modelling exercises, and the creation of a network of researchers and practitioners.

## Self-evaluation

The three workshops organized under this project succeeded in bringing together diverse stakeholders around the problems of rural flooding in Assam and urban flooding in Bangalore. The workshops were designed to sensitize the participants about the need for systems thinking and adaptive governance in the context of climate change. Participants from sub-national government departments, academic institutions, and civil society organizations were able to relate these concepts to their work domains. Particularly by using the tool of group model building, these participants were able to better appreciate the complexities of systems like river basins. They were able to identify constraints in conventional governance set-ups and were able to propose possible solutions towards making governance more adaptive. The participants from Bangalore and Guwahati workshops were able to effectively communicate their insights to national government officials in the Delhi workshop. The policy brief and the journal paper prepared by the study team will disseminate the findings of this project to a larger policy and research audience. In the process, young scientists who were members of the study team as well as participants of the workshops were able to interact with eminent resource persons and also learn new modeling tools and stakeholder engagement methods.

## Potential for further work

There is a plan by the project team to write proposal for systems dynamics modelling to diagnose similar contexts for submission to APN calls for research projects as suggested in the final workshop by the stakeholders. TERI has already submitted an expression of interest for development of a pedagogical framework for capacity building programs under APN's Climate Adaptation Fund.

## Publications (please write the complete citation)

1. Varma, N., Kelkar, U., Bhardwaj, S., Singh, P. and Mishra, A. 2014. Climate, Disasters and Development-Testing the waters for adaptive governance in India. Vision-Journal of Business Perspective. Special issue on governance and public policy (forthcoming)
2. Varma, N., Kelkar, U. and Mishra, A. 2014. Development, Disasters, and Decision-making: Adaptive Governance for Rural and Urban Flooding in India. Proceedings of Resilience 2014, Montpellier, France

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### **Preface**

This report describes the process and outcomes of introducing government and non-government stakeholders to the concepts of systems thinking and adaptive governance. Responses to a common climate stress, viz. flooding, are considered in two different socio-economic, political and ecological contexts. One context is the megacity of Bangalore, in Karnataka State in south India, and the other context is the agrarian villages of Lakhimpur district, on the banks of the Brahmaputra River, in Assam State in north-east India. In Bangalore, high intensity rainfall causes urban flooding due to inadequate drainage and unplanned development in lake beds and low-lying areas. In Lakhimpur, repeated floods due to breaching of the earthen embankments prompted the construction of a geotextile embankment in one of the locations but the ecosystem regime has completely changed from fertile alluvial land to sediment deposited wastelands.

## **Table of Contents**

<b>1.0 Introduction</b>	1-2
1.1. Climate risks and policy response: India within the South Asia region	1-2
1.2 Need for Adaptive governance	2
1.3 Problem contexts for project	2-4
1.3.1 Villages of Dhukhana in Lakhimpur district of Assam	2-3
1.3.2 Bangalore city in Karnataka	3-4
1.4. Objectives of project	4
<b>2.0 Methodology</b>	4-7
2.1 Guwahati workshop- 28 <sup>th</sup> -31 <sup>st</sup> January	5-6
2.2 Bangalore workshop- 24 <sup>th</sup> -25 <sup>th</sup> April	6-7
<b>3.0 Results and discussion</b>	7-13
<b>4.0 Conclusions</b>	14
<b>5.0 Future direction</b>	14
References	15-16
Appendix	

## 1.0 Introduction

### 1.1 Climate risks and policy response: India within the South Asia region

It has been well established via the reports of the Inter Governmental Panel on Climate Change (IPCC) that the climate is changing and the impact of anthropogenic activities on the climate is unequivocal (IPCC, 2007). The change although at a global level has its impacts felt varyingly at different ecosystem scales, which have been constantly researched and debated for future predictions in the scales of political jurisdiction to fit the need of policy making for anticipatory action.

Reduced water flows predicted for the major river systems of South Asia are expected to result in adverse impacts on agricultural production, hydro-energy generation, and physical infrastructure, all of which will have significant welfare implications in the region. Climate change is also associated with the risk of flooding, and in the South Asian countries of Bangladesh, India, Nepal and Pakistan, the frequency and magnitude of disastrous floods is observed to have already increased. Similarly, the frequency of glacial lake outburst floods (GLOFs) in the Himalayas is reported to have risen in recent decades. Thus, although the distinction between strictly climate induced events and anthropogenic influences that aggravate the severity of natural hazards is still unclear, there is enough evidence to suggest the increased vulnerability of the entire South-Asia region (Sud et al., forthcoming).

Particularly over India, significant warming trend have been observed in the past 100 years (Hingane et al., 1985, Kothawale et al. 2010). There is a trend of warming in the recent 30 years over most parts of India (MoEF, 2010) although the profile of rainfall have been trendless on India wide scale, several regional trends have been reported and well researched (Parthasarthy, 1994, Pant and Kumar, 1997, Rupa Kumar 1992, Guhathakurta and Rajeevan, 2008, Krishna Kumar, 2010). Along with an overall increase in extreme rainfall events and their intensities in the past 100 year period (Sen Roy and Balling, 2004), recent years have also seen an increase of frequency and intensity of heavy to very heavy rainfall events and a decline of low rainfall events (Goswami et al., 2006). Hence, there is ample scientific evidence for the phenomena of climate change and growing risk of extremes over Indian context.

A changing climate not only leads to changes in frequency, intensity, spatial extent, duration and timing of extreme climate events (IPCC, 2012) but also makes it challenging to predict such events owing nonlinear interactions amongst various natural processes and inherent uncertainty of the climatic system. Furthermore, the degree of impacts of such events depends on elements of vulnerability and adaptive capacities of varying social-ecological contexts. In the midst of dynamic complexity between society and ecosystems and future uncertainty, there is always scope of surprises i.e. events outside the realm of human anticipation and also well-intentioned and planned strategies becoming maladaptive. This creates a need of iterations between science-policy and practice and introduction of learning and flexibility in public policy processes.

There is an urgent need for integrating planning for climate change adaptation (CCA) with disaster risk reduction (DRR) to avoid duplication, better management of funds and learning across science-policy and practice. Though the approaches are finding convergence in international and regional

policy processes, challenges are observed towards operationalizing such convergence in India. The climate change response planning in the country is ambiguous about the convergence of DRR and CAA while the disaster management policy has evolved in a more reactive manner rather than being anticipatory (Varma et al., forthcoming).

The on-going process of climate policy and disaster management planning in India takes cognizance of the risk of alterations in magnitude and frequency of natural hazards in the future and creates scope for capacity building through generation and dissemination of scientific information. But this at best, addresses the design part of adaptation planning, uncertainties for implementation and ensuring desired outcomes remain. Although, processes for consultations during policy design or training programs for informed decision making exists, they have paid little focus on the dimension of communication. Current practices of science-policy communication are more expert driven and fail to create space for knowledge sharing among communities, development practitioners and institutions of lower levels of governance and thus miss out on the root causes of vulnerability and elements of adaptive capacity in different contexts. There is a need to make long term adaptation planning more grounded in order to avoid unanticipated outcomes after implementation.

## **1.2 Need for adaptive governance approach**

There is an urgent need to look towards the paradigm of adaptive governance which seeks to learn from diverse knowledge systems and experience, networking among various actors to facilitate social learning of novel solutions and leadership to navigate change in social-ecological processes (Folke et al., 2005). It has the potential of guiding planning processes, which can produce strategies, which are not only robust in design but also socially acceptable. However, the capacity to operationalize such a governance approach seems to be questionable not only in India but the entire South Asia region (Sud et al., forthcoming). In the entire region, there seems to be still a legacy of predict and control approach for policy planning and management. In climate change adaptation the trend in the region seems to be largely towards ambiguous climate change plans, new institutions for information generation on risks and lack of documentation of implementation projects (Sud et al., forthcoming).

## **1.3 Problem Contexts for project**

Two cases with varying development contexts in India-one of few villages in Lakhimpur district of Assam in north-east of India and another of Bangalore city in Karnataka in south of the country were selected for the project which illustrate the mismatches between needs and current responses.

### **1.3.1 Villages of Dhokuakhana in Lakhimpur district of Assam**

The Lakhimpur District within the state of Assam is situated in the north bank of the Brahmaputra River and has two administrative sub divisions- Dhokuakhana and North Lakhimpur. The population in the villages situated near the bank areas of Dhokuakhana mostly belong to Mishing tribe. This community is settled in the north bank of Upper Brahmaputra Valley and has always experienced annual floods during the monsoon period and have been coping through special types of huts over tree stumps, boating skills, shifting livelihoods between agriculture, fishing and animal husbandry.

Since 1955, following devastating floods from change of river course and landslides triggered by an earthquake of 8.3 Richter scale in Assam, earthen embankments were constructed in both banks for flood control. The Mishings of Upper Brahmaputra Valley could totally transform their forest-covered habitat into a productive paddy cultivated agro-ecosystem following the intervention of Sissikolghor-Tekeliphuta embankment in the north bank.

The increase of the sediment load of the Brahmaputra has been gradually changing the flow pattern of Brahmaputra and its tributaries. Multiple channels of the river have formed in upstream region while there is also a raise of the river bed leading to erosion of river banks and increase in frequency of floods, respectively (Varma and Mishra, 2013, Varma and Mishra, submitted). Since late 90s, issues of embankment breach, lack of their proper maintenance and insufficient relief packages from National government dominated the legislative assembly debates of Assam. Since the breaches of Sissikolghor-Tekeliphuta embankment from 1998, heavy crop area damage occurred due to inundation of the villages; finally shifting the productive paddy fields to sediment filled landscape (Varma and Mishra, 2013, Varma and Mishra, submitted).

The coarse sand deposition after recession of flood waters has not only occurred in these villages, as similar events are also observed in upstream and downstream areas of entire Upper Brahmaputra Valley. However, the embankment breached continuously from 2005-2008 near a cluster of 4 villages within a 5km radius of the embankment, at a time when the High Flood Record did not peak. In 2009, the Government of Assam had responded by constructing a geo-textile revetment for this vulnerable 5km radius, while risks of inundation persisted in upstream and downstream areas and the problem in this village cluster had shifted from inundation to a situation of landlessness and livelihood loss. On one hand, experiments with plantations and subsistence farming are being tried, while on the other hand there are protests for compensation for land loss and mobilization for empowerment of the newly reconstituted Mishing Autonomous Council (MAC) (Varma and Mishra, 2013, Varma and Mishra, submitted, Varma, et al., forthcoming).

### **1.3.2 Bangalore city in Karnataka**

It is a paradox that the city of Bangalore experiences floods though not being located on the banks of any river. In 2013, 1077 flood-prone areas were identified within Bangalore (Mallikarjun 2013) and such events lead to traffic disruptions, water logging of homes, loss of work days, and increase risk of water-borne diseases (Ramachandra and Mujumdar 2009, Gupta and Nair 2011, CED 2011). A combination of ecological and developmental changes of recent decades has led to inadequate drainage capacity of the city leading to floods during rainy season.

Since the 16<sup>th</sup> century the city had a cascading network of connected tanks for capturing the rainwater flow into the surrounding valleys. These man-made lakes could make provisions for drinking water, agriculture and fishing and could regulate storm flow and recharge groundwater aquifers. As Bangalore changed into a megacity in the 20<sup>th</sup> century, demands started rising and there was a need to pump drinking water from a distance of 100 km from the Cauvery River. The built up area expanded and as the importance of the water bodies ceased, infrastructure development started in the catchment area of the lakes reducing the number of water bodies drastically from 51 in 1973 to only 17 in 2007 (Ramachandra and Mujumdar 2009). This inturn has made Bangalore dependent on a single source of drinking water i.e. the Cauvery River, which is again the source of a

political conflict for water sharing with the riparian State Tamil Nadu. The increase in built up area over lake catchments is also driving reduced groundwater recharge.

Storm water drains that were constructed on channels connecting the tanks have increasingly been encroached and choked by the dumping of solid waste, sewage and industrial effluents as the sewage treatment capacities have been exceeded (Jamwal et al 2014). On one hand the alignment of sewage pipes with drainage channels and disrepair of leaks of these pipes has reduced the storm water drainage capacity and on the other burial of natural streams, construction of covered drains, and increase in impervious area has been increasing the runoff, thus together driving the flood incidences.

#### **1.4 Objectives of project**

In the above explained rural context of Assam, an ecological regime change has occurred but formal responses appears to be locked-in a certain type of technological response. There is no attempt of diagnosis of the linkages of such interventions with the social dynamics of the Mishing community. While, in the urban planning of Bangalore, there seems to be a neglect of the complex linkages among the ecosystem services which is increasing the vulnerability of the city to floods and scarcity of water (Varma et al., forthcoming). There is a need to look into each of the contexts in a more holistic manner to understand the inter-linkages across the social and ecological changes.

Adaptive governance recognizes systems thinking as a methodology for management of linkages across risks, impacts and responses in social-ecological contexts. It seeks stakeholder participation in every level of policy making for a shared vision for intervention (Pahl-Wostl, 2009, Rijke et al., 2012). The aim of this project is thus to introduce the principles of this approach for flood management in India, in order to create an enabling environment for better communication between scientists, policy makers and practitioners, create capacity to comprehend knowledge from diverse sources and learn importance of iterative processes for public policy consultations. Thus the main objectives of the project are:

1. Create understanding of principles of adaptive governance among policy makers, practitioners and researchers in Assam and Karnataka in India
2. Provide hands-on training on participatory model building techniques and systems modelling tools
3. Provide operational framework for implementation of the principles in resource governance in India

#### **2.0 Methodology**

The project used Soft Systems Methodology (SSM) in diagnosing the problem contexts and created an enabling environment for social learning among participants of 3 workshops, which is much sought for practicing adaptive governance (Checkland and Scholes, 1990; Checkland, 1985). Under this project 2 workshops were held on systems thinking and adaptive governance in TERI research centres in Guwahati in Assam and Bangalore in Karnataka that used above contexts as respective case studies. Though it was a capacity development project, the methodology had elements of exploratory research; group modelling among the participatory modelling techniques was used through which preliminary conceptual systems models were shared with different groups of stakeholders in each workshop and a step wise process of iteration was followed (Vennix, 1996, Voinov and Bousquet, 2010, Varma, et al., forthcoming).

Trends of land use land cover (LULC) since 1990s to 2014 was derived for the vulnerable cluster of 4 villages in Dhokuakhana subdivision of Lakhimpur district of Assam and from 1970s to 2014 for Bangalore city. The Landsat and MSS data is used to develop LULC analysis for these areas. The satellite data was first imported for layer stacking in ERDAS 9.2 and FCC image was created to classify different land use based on pixel values. A hybrid classification scheme is used based on complex logical model in ERDAS 9.2 software. For Bangalore case, a change detection matrix was created to see the changes in land use and land cover since 1973 to 2014 for Bangalore.

### **2.1 The Guwahati workshop: 28<sup>th</sup> - 31<sup>st</sup> January, 2014**

For this workshop, a study conducted by the first author regarding the issues of villages of Dhokuakhana circle of Lakhimpur district was drawn to construct the preliminary models. The study inferred that there are 4 narratives surrounding the problem of flood, erosion and sediment deposition followed by 4 distinct stakeholder groups- Chief Engineers Office, WRD, Government of Assam who believe in their interventions but face constraints of funding, Community and civil society who believe that the area has been neglected by the government, Extension offices of Government of Assam in Dhokukhana sub-division who believe that the problem lies with the attitude of the villagers and Academia who feel flood and erosion are basin wide problem (Varma and Mishra, 2013, Varma and Mishra, submitted). These 4 narratives were captured through conceptual systems modelling using causal loop diagrams (Sterman, 2010) and were used as preliminary models. In the workshop, stakeholders were invited from Lakhimpur district and Guwahati and were grouped as follows-

- Group Water Resources Department (WRD) – This constituted employees of the Chief Engineers Office, WRD, Government of Assam in Guwahati
- Group Civil society – This constituted members of local non-government organizations working in the villages of Dhokuakhana and Mishing student activists
- Group Revenue and disaster management- This constituted employees of extension offices within Lakhimpur district of Revenue and disaster management department of the government of Assam and Lakhimpur district disaster management authority under the Assam Disaster Management Authority (ASDMA).
- Group Academia- This constituted doctoral candidates from Indian Institute of Technology (IIT), Guwahati from both humanities as well as civil engineering departments and also faculty member from government college of Lakhimpur.

Following steps were followed in the course of 4 days to facilitate learning within and among the groups (also see appendix)-

- Step 1: The participants were exposed to elements comprising the narratives but as embedded in the larger discourses of the entire Brahmaputra basin through lectures by resource persons. Lectures included a historical profile of the interactions between human society and Brahmaputra River, opportunities and challenges for government responses to flood and erosion, governance challenges in the basin along with stories from flood victims through screening of a movie. Following a brief introduction to systems thinking and the concepts of narratives and discourse, the 4 groups were formed and a discussion among the group members was encouraged to understand, modify the preliminary conceptual models and think about suitable

interventions. After a round of modification in the models, a plenary was arranged where a group representative presented the modified model along with an intervention and its justification. The plenary was followed by a question and answer session among the groups regarding facts and reasoning of the causation chains and feedbacks in each others' models.

- Step 2: A lecture on uncertainty and climate change risk followed after the question and answer session of Step 1. Then the groups resumed and were encouraged to reflect on the discussions after the plenary and also on future risks and uncertainty. Once again the process of plenary was followed and opportunity was given for new questions and clarifications.

A transcript of the recordings was prepared and shared with the participants and their feedback was invited.

## **2.2 The Bangalore workshop: 24<sup>th</sup> - 25<sup>th</sup> April, 2014**

In this case, we conducted a literature survey and semi-structured interviews with stakeholders of government departments like Bangalore Development Authority (BDA), Lake Development Authority (LDA) and Bangalore Water Supply and Sewerage Board (BWSSB) and also think tanks like Ashoka Trust for Research in Ecology and Environment (ATREE) and Environmental Management and Policy Research Institute (EMPRI) in the month of December, 2013. Here, we found that stakeholders had an impression of complexity and need of integrated studies but instead of a coordinated response the practice was more of fault finding among institutions or citizen behaviour.

We found three interlinked issues i.e. Storm water and sewerage, Urbanization and land use, Demand for public services and infrastructure development to dominate discussion topics during our consultations, elements of which were also identified in earlier research.

These 3 issues were presented as preliminary conceptual systems models again using causal loop diagrams. Participants included representatives of the Bangalore Metropolitan Region Development Authority (BMRDA), BWSSB, Central Ground Water Board (CGWB), EMPRI, LDA, Administrative Training Institute (ATI) and State Institute for Urban Development (SIUD), Mysore, in addition to research and academic institutions ATREE, Indian Institute of Science (IISc), Indian Institute for Human Settlements (IIHS), and Azim Premji University; and civil society organizations like Environment Support Group (ESG). The same steps like in Guwahati were followed but here participants were allowed to pick and chose the issues for formation of 3 groups (also see appendix).

- Step 1: Lectures on inter-linkages of lake ecosystem, urbanization, and peri-urban issues were conducted which touched upon the 3 interlinked issues for group activities. This was followed by group activities that started with modification of the preliminary models and a plenary to identify linkages within the issues and facilitate new questions and points of clarification.
- Step 2: As Guwahati workshop, further iterations were encouraged after the plenary and a lecture on uncertainty and climate change.

A transcript of the recordings was prepared and shared with the participants and their feedback was invited. Both the transcripts were analyzed using a coding exercise which helped to identify key barriers for bringing a shared vision among stakeholders for management in both contexts (Varma, et al., forthcoming). The common themes analyzed were discussed in a brainstorming session in the

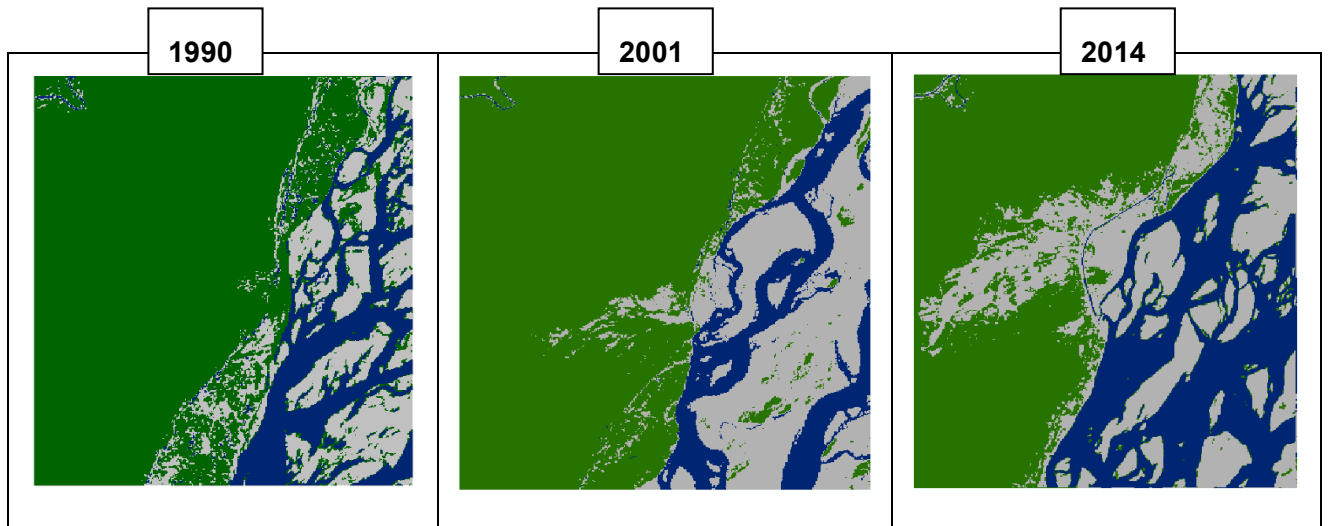


final workshop in TERI, New Delhi on 20<sup>th</sup> August with selected participants from Guwahati and Bangalore workshops along with participants from Central Water Commission, Government of India, TERI University, IIT-Delhi, South Asian Association for Regional Cooperation (SAARC) Disaster Management Cell, National Water Development Agency (NWDA) and TERI.

### **3.0 Results & Discussion**

The Step 1 of both the workshops explained the flood issue in each context through different discourses that helped the participants to not only understand the context but also acknowledge the different ways of knowing the problem. It also explained the need of systems thinking for a holistic understanding of different elements of the problem and principles of adaptive governance for continuous learning. Step 2 introduced the trends of the problem through the LULC analysis (see Figures 1 and 2), risks of climate change over each context and future uncertainty.

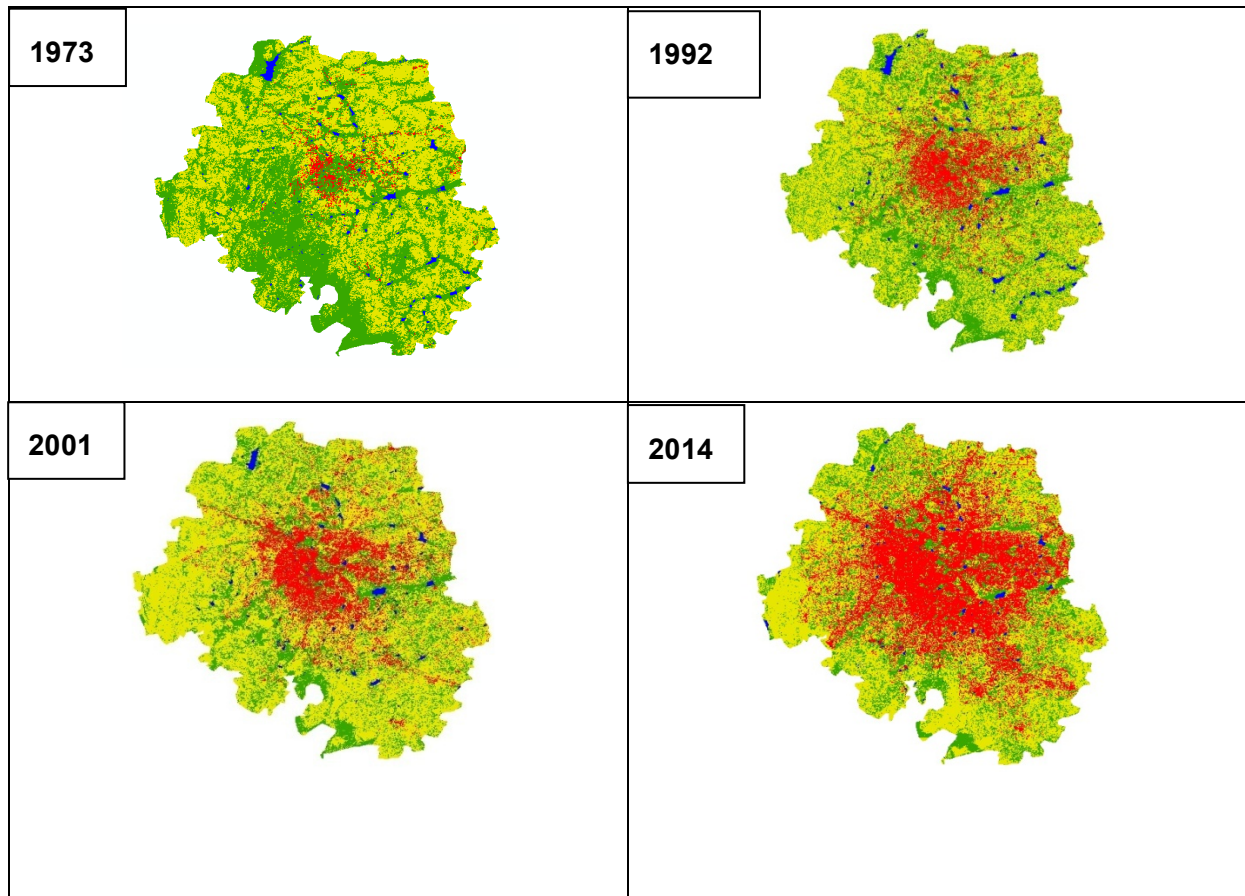
The LULC analysis illustrates lateral migration of Brahmaputra and increasing trend of sediment deposition on agriculture land in the Dhokuakhana villages (Figure 1) while drastic changes in land use in the form of reduction in vegetation cover, progressive increment in built up areas and decrease of water bodies in Bangalore (Figure 2).



**Legend**

- Water
- Sediment
- Vegetation

**Fig1. LULC classification of for small stretch of Brahmaputra in Lakhimpur District of Assam**

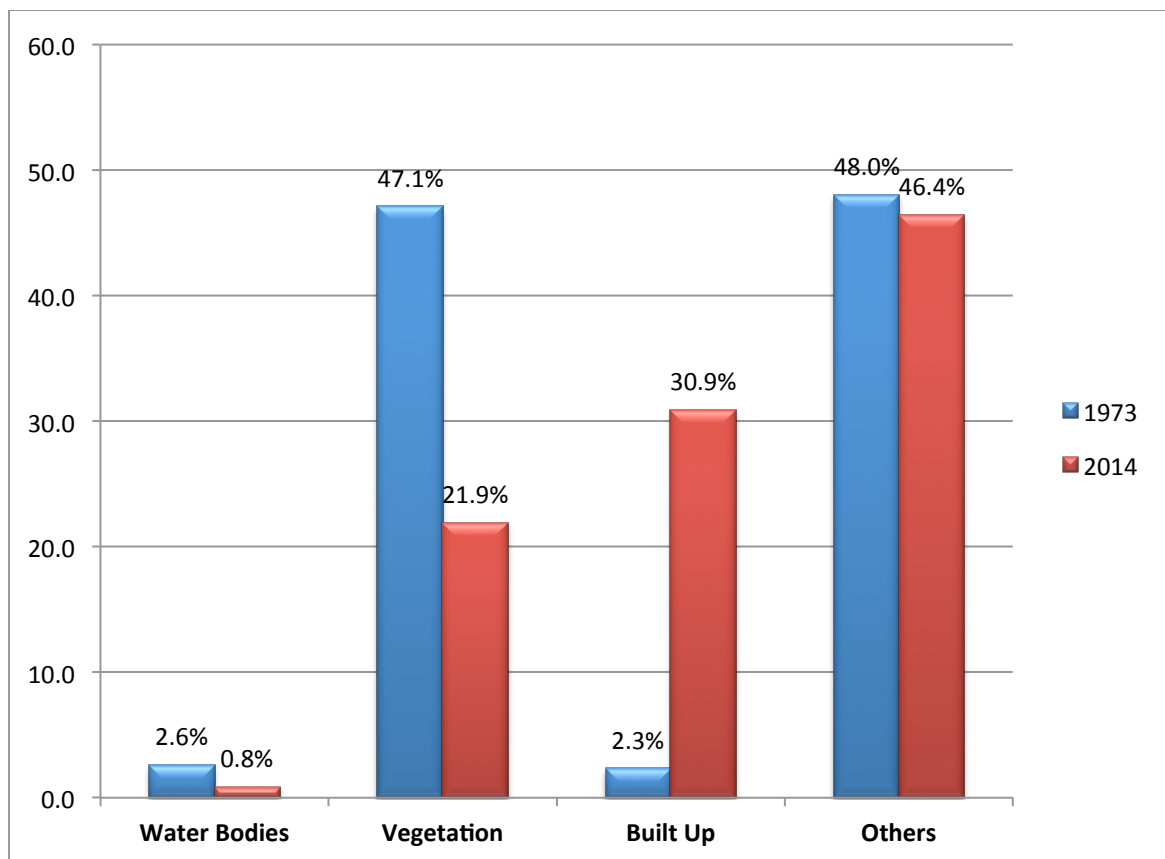


**Legend**

- Water Bodies
- Built Up
- Vegetation
- Others

**Fig 2. LULC classification of Bangalore Metropolitan Region**

From the LULC map of Bangalore for 1973, 1992, 2002 and 2014 the change matrix was developed to see the impact of urbanization on 4 different classes, which has been classified for the study (Figure 3). The change matrix for year 1973 to 2014 shows the percentages of the different land use changes during this course of time. It can be seen from the change matrix that how the built-up has increased over different land classes. From 1973 to 2014 other classes (i.e. fallow and agriculture Land), water bodies and vegetation cover has been lost to built-up; also the vegetation cover is lost to other classes by approximately 20% in this time. These changes lead to significant increase in impervious surface.



**Fig 3. Spatial Distribution of Change in Land use in Bangalore Since 1973 to 2014**

Image 1- Participants following the 2 step methodology in Bangalore workshop



Image2- Participants following the 2 step methodology in Guwahati workshop



The group activities in each step of the above explained methodology provided opportunity to 24 participants in Guwahati and 34 participants in Bangalore, ranging from PhD scholars, researchers from think tanks, faculty members of colleges, government officials of different levels i.e. subdivision, district and State to civil society members, for hands-on training of conceptual systems modelling using causal loop diagrams and also introduced Vensim software for modelling systems dynamics (see Image1 and Image2 above). It enabled the participants to think about the problem through causality chains and feedbacks and derive solution amidst the complexity. Moreover the group modelling exercise provided the means to the participants to learn different dimensions of the problem from varying perspectives, question assumptions and clarify misconceptions (please see feedback in annexure).

In both workshops, willingness for meaningful learning among the participants was observed given such means of social learning. In the deliberative process in Bangalore workshop a consensus started to emerge around long term innovative strategies like alternate pricing of water, use of treated waste water for non-potable consumption and rain water harvesting instead being dependent on single source along with augmentation of sewage treatment capacity and zoning of the city using an interdisciplinary team for future infrastructure development. Similarly, in the Guwahati workshop misconceptions about compensation of land loss and social issues faced by the community were clarified and a common need was felt for regulatory framework for reclamation of new land that appears within the river course after erosion in one bank, formation of interdisciplinary teams from the North-east region for conduction of environment impact assessments before infrastructure development and evaluation of ongoing infrastructures, re-thinking of navigation as a strategy for increasing accessibility as well as livelihood generation in place of highway construction that increases sediment load and opportunity to MAC to submit proposals to WRD for improvement of flood control.

Different institutions looked into different dimensions of the problem without transparency. Ignorance of guidelines for land acquisition among officials of lower levels of government departments in Assam or lack of consultations with the agency designing drainage maps by agency developing infrastructure in Bangalore are symptomatic of lack of co-ordination. There are issues of unawareness of formal rules like rules of opening bank accounts among rural communities or waiting for compensation for eroded land when such claims are invalid considering erosion is not recognized as disaster. There is unawareness of local customs and issues among government officials while there is observation of powerful interest groups circumventing rules. All of this leads to stereotyping certain behaviour or groups leading to mistrust among government and citizens further inhibiting compliance to rules. Formal responses not matching community needs, exclusion of social groups like peri-urban settlers from planning of provisioning services and lack of access to data, all driving discontent and mobilization for autonomy as in case of villages in Lakhimpur in Assam or civil society campaigns for data availability.

Given the 2 contexts, in order to realize the goal of shared vision among stakeholders, it was asked in the brainstorming session (see image 3) of the final workshop as how do we address barriers that arise due to following:

1. Misdiagnosis: What can enable better diagnosis to inform decision making?
2. Communication- How do you think there can be better communication within line departments, across departments and government and citizens
3. Labeling- How do you think we can steer away from stereotyping and build better understanding of context for guiding decisions
4. Mistrust- What can be the best ways to build trust among diverse stakeholders

### **Salient features of the discussion**

- Implementation is a problem due to lack of shared vision, there is a need to go from vision to strategies and strong evaluation for learning.
- A communication strategy of benefits of public sector projects is very important for people's acceptance to even endure during inconvenient times of the project. In this regard the Delhi metro was sighted as a glaring example.
- There is communication in lower levels of government and also among this level and citizens due to individual and community will but communication in higher level like between ministries is an issue.
- There is a need to look into existing values rather than incorporating definitions from the west.
- There has to be an excellent system of records keeping and access to such records, for that instance single window approach of Karnataka's government E-governance cell is an example.
- Many of the problems of misdiagnosis happen because of lock-in of institutional legacy.
- Situation analysis of resources within a context like a resource inventory of an area should be done instead of increasing transaction costs.
- Research should look into group modelling like in this project coupled with simulations for case studies to enhance shared vision.
- Lack of institutional framework and resources to incorporate recommendations from climate research in sub-national levels.
- There is a need of a common language across line departments and while communication with citizens in order to avoid plurality of interpretations.
- Communication strategies should be designed for an evolving context to understand changing aspirations and new meanings of ecosystems as they emerge
- Instead of discarding studies from certain agencies outside the government, there is a need for compilation of all studies for a holistic understanding.
- Trust is required to maintain communication and that can come by meeting again and again. Thus an enabling environment is needed for such informal meetings in specific contexts instead of formal communication channels.
- An enabling environment is also required for the government officials to steer clear from motivated complaints for public service as this adds on to the mistrust from citizens.
- There is a need for respect of policy decisions, it has to be evaluated after implementation but questioning after formulation needs to be checked.
- There is a tendency of public agencies not trusting the inputs from the citizens because it is difficult to incorporate citizens' views unless it is statutorily required.

- Mistrust is a function of labeling as well as complexity; it is basically misdiagnosis and lack of knowledge that is driving mistrust.
- Role of media, social media, community radio should be looked into for enhance the interface between government and citizens for reducing mistrust.

Image 3- Brainstorming session of final workshop-20<sup>th</sup> August, 2014



## 4.0 Conclusions

The project has met its aim of introducing adaptive governance to researchers, practitioners and government employees from sub-national to national level, provided hands-on training on systems dynamics tool called conceptual modelling and facilitated interactions among stakeholders from academia, civil society and government across political boundaries. The findings of the paper have been presented in Resilience, 2014 conference in France organized by the French node of the Resilience Alliance and a manuscript has been submitted to a special issue on governance and public policy of sage publication-*Vision-A journal of Business perspective*. The findings were presented in a final workshop in New Delhi and a brainstorming session was organized on the findings.

It is clear from our project; there is a need of social learning for bringing a shared vision among all stakeholders for not only compliance to rules but rather commitment towards co-management. Tools such as group modelling can provide the means of such social learning. In both the workshops the importance of such tools to structure deliberations was emphasized (see appendix for feedbacks) and in final workshop in New Delhi, the need for extending the conceptual models to systems dynamics models for simulation was also mentioned. In order to practice such a process, one of the low hanging fruits can be to introduce such tools in the on-going capacity development programs of various think tanks for training policy makers for decision making in midst of climate change challenges and also NIDM and State and District Disaster Management Agencies of India. There is a need for policy planning to incorporate strong monitoring and evaluation frameworks, access to evaluation reports for public deliberations and flexibility to change policy goals.

## 5.0 Future Directions

Our recommendations are in two levels for policy studies in India; one is in the level of research, which feeds into policy design, and other is in the level of capacity building. For the former there is a need to incorporate studies using interdisciplinary and trans-disciplinary methodologies apart from studies following pure natural or social science discipline. But in order to achieve this, we realize that there has to be first capacity built for both applied research and its need for policy making, hence centres are required within universities to promote and build capacity in applied research along with incorporation of participatory modelling tools (e.g. used in our project) in on-going capacity programs for government officials.

There is a plan by the project team to write proposal for systems dynamics modelling to diagnose similar contexts for submission to APN calls for research projects and TERI has already submitted an expression of interest for development of a pedagogical framework for capacity building programs under APN's Climate Adaptation Fund.



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## Appendix

### Appendix 1. Workshop Detail

#### **Guwahati, Assam Workshop**

Title: Capacity Building Workshop on Systems Thinking and Adaptive Governance: The Context of Flood in Lakhimpur District, Assam

Date: 28<sup>th</sup> – 31<sup>st</sup> January, 2014

Venue: TERI North-Eastern Regional Centre, Chachal, Express Highway, Guwahati

#### **AGENDA**

<b>Tuesday, 28 January 2013 Registration starts at 9.30 AM</b>		
10 –10.30 AM	Introduction to systems thinking and adaptive governance	Prof. Arabinda Mishra Dean, Faculty of Policy and Planning, TERI University, New Delhi
10.30 –11 AM	Government approach towards flood and erosion from Brahmaputra river	Shri Ratul Sarma Former Commissioner and Special Secretary to Water Resources Department, Government of Assam
11.30 AM –12 PM	The Brahmaputra: social life of a river	Prof. Arupjyoti Saikia Associate Professor, Department of Humanities and Social Science, Indian Institute of Technology Guwahati
12 – 12.10 PM	<b>Tea / Coffee</b>	
12 – 1 PM	Movie screening and discussion “A River Story- Of Hope and Despair”	Mr. Mauli Senapati Film maker
1 – 1.30 PM	<b>Lunch</b>	
1.30 – 2 PM	Brahmaputra Basin and governance needs	Prof. Sanjoy Hazarika Director, Centre for North East Studies and Policy Research, Jamia Milia Islamia, New Delhi
2 – 2.45 PM	Modeling, narratives and discourses influencing decisions	Dr. Vishal Narain Associate Professor, Public Policy and Governance, Management Development Institute, Gurgaon
2.45 – 3 PM	<b>Tea / Coffee</b>	
3 – 5.30 PM	Break away groups learn to develop preliminary models and present an intervention to the plenary	Facilitated by Navarun Varma, Ulka Kelkar and Saurabh Bhardwaj, TERI
<b>Wednesday, 29 January 2013</b>		
9.30 AM – 1 PM	Breakaway groups consider modifying models and interventions and present rationale to plenary	Facilitated by NavarunVarma, Ulka Kelkar and Saurabh Bhardwaj, TERI
1 – 1.30 PM	<b>Lunch</b>	
1.30 – 2 PM	Climate change and associated uncertainty	Mr. Saurabh Bhardwaj Associate Fellow, Earth Science and

		Climate Change Division, TERI
2 – 2.30 PM	Multiple states of context	Mr. Navarun Varma Research Associate, Earth Science and Climate Change Division, TERI
2.30 – 2.45 PM	<b>Tea / Coffee</b>	
2.45 – 4.45 PM	Elements of adaptation and resilience	Dr. S Ravi Rajan Senior Research Fellow, Asia Research Institute and Fellow, Tembusu College, National University of Singapore  Prof. Arabinda Mishra Dean, Faculty of Policy and Planning, TERI University, New Delhi
4.45 – 5.30 PM	TERI movie on climate change	
<b>Thursday, 30 January 2013</b>		
9.30 – 10.00 AM	Government approach towards disaster risk reduction	Ms. Nandita Hazarika Deputy Secretary and State Project Officer (DRR program), Assam State Disaster Management Authority
10.15 AM- 1.00 PM	Panel discussion on novel interventions Moderated by Mr. Dipankar Saharia Associate Director, Environment and Industrial Biotechnology Division (EIBD), TERI	Dr. K M Nabiul Islam Senior Research Fellow, Bangladesh Institute of Development Studies (BIDS), Dhaka (tentative)  Mr. B.N Thakuria Executive Officer (Tech) Flood and River Erosion Management Agency of Assam (FREMAA)  Dr. Partha Jyoti Das Head, WATCH Program Aaranayak  Prof. Chandan Mahanta Department of Civil Engineering, Indian Institute of Technology Guwahati
1 – 1.30 PM	<b>Lunch</b>	
1.30 – 2 PM	Approaches for infrastructure development in an uncertain future	Dr. S Ravi Rajan Senior Research Fellow, Asia Research Institute and Fellow, Tembusu College, National University of Singapore
2 – 2.15 PM	<b>Tea / Coffee</b>	
2.15 – 5.30 PM	Breakaway groups consider modifying models and interventions	Facilitated by Navarun Varma, Ulka Kelkar and Saurabh Bhardwaj, TERI
<b>Friday, 31 January 2013</b>		
9.30 AM – 1 PM	Breakaway groups present models and	Facilitated by NavarunVarma, Ulka

	rationale to plenary	Kelkar and Saurabh Bhardwaj, TERI
1 – 1.30 PM	<b>Lunch</b>	
1.30 – 2 PM	Operationalizing techniques and principles learnt in the workshop and ways to sustain network	Discussion with participants
2 – 2.15 PM	Closing remarks	Dr. Dipankar Saharia Associate Director, Environmental and Industrial Biotechnology Div., TERI
2.15-2.30 PM	Vote Of Thanks	Navarun Varma, TERI

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### ***Bangalore, Karnataka Workshop***

Title Capacity Building Workshop on Systems Thinking and Adaptive Governance: The Context of Urban Flooding and Water Stress in Bangalore

Date: 24<sup>th</sup> – 25<sup>th</sup> April, 2014

Venue: TERI (The Energy and Resources Institute), 4th Main, 2nd Cross, Domlur 2nd Stage, Bangalore 560071

### **AGENDA**

<b>Thursday, 24 April 2014 Registration starts at 9.30 AM</b>		
10 – 10.15 AM	Welcome remarks	Mr P R Dasgupta Director, TERI SRC
10.15 – 10.45 AM	Overview of workshop approach and goals Preliminary conceptual models of urban flooding and water stress in Bangalore	Mr Navarun Varma Research Associate, Earth Science and Climate Change Division, TERI
10.45 – 11.15 AM	Urban flooding, water stress, and lake ecology: challenges and responses for Bangalore city	Dr Ritu Kakkar Director-General EMPRI
11.15 - 11.30 AM	<b>Tea / Coffee</b>	
11.30 AM – 12 PM	Water stress, systems thinking and adaptive governance in an urbanizing basin: focus on Bangalore	Dr Veena Srinivasan Fellow, Centre for Environment and Development, ATREE
12 – 12.30 PM	Urbanization and peri-urban water insecurity	Prof. Vishal Narain Associate Professor, Public Policy and Governance, Management Development Institute, Gurgaon
12.30 – 1 PM	Challenges of urban services and governance in Bangalore	Dr Kala Sridhar Head, Public Policy Research Group, Public Affairs Centre
1 – 2 PM	<b>Lunch</b>	

2 – 4 PM	Group activity: Discuss preliminary models, develop them further, and identify possible interventions	Facilitated by Navarun Varma, Saurabh Bhardwaj, and Prasoon Singh, TERI
4 – 5 PM	Plenary: Groups present interventions to each other	Facilitated by Navarun Varma, Saurabh Bhardwaj, and Prasoon Singh, TERI
Friday, 25 April 2014		
10 – 10.15 AM	Trends in land use change for Bangalore	Mr Prasoon Singh Research Associate, Earth Science and Climate Change Division, TERI
10.15 – 10.30 AM	Climate change and associated uncertainty	Mr Saurabh Bhardwaj Associate Fellow, Earth Science and Climate Change Division, TERI
10.30 – 11 AM	Bangalore urban sprawl and pressure on resources	Dr H S Sudhira Gubbi Labs
11 – 11.15 AM	Tea / Coffee	
11.15 – 11.30 AM	Urban heat island effect in Bangalore	Mr Kiran Kumar Research Associate, TERI
11.30 AM – 12 PM	Urban flooding in Mumbai, Manila and Bangkok	Dr Archana Patankar Senior Research Fellow, Regional Centre for Urban and Environmental Studies, All India Institute of Local Self Government
12 – 12.30 PM	Systems thinking and adaptive governance concepts in the context of issues discussed in the workshop	Prof. S Ravi Rajan Senior Research Fellow, Asia Research Institute and Fellow, Tembusu College, National University of Singapore
12.30 – 1.30 PM	Lunch	
1.30 – 3.30 PM	Group activity: Consider modifying models and interventions	Facilitated by Navarun Varma, Saurabh Bhardwaj, and Prasoon Singh, TERI
3.30 – 4.15 PM	Plenary: Groups present models and rationale	Facilitated by Navarun Varma, Saurabh Bhardwaj, and Prasoon Singh, TERI
4.15 – 5 PM	Operationalizing techniques and principles learnt in the workshop and ways to sustain network	Comments by Prof. Ravi Rajan Discussion with participants
5 – 5.05 PM	Vote of thanks	Navarun Varma, TERI

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### **Delhi Workshop**

Title: Policy Dialogue on Operationalizing Adaptive Governance in India

Date: 20<sup>th</sup> August, 2014

Venue: TERI (The Energy and Resources Institute), Darbari Seth Block, Indian Habitat Center Complex, Lodhi Road, New Delhi – 110003

### **AGENDA**

9.30 – 10 AM	Registration and Tea/Coffee
10 – 10.10 AM	Welcome remarks and overview Dr P.G. Dhar Chakrabarti, Distinguished Fellow, TERI
Session 1 10:10-10:15AM	River basins as complex systems Chairperson: Mr Ashok Jain, Advisor to Planning Commission, Government of India
10.15 – 10.30AM	Setting the context: Experiences from Lakhimpur district in Assam and Bangalore city, Karnataka Mr Navarun Varma, Associate Fellow, TERI
10.30 – 10.45AM	Discussants: <ul style="list-style-type: none"> <li>• Ms. Suparana Katyaini, IIT Guwahati</li> <li>• Dr. Veena Srinivasan, ATREE, Bangalore</li> </ul>
10.45 – 11:05AM	Comments from chair and open discussion
11.05- 11. 20AM	<i>Tea / coffee</i>
Session 2	From Natural resource management and Disaster risk reduction to Adaptive governance
11.20 – 11.25 AM	Chairperson: Dr. P.G. Dhar Chakrabarti, Distinguished Fellow, TERI
11.25 – 11:40 AM	The Adaptive governance approach-Challenges and opportunities for India Dr. Arabinda Mishra, Professor and Dean, Faculty of Policy and Planning, TERI University
11: 40AM – 1PM	Introduction of issues for shared vision and brainstorming on operationalizing adaptive governance in India Moderator: Navarun Varma, Associate Fellow, TERI and Ulka Kelkar, Fellow, TERI



1-1:15 PM	Comments from chair and open discussion
1.15 – 1.20PM	Vote of thanks Ms. Suruchi Bhadwal, Fellow and Associate Director Earth Science and Climate Change Division, TERI
1.20 PM	<i>Lunch</i>

### Participants List

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## Appendix 2.

### Funding sources outside the APN

TERI has provided in-kind support to the project, the details of which are included in the budgetary head of the proposal.

## Appendix 3.

### List of Young Scientists

Name	Organisation	Involvement
Suparana Katyaini PhD Research Scholar	Dept. Of Humanities and Social Sciences, Indian Institute of Technology, Guwahati, Assam	Speaker and participant in Guwahati and Delhi workshop
<p><b>Feedback:</b> As an academican, what I realized is that gaining a deeper understanding of the perspectives of different stakeholders and of the evolutionary process through which these perspectives have developed. I could overcome some of the limitations in my understanding and approach to addressing the issue of flood through the capacity building workshop. The workshop has enabled me to view the policy prescription from the sustainability lens and identify both the strengths and weaknesses. Through the workshop my research work has benefited in terms of going over the disciplinary boundaries to find more practical solutions which are both scientifically sound and socially accepted.</p>		
Mirza Zulfiqur Rahman PhD Research Scholar	Department of Humanities and Social Sciences, IIT Guwahati, Assam, India	Participant in Guwahati and Delhi workshop
<p><b>Feedback:</b> The meeting of a diverse range of stakeholders was quite novel. There was much clarity due to the approach taken, and many of the daily problems that we grapple in our research work, got a lot uncluttered. The discussion was quite rich in the group.</p>		
Kitriphar Tongper PhD Research Scholar	University of Leeds	Participant in Guwahati workshop
<p><b>Feedback:</b> By bringing together researchers, NGOs and government officials working on flood issues, this workshop showed that, discussion can be a powerful tool to bring about consensus and understanding of the problems related to flood problem and management. As was evident from the active participation during the presentation sessions, the process of making problem diagrams and discussing possible solutions did bring about new questions and concerns among the participants.</p>		
Arnab Nandi Researcher	IIT Guwahati	Participant in Guwahati workshop
<p><b>Feedback:</b> Being water resources engineer the entire concept of systems thinking provided a new direction of thinking to me. I'm glad to have reinforced my technical knowhow with the social science perspective which has in a big way, helped me to broaden my knowledge of the globally important Brahmaputra basin.</p>		
Name	Organisation	Involvement
Tarun Sharma Researcher	Indian Institute of Science, Bangalore	Participant in Bangalore workshop
<p><b>Feedback:</b> Integration of geospatial topography with agent based modelling was illuminating. I might use Vensim with function parameters for causal loop estimations. I am hinged to geospatial topography and the likes. I am likely to pursue this post my current project.</p>		
Seema Mundoli	Azim Premji University, Bangalore	Participant in Bangalore

Researcher		workshop
<p><b>Feedback:</b> It was very interesting to know about the different kinds of work that is being done by the various organisations, as well as the results of research that has already been carried, with regard to water related issues in Bangalore. Different organisations have focused on different aspects of the water stress and there seems to me a huge potential for linking together to address this serious problem. If the academic community can come together maybe there is hope that we can engage more effectively with the government institutions. There were certain complexities of these interactions I was not aware of before the conference and hope to be able to include them in my future work.</p>		
B.S. Shankar Researcher and Trainer	State institute for Urban Development, ATI, Mysore	Participant in Bangalore workshop
<p><b>Feedback:</b> Following were well understood and appreciated via the workshop: urban flood situation in Bangalore and other cities, role of various departments and NGOs to resolve those, policy interventions in urban management. Being a trainer myself, I learnt a lot from the views expressed by others in the workshop and will plan to include the learnings in my future work.</p>		
Name	Organisation	Involvement
Prasoon Singh Research Associate	Earth Science and Climate Change Division, TERI, New Delhi	Speaker and participant in all the workshops
<p><b>Feedback:</b> These workshops helped me to understand and identify the core features of adaptive governance and system thinking approach which includes experimental learning to address multi scale socio-environmental dilemma in context of flood management and related issues in both urban and rural context. The conclusion which strongly came out of these discussions and participatory modelling process to resolve these multi scale issues and concerns is trust building among all stakeholders which is possible only through social learning, institutional development and through collaboration and linking scientific knowledge with policy. I hope to incorporate this knowledge into my future work.</p>		
Ayyan Karmakar Research Associate	Water Resources Policy & Management, TERI, Bangalore	Participant in Bangalore workshop
<p><b>Feedback:</b> The outbreak sessions had extensive discussions on the subject matter and related areas. Apart from this, the knowledge shared by the variety of speakers was helpful. The workshop inspires for an integrated approach with multiple institutions and presents a scenario of Bangalore City which opens a great deal of scope for working in the water sector as well.</p>		

## Appendix 4. Workshop reports

### ***Guwahati Workshop report***

#### **Capacity Building Workshop on Systems Thinking and Adaptive Governance The Context of Flood in Lakhimpur District, Assam 28-31 January 2014**

**Venue: TERI North Eastern Regional Centre, Chachal, Express Highway, Guwahati**

#### **Overview**

The Energy and Resources Institute (TERI), New Delhi with the support of the Asia Pacific Network for global change research (APN) organized a 4 day capacity building workshop on "Systems thinking and Adaptive governance with the context of flood in Lakhimpur district of Assam" from 28th to 31st January. The workshop had a mix of panel discussions, lectures and group activities using conceptual systems modeling techniques which helped stakeholders to understand issues of flood from different perspectives; learn about challenges posed by uncertainty and strategize accordingly. It provided an opportunity to learn theory and practice of systems thinking and network with peers from civil society, academia and government. Resources persons included eminent researchers, faculty members and government officials from institutions like Humanities and Social Science Dept. of IIT, Guwahati, Management Development Institute (MDI), Gurgaon, National University of Singapore (NUS), TERI University, Assam Agricultural University, Water Resources Department (WRD), Govt. of Assam (GoA), Centre for North East Studies and Policy Research, Jamia Milia Islamia, Aaranayak, Guwahati and Assam State Disaster Management Agency (ASDMA). Stakeholders included researchers and scholars from IIT, Guwahati, Lakhimpur College, student activist associations and non-governmental organizations like Rural Volunteers Cell (RVC), Aaranayak and Farm2Foods, government officials from extension offices of Revenue and Disaster management Department and WRD, GoA.

#### **Date: 28 January 2014- Day 1**

The workshop began with opening remarks by Dipankar Saharia, Associate Director of Environment and Industrial Biotechnology Division and Coordinator of TERI-North East, who raised issues of flooding and erosion as the major concerns of the State of Assam. He mentioned that erosion has affected settlements, rendered people landless and has been contributing to out-migration. Following these remarks there was a round of introductions among the stakeholders which included doctoral students, government officials and members of Non-Governmental Organizations. Navarun Varma, Research Associate, Earth Science and Climate Change division of TERI then explained the purpose and structure of the workshop and mentioned the aim of the workshop is about understanding causes, impacts, and responses and linkages between the three for flood hazard. The lectures, panel discussions and breakout activities were designed to gain an understanding of issues of hazard, governance and uncertainty surrounding the Brahmaputra basin through different perspectives and also learn an approach for integrating different aspects of a problem.

#### **Lecture- Dr. Arup Jyoti Saikia, Associate Professor, Humanities and Social Science Department, IIT, Guwahati**

The first lecture was from Dr. Arup Jyoti Saikia, Associate Professor, Humanities and Social Science Department, IIT, Guwahati on the environmental biography of the Brahmaputra River. This river has a large and ferocious character but in order to investigate issues of uncertainty, erosion, siltation one has to demystify romantic stories surrounding it. The river and humans, through their interactions, have together shaped the destiny of the region. People's experiences of the river of the last thousand years needs to be retold. There are several historical examples of human experimentation with rivulets in the

Garo and Khasi Hills of the Brahmaputra basin. However, till the close of the 20th century, people refrained from living close to the river. The notion of human settlement is a very recent story – a very short time frame in human history of the basin. In the last few hundred years, as the hills (i.e. the Eastern Himalayas) became increasingly uncomfortable as a source of life, people started descending from the hills and settling in the plains and adapting to life in the floodplains (through their houses and crops).

Humans had become attuned to the flood regime of the Brahmaputra. Several elements contributed to people coming close to the river e.g. boats, gold washing, fishing, driftwood, pirates, dacoits and military strategies. There is a need to reflect on and learn from this rich historical experience, rather than bringing in ready-made doses of experience from other landscapes. In answer to audience questions he mentioned dearth of major research projects on the Brahmaputra River and expressed his uneasiness with the idea of experts. Engineers' expertise of the Brahmaputra dates back only 50 years and European expertise has been restricted to military strategy and hydropower generation.

**Lecture-Mr. Ratul Sarma, Retd. Commissioner and Special Secretary to the Govt. of Assam, Department of Water Resources, Government of Assam (GoA)**

Right after a historical perspective, the participants were exposed to the views from the government. Mr. Ratul Sarma, Retd. Commissioner and Special Secretary to the Govt. of Assam, Department of Water Resources, GoA presented on the challenges of planning due to changing nature of the course of the Brahmaputra river. He pointed out that protecting the Brahmaputra from erosion in the upstream may increase the same risk in downstream. He also showed the river's elevation profile and its sharp drop of 3000 meters and demonstrated its huge hydropower potential. The river is widening at an alarming rate: it has increased by more than 50% due to erosion in the last 30 years. The estimated annual average land loss is nearly 8000 hectares. The main cause of siltation in the main branch of Brahmaputra is its upstream tributaries, the gradient of upstream river is too steep and the water flow with great potential energy and while coming down brought lots of silt downstream. According to him the causes of the decrease of the "natural discharge carrying capacity" and increase of the width of Brahmaputra in Assam are- 1) the frequent tectonic activities which trigger geo-morphological changes and landslides in the upper catchment leading to excessive sediment charge in the river and 2) rising of river bed due to the sediment deposition in the downstream. Further he shared facts like the river has 1280 Km of shore line which is vulnerable to erosion, the total eroded area since 1954 is 4,27,000 Ha which is 7.4 % of the total plane area of Assam and nearly 1,30,000 families are affected due to erosion in the Brahmaputra basin.

For the protection of the river bank of Brahmaputra the government has responded with the implementation of the National Flood Policy, 1954 which has immediate measures as embankment construction and drainage channels, short term measures as improvements over the immediate measure infrastructures and long term as construction of storage reservoir and additional embankments. He described various embankment schemes being constructed by the government with national and international funding. He gave examples of different types of embankments and illustrated problems created by encroachment. A pilot project from downstream of Pandu to Bohori (about 35 Km) in downstream region within Assam is proposed for channelization of Brahmaputra for reclamation of huge area. He called for soil conservation with the cooperation of communities as an important measure, and also recommended upstream storage reservoirs. Further, he identified budgetary constraints along with delays in allocation process as a barrier implementing flood/erosion protection plans. He also criticized the upstream State of Arunachal Pradesh's unilateral decision for going ahead with run of the river projects which have serious impacts in downstream localities within Assam.

The participants questioned the downstream impacts of proposed dams within Assam like release of water and siltation and the community's response to non-structural measures. Some also pointed out the need for basin-level planning and cooperation with the upstream state of Arunachal Pradesh. Despite the prevalent view that flood control would have been easier in the absence of embankments, one participant spoke about the false sense of security that embankments have created among communities and noted that it is an irreversible decision. He also pointed to the risk that the same may happen in the case of other engineering solutions, such as new projects like geotextile revetment or upstream reservoirs as proposed by Mr. Sharma.

#### **Movie screening- Filmmaker Mr. Mouli Senapati**

After this talk there was a movie screening for an hour by a filmmaker from Assam, Mr. Mouli Senapati. The objective of the film was to portray the human stories behind the statistics of floods and erosion. This was followed by lunch.

#### **Lecture- Professor Sanjoy Hazarika, Center for North East Studies and Policy Research, Jamia Milia Islamia**

After the lunch, Professor Sanjoy Hazarika, Center for North East Studies and Policy Research, Jamia Milia Islamia connected with participants from TERI, Delhi through video conference. Professor Hazarika started by emphasizing the need to visualize the river as an entity in itself – not just something for enjoyment or use of humans. In order to design interventions for controlling is to challenge this entity. He spoke about three aspects of governance in the context of flooding in Assam:

- Accountability
- Transparency
- Dialogue

In order to illustrate the 3 above elements of governance he pointed out 3 important questions in the midst of his talk-

1. Who is responsible for the damage caused by embankments?
2. Why is it that the ecologically richest parts of our country are home to the poorest people?
3. It is an alarming trend that North Eastern states have lost more forest area than any other part of India in the last few years. Why is this happening – even in areas with community-led forest management? What is the responsibility of non-constitutional traditional authorities to natural resource management?

He mentioned that accountability is essential for the government while designing policies or interventions for a vast and evolving region like the Brahmaputra river basin. Questioning the transparency of the policy process, he called for a greater focus on the needs of the masses rather than policy being driven by the ideas and concerns of a few. Inclusive governance means that the government has to plan for the region as if people matter, otherwise it can create a situation of conflict. He felt that the government has failed to provide the basic needs of the poorest leading to issues of conflict. Such conflicts in parts of Assam with resource-dependent people also demonstrate that people have not been involved in processes of government and fear that they will lose their land. Political insurgency has reduced but ethnic conflict has increased. This means that there is a need for greater dialogue between traditional and constitutional institutions. In this context, he also pointed out the importance for researchers in both social sciences and life sciences to work together.

He also mentioned the future risk of unsilted water reaching Brahmaputra in Arunachal itself as a result of eleven cascading dams proposed to be implemented by China in Tibet in the next 10-15 years. Finally,

he criticized the lack of specialization and the exceedingly slow processes of the government in north east India. The government tends to function on an ad hoc basis without any long term memory or strategic vision.

**Lecture- Dr. Vishal Narain, Associate Professor, Management Development Institute (MDI), Gurgaon**

After presentations of different perspectives surrounding the issues in Brahmaputra Basin, Dr. Vishal Narain, Associate Professor, Management Development Institute (MDI), Gurgaon, India introduced the participants to the concepts of narrative, discourse, and model. He explained that it is our understanding, and more so its articulation, that influences policy choice. For example, in the preceding lectures, the historian, the government representative, and the film-maker addressed the same problem of flooding in very different ways. He explained that a narrative is a story with a lesson – that is used to justify a policy intervention. Such a story may be repeated such that it comes to acquire the status of established wisdom.

Such narratives help to simplify complexity. Narratives persist because they are consistent with certain scientific theories and because they serve the interests of certain groups. But the problem with narratives is that they become a blueprint for development. Hence, to understand any policy choice, we need to understand the dominant narrative. A discourse, on the other hand, is an ensemble of ideas which shapes problems. Examples of development discourses are neo liberalism, gender, climate change, and affirmative action. Similarly, discourse can be linked to explain narratives and policy choices can be understood by identifying the underlying discourses and narratives. For instance, the North-South discourse in climate change has become the basis for international negotiations and donor funding. Dr.Narain then described the purpose of modeling and types of modeling according to the need of understanding a context or anticipating future trends. He pressed the importance of these concepts because in order to identify a policy solution it is imperative to recognize how the problem is framed. In response to questions from participants, Dr. Narain agreed that discourses are about power and about which interest groups have the strongest influence on policy. Discourses often influence donor priorities and are often accepted by recipients because they come from donors (e.g. the formation of water user associations as suggested by the World Bank was considered as mandatory by the recipient government bodies). According to him there is always a need to challenge conventional wisdom and come up with counter-narratives of a problem situation.

After Dr. Narain's lecture, Professor Arabinda Mishra explained about the key concept around which the workshop was conducted i.e. systems thinking. He explained that in defining any system, inter-relationships within elements of a system are the most crucial. He mentioned that changes in one element of a system stimulate responses (or adaptation) in other inter-related elements; hence the focus is on complex adaptive systems (CAS). Both complexity and adaptive behavior are inherent in such systems. Not only do the individual entities change, but the entire system may change which becomes an important aspect when it comes to policy interventions. Typically policy interventions are directed at specific entities not at the system as a whole. So policy outcomes may not materialize as socially desired and even throw surprising results. Systems have an inherent tendency to go back to their natural / equilibrium states, after being subjected to pressures. Some powerful equilibrium states are called "attractor states" but other equilibrium states can be "surprises". Dr Mishra further explained the concepts of resistance as the capacity to retain in any equilibrium state while resilience as the capacity to shift to other equilibrium states without losing its structure and identity while collapse as the loss of the system structure.

Ignorance about certain elements or interrelationships in the system translates into uncertainty about the outcomes. Hence a paradigm shift towards acknowledging uncertainties while planning is needed. The standard rational actor model assumes the existence of a defined objective function, knowledge of all the alternative ways to achieve that objective, and a method to optimize the objective function. The alternate organizational behavior model is defined in terms of standard operating procedures. In the group politics model, outcomes are the result of bargaining or negotiations. But systems thinking approach strives to explain outcomes that cannot be explained by these three models, particularly when it comes to complex systems with human-nature interactions, such as flood management. Here outcomes are defined because of the behavior of a complex adaptive system. In the flood management example, the rational actor model leads to a limited focus on only technologies, the organizational behavior model leads to a focus on only institutions, and the group politics model leads to a focus on only conflicts. But it is important to look at flood management through a systems thinking lens. The application of this approach attempts to capture all inter-relationships in a system, for example by using the tool of causal loop diagrams. It attempts to capture linkages within narratives in the model. From a governance perspective, it becomes useful to identify factors which prevent different narratives from coming together, and identify possible barriers as well as bridges. He concluded by saying that systems thinking becomes more meaningful if it is embedded in public policymaking, for which the first step is for different stakeholders to recognize that there may be more than one narrative of an issue.

Group activity was initiated after this lecture. 4 groups were made- Water Resources Department, Other government departments, Academia and NGO/Civil society. Preliminary model was shared with each group and participants got hands-on the systems thinking technique called causal loop diagrams (CLDs).

#### **Date: 29 January 2014- Day 2**

The lecture series was started on Day 2 after lunch due to continued group activities in the morning.

#### **Presentation on Multiple states of context: case of villages within Dhokuakhana sub-division in Lakhimpur District of Assam- Navarun Varma and Prasoon Singh, TERI**

The first presentation was by Navarun Varma, Research Associate, The Energy and Resources Institute (TERI) who presented a part of his doctoral research work which has its empirical work in the context of the group activities. He explained multiple states of the part of Upper Brahmaputra Valley agro-ecosystem comprising of some villages in Dhokuakhana Sub-division of Lakhimpur district in Assam. From paddy cultivated agro-ecosystem, the ecological regime had shifted towards coarse sediment deposited landscape. The local riparian tribe-Mishings had become rich paddy cultivators as they started cultivating transplanted varieties of rice after flood protection through embankment in mid 50s. Although there were breaches in 60s, major breaches around the studied villages started from 1998 with a peak High Flood Level (HFL) in this upstream region. But the breaches were continuous from 2005 till 2009 without any peaks in the HFL, thus the breaches may not be just due to thrust of flood waters. Moreover, the Mishings were losing land due to erosion of the Brahmaputra and the receding flood waters deposited huge amount of coarse sediment in the remaining cultivable land. Since 2010, few villages stay protected from further inundation due to construction of a 5km. geo-textile revetment, but the issue has changed from flood hazard to landlessness. Following this, Prasoon Singh, Research Associate, TERI presented landsat images from 1990, 2001 and 2014 of the same 5km stretch in order to illustrate the changes owing to flood, erosion and sediment deposition.

#### **Presentation on Climate change and associated uncertainty- Mr. Saurabh Bhardwaj**

After illustration of the changes that have been occurring till date in this part of Upper Brahmaputra Valley, Mr. Saurabh Bhardwaj, Associate Fellow presented on future risk from the global phenomenon



of climate change and the associated uncertainties. He started his presentation by explaining the basics of climate, its difference with weather processes and emphasized on the complex interactions between each climate component. The components within the climate system interact non-linearly amongst each other that lead to climate variability at spatial as well as temporal scales. Any change or forcing in one the component induces change or responses in all the other components in a non-linear way which makes the scientific problem of assessing the change highly complex. He showed how these non-linear interactions are numerically quantified by using various models which are a set of mathematical equations explaining the various dynamical processes that govern the climate system. The framework of a climate model along with the flow chart of climate modeling process was explained wherein the importance of observations was established. Mr. Bhardwaj stated that observations not only help in model development and help in model simulation by providing boundary forcing and initial conditions, it also helps in validation process for any model. He then pointed out on the uncertainty aspect in the climate science and modeling which arises due to lack of observations, type of observations and resolution of model utilized. Hence to overcome these uncertainties, it was mentioned that Intergovernmental Panel on Climate Change (IPCC) have brought out various scenarios and ensemble approach which the modeling community uses to present their results to the research community and stakeholders.

### ***Bangalore Workshop report***

#### **APN-TERI Workshop on Systems Thinking and Adaptive Governance: The Context of Urban Flooding and Water Stress in Bangalore**

**24-25 April 2014**

**TERI SRC Bangalore**

#### **Overview**

TERI organized a workshop on “Systems Thinking and Adaptive Governance: The Context of Urban Flooding and Water Stress in Bangalore” during 24-25 April 2014. This workshop was supported by the Asia Pacific Network for Global Change Research (APN) under its CAPABLE capacity building programme. The aim of this workshop was to create a greater appreciation of the principles of systems thinking and adaptive governance among government and non-government practitioners, and to discuss how these principles can be operationalized in the context of Bangalore. The thematic focus was on the issues of urban flooding and water stress. In Bangalore, high intensity rainfall causes urban flooding due to inadequate drainage and unplanned development in lake beds and low-lying areas.

This two-day workshop had an interesting mix of expert presentations and group activities to introduce participants to systems thinking and adaptive governance in the Bangalore context. Participants used simple conceptual modeling techniques in groups to understand issues such as urban flooding, water stress, and ecological degradation from different perspectives, factor in the challenges posed by uncertainty due to climate change, and strategize accordingly.

Participants included representatives of the Bangalore Metropolitan Region Development Authority (BMRDA), Bangalore Water Supply and Sewerage Board (BWSSB), Central Ground Water Board (CGWB), Environmental Management and Policy Research Institute (EMPRI), Lake Development Authority (LDA), Administrative Training Institute (ATI) and State Institute for Urban Development (SIUD), Mysore, in addition to research and academic institutions like Ashoka Trust for Research in Ecology and the Environment (ATREE), Indian Institute of Science (IISc), Indian Institute for Human Settlements (IIHS), and Azim Premji University; and civil society organizations like Environment Support Group (ESG).

In his welcome remarks Mr P R Dasgupta, Director, TERI Southern Regional Centre gave an insight into existing issues of water scarcity, lake encroachment, ground water depletion, and urban flooding in Bangalore and climate change related environmental issues in the state as a whole. Talking about the relevance of this workshop he believe that the results of this workshop will certainly lead to a certain amount of coordinated thinking at the state level and at the city level. He also expressed concern for existing lot of uncoordinated spasmodic reactions to a certain symptoms in the governance. In his final remark he thanked APN for supporting these series of workshop and hoped this workshop will be able to address the issues and come out with concrete solutions of water scarcity and flood problem in a collective manner.

***Mr NavarunVarma, Research Associate, Earth Science and Climate Change Division, TERI***

He presented the objective of this workshop along with the approach and methodology for participatory modelling exercise on system thinking and adaptive governance.

***Ms Ritu Kakkar, Director-General, Environmental Management and Policy Research Institute (EMPRI)***

Ms Ritu Kakkar's talk focussed on the challenges and responses for Bangalore city in terms of water management. According to the projects EMPRI has done on water management issues in Bangalore, the key challenges what the city is facing right now are critical like any other fast growing city in India. Water management is a biggest challenge in the city at all level and rapid population growth, unplanned city development, damages to natural resources, increase in waste; climate change related issues and pollution further worsening the situation.

As for as the water sector is concern there are many challenges in supply of safe drinking water. The water availability and water quality are big issue as the available water is not sufficient to full fill the demand side. Surface and ground water pollution, encroachment of the lakes, mixing of sewage into drinking water supply and water losses from supply distribution system (around 45% as the water brought to the city from great distance from Cauvery River) are main reasons for poor water quality and quantity.

Talking about the Flooding problem in Bangalore she discussed the causes and associate risk of flooding in urban environment. Flooding in Bangalore is a result of cumulative impact of Urban Development. With growing population, city needs to expand itself to accommodate and cope up the pressure. For the development of the city it needs resources in terms of construction materials, Land, food etc this aggravates impervious surface, over cultivation, soil erosion, deforestation as the large areas of forests near the rivers/catchment of cities are being cleared to make room for settlements, roads and farmlands due to which soil is quickly lost to drains and reducing the carrying capacity of the drains causing over flowing. The areas which were essentially created by the storm water drains to let their flood waters pass freely being tress-passed for developmental purposes resulting in obstruction of water flow and thus contribute immensely to the fury of floods.Areas near and around the city and the lakes in Bangalore which used to serve as the storage of rainwater are being taken by the development authorities and private players for the construction purposes in unplanned manner. Due to these unplanned developments natural drains are filled up and the lakes are no more interconnected to facilitate storm water flow. Giving the example of 2005 and 2013 flood incidents in Bangalore she explained the severity of the incident and related damages to infrastructure and commerce. The main reason identified was the chocking of storm water drains and excess rainfall.

Talking about the EMPRI's work for the development of Karnataka State Action Plan for Climate Change, they have mentioned the problem associated with water resources management for the Bangalore. The

city is facing the severe problem of water scarcity. Supply and demand side gap is 135 mld and expected to grow more if the adaptive measures are not implemented in priority basis. Karnataka experienced a decline in net annual ground water availability by 3.2% between 2004 and 2009. Notably Bangalore, Kolar, Tumkur and Chitradurga draw much more water than is naturally recharged. For the management of ground water EMPRI has recommended monitoring and mapping of ground water for quality and quantity as well as Establishment of a state level policy body to review the possibility of prohibiting the use of groundwater for non-drinking and non-emergency uses. The city has a great potential of Rainwater harvesting which can be used for irrigation, drinking water supply and ground water recharge, extension of BWSSB rule on rainwater harvesting to other urban local bodies will help in managing ground water. There is need of awareness for the acceptance to use the treated water in industrial and urban local bodies. In agriculture sector as it is the largest consumer of water and demands 84% of utilisable water of the state, low priced irrigation water is a substantial barrier for investment in water infrastructure and sustainable resource utilisation and management. To overcome this problem Water resource department has to lead a cost benefit analysis in order to assess the financial burden of irrigation water and to formulate a pricing policy rationalising irrigation in view of long-term sustainability and the need for adequate finance. EMPRI's research on Bangalore's lakes applies a holistic approach to lake conservation along with drainage and protection of surface water quality, under which **lake health report cards** have been prepared. EMPRI also conducts rainwater harvesting training programmes, bio medical waste management programmes, and solid waste management programmes. **Water safety plan for Bangalore** is a modern approach to improve the quality of drinking water, prevent water loss, and upgrade the existing system.

***Dr Veena Srinivasan, Fellow, Centre for Environment and Development, Ashoka Trust for Research on Ecology and the Environment (ATREE)***

Dr Veena Srinivasan presented a quantitative system dynamics analysis of water availability for Bangalore city. She pointed out the inequities in water supply within the city, which are not usually captured in systems models that focus on aggregates. Her presentation attempted to address questions such as how future levels of water consumption can be sustained and how resilient the city is to multi-year droughts. The study investigates the reasons for 80% reduction in flows to the TG Halli reservoir since the 1980s. There are different hypotheses for this little understood phenomenon. Dr Srinivasan explained it in terms of blockages as the city urbanized, which she termed the "million puddles theory". The presentation also pointed out downstream issues in wastewater treatment related to inequity, lack of **compliance**, and lack of **capacity to treat river water with industrial effluent**.

Citing the study ATREE has done on Bangalore's water situation; the key concerns raised in the study was the sufficient water availability to meet the demand as the supply demand gap is huge, equitable distribution of water which is not there; big variations in supply from 25 to 330 LPCD raising the concern of system approach and management of water resources. Groundwater extraction is correspondingly higher in wards with fewer water supplies even at current extraction rates; GW Levels have been declining in peri-urban areas but are rising/stable in central Bangalore. With the rising demand of water and with limited and almost constant supply of water from surface water sources from Cauvery river and Arkavathi (TG Halli) basin Ground water supply is rising leading to depletion of ground water and declining of GW table; raising the issue of sustainable supply of water in future. The fourth concern and question arises about the city's resilience towards multiyear droughts. Bangalore is largely dependent on Cauvery water supply and in case of multiyear drought a major source of vulnerability came up in the form of inter-state conflict between Karnataka and Tamil Nadu and in recent years with the Mandya farmers as they believe their water is diverted to Bangalore. These are the main question arises when we talk about the modelling of water supply problem in Bangalore.

For the solution point of view she discussed the BWSSB plan of Cauvery Stage IV Phase 2 and Netravati (Yettinahole) project which is in pipeline. But there are the possibility of applying lots of soft options for the management of water supply in Bangalore which includes proper wastewater management, rejuvenating the existing water bodies, rainwater harvesting and ground water recharge and efficiency improvement of existing water supply system.

Talking about the learning and thinking from system perspectives on Bangalore's water situation; issues and solutions, her main concern was focussed on two issues. One is the rejuvenating the Arkavathy and second is wastewater recycling. Giving the example of the study conducted on Arkavathy Catchment which partly covers Bangalore city though but the issues are similar irrespective of geographical coverage. She divided the catchment into upstream and downstream and discussed the issues separately for each part.

The upstream catchment is 1400 km<sup>2</sup> TG halli reservoir which receive annual rainfall of 800 mm and used to be the major source for water in Bangalore with design capacity of 148 mld but now it is only supplying 30 mld of water to the city. So there is almost 80 % decrease in incoming water in the reservoir. There is a sharp decline of Inflows into the TG Halli reservoir, which supplies Bengaluru, although there are no new upstream dams constructed. So to investigate the decrease of flow over time there is need to understand the soci- hydrologic linkage. They have taken into consideration these five hypotheses which could be the reason for this decline

1. Decreasing Rainfall
2. Increasing temperature
3. Loss of deep aquifer due to Ground water pumping
4. Increase ET due to Land Use change and
5. Million puddles due to urbanization

But these hypothesis are partly explains the reasons for decline in flow as per there analysis but not convincingly.

Downstream catchments are facing problem of waste water. The downstream catchment Vrishabhavathy receives all the sewage and wastewater from Bangalore which contain more than 64 % untreated water, causing the threat of serious health impacts. Wastewater is used for irrigation in peri urban areas because it is nutrient rich and has economic benefits. It is also a promoted solution towards sustainability. But increased toxicity level in wastewater may have impacts on waste water reuse. More over waste water recycling and treatment facility is inefficient and insufficient. Most water is treated directly from River not in Sewerage system. Only 20% of river water is being treated and that not to effectively. As per the Gov. Notification large apartment and housing complexes have to have their own decentralized waste water treatment system but many break down in few months due to lack of enforcement and lack of incentives and capacity from the Gov.

***Prof. Vishal Narain, Associate Professor, Public Policy and Governance, Management Development Institute (MDI), Gurgaon***

Prof. Vishal Narain investigated how a periurban conceptual lens can be applied to environmental issues to help to take a system approach in understanding urbanization and its consequences. He defined the peri-urban concept as where the rural and urban co-exist and where the ecological footprint of the city falls. Land loss and land acquisition processes accompany urban expansion, but the impacts on water access and security are not well known. Increase in waste water due to urbanization affects both food producers and consumers. Yet there is a fragmentation or dichotomy between urban planning and rural development. Current institutions do not allow planning for both together e.g. urban water supply may

be expanded at the cost of rural water supply. Peri-urban locations have to face both urban and rural stressors. While the peri-urban elite are able to gain from both new urban and existing rural opportunities, peri-urban tenants and sharecroppers are hurt the most. Hence there is a need to create dialogues or forums for agencies and actors along the urban-periurban-rural spectrum to interact and work together. (One of the comments following this presentation highlighted the roles played by sub-urban aspirations and the real estate mafia.)

***Dr Kala Sridhar, Head, Public Policy Research Group, Public Affairs Centre (PAC)***

Dr Kala Sridhar presented the challenges of Urban services and governance in Bangalore in context of Urban flooding and water stress. She presented the causes and consequences of urban flooding and the solutions and recommendations for the future. She compared demography of different cities in India in terms of Density which is relevant as it encroaches the flood plain of the cities which is one of primary cause of urban flooding. In this context Bangalore stands 6<sup>th</sup> with population density of 10600/km<sup>2</sup> compare to the other municipal cities in India and its much beyond the average density compare to the other cities in Karnataka. She also compared the services in Bangalore against benchmarks which showed its poor performance in the services related to drainage infrastructure, solid waste management and water quality. Comparing the Bangalore solid waste management practice with Surat it is evident that the Surat has improved its urban services after the plague but Bangalore is on the brink of a solid waste management crisis. There is a multiplicity of institutional arrangements which acts as a hindrance to effective urban governance. Pricing is a very important issue: since the city first uses the cheapest sources of water, and then as it grows, goes to more distant and costlier water sources, the marginal cost, not the average cost, should be used to price water in a growing city. (But one of the questions that arose in reaction to this recommendation was whether evidence from around the world shows an impact of pricing on behavioural change).

***Mr Prasoon Singh, Research Associate, Earth Science and Climate Change Division, TERI***

Mr Prasoon Singh presented the Decadal Trend of Land Use changes in Bangalore using remote sensing data. It was seen in Bangalore since 1973 to 2013 there was sharp increase in built-up area more than 100 percent, there was sharp decline in number of water bodies, vegetation cover and increase in fallow land.

***Mr Saurabh Bhardwaj, Associate Fellow, Earth Science and Climate Change Division, TERI***

The topic of Mr.Saurabh Bhardwaj's presentation was "Climate change and associated uncertainty". He started his presentation by explaining the basics of climate, its difference with weather processes and emphasized on the complex interactions between each climate component. The components within the climate system interact non-linearly amongst each other that lead to climate variability at spatial as well as temporal scales. Any change or forcing in one the component induces change or responses in all the other components in a non-linear way which makes the scientific problem of assessing the change highly complex. He showed how these non-linear interactions are numerically quantified by using various models which are a set of mathematical equations explaining the various dynamical processes that govern the climate system. The framework of a climate model along with the flow chart of climate modelling process was explained wherein the importance of observations was established. Mr.Bhardwaj stated that observations not only help in model development and help in model simulation by providing boundary forcing and initial conditions, it also helps in validation process for any model.

He then pointed out on the uncertainty aspect in the climate science and modelling which arises due to lack of observations, type of observations and resolution of model utilized. Hence to overcome these uncertainties, it was mentioned that IPCC have brought out various scenarios and ensemble approach which the modelling community uses to present their results to the research community and

stakeholders. The climate exposure and risk over the Karnataka state was also explained by him. Referring to the existing literature he mentioned that mean annual temperature, rainfall and intensity are projected to increase over the state for the future time periods of 2020-2080. Long term historical district wise climatological trends and future projections for the state were also illustrated by him in his talk.

He ended his presentation by showing national coverage on climate change impacts on Bangalore and emphasized on the awareness which should be an important part of any climate change action plan.

***Mr D Kiran Kumar, Research Associate, Sustainable Habitat Division, TERI***

Mr D KiranKumar, presented data on the urban heat island effect and increase in imperviousness factor in Bangalore.

***Dr Archana Patankar, Senior Research Fellow, Regional Centre for Urban and Environmental Studies, All India Institute of Local Self Government***

Ms ArchanaPatankar, discussed the findings of an APN-funded research study on urban flooding in Mumbai, Manila and Bangkok and the resulting costs to households and city economies. In the context of flooding the profile of these cities are similar. These 3 cities are coastal consist of huge industrial, residential and commercial establishment along with large population lives in improper settlement. So the vulnerability in the context of flooding is similar. They have conducted a loss and damage methodology to assess the economic impact of flooding in these cities. She also emphasized to use the framework for the loss and damage assessment because unless we have an impact assessment done for flooding we can't really inform a better adaptive interventions and nor we can identify who is vulnerable and at what extent they are vulnerable and how to address the vulnerability and adaptation at the same time.

***Dr H S Sudhira, Gubbi Labs***

Dr H S Sudhira, used geospatial analysis and agent-based models to assessing headwater streams and flooding in the urban watershed of Bangalore. Highlighting the burial of **first and second order streams** and the construction of **covered drains**, he showed that urban flooding in Bangalore is a unintended consequence of several unintended consequences of urbanization and urban governance.

***Prof. S Ravi Rajan, Asia Research Institute, National University of Singapore and University of California, Santa Cruz***

Prof Ravi Rajan, spoke about systems thinking and adaptive governance concepts in the context of issues discussed in the workshop. He pointed out the need for education and raising awareness among elected representatives at the municipal level. Multistakeholder dialogues are more difficult when stakeholders do not share a common literacy or language about concepts and are unable to discuss issues of mutual interest on a common footing. This shared language has to be created.

**Group activities**

***1. Issues with systems thinking***

The land use group found it difficult to add social and institutional aspects to the model. The physical linkages in the system were complex enough. One of the participants asked whether the three models would be linked, to which the TERI expert replied that the systems thinking process followed in the workshop was more about how a negotiated solution could be achieved. How do we prioritize within systems thinking? If there are competing priorities, which stakeholders should be given priority?

## 2. Problem context

A government participant said that despite government notifications, illegal land use is still happening (e.g. large apartment complexes are being built on major storm water drains or rajakluves). Policies are not enough to ensure compliance. There is political pressure. Agricultural or common land is declared as barren and hence eligible for conversion. Eucalyptus is planted to drain the lake bed and then convert it for real estate developments. As one government participant put it, poor people are encroaching illegally but bureaucrats are encroaching legally. Another participant also pointed out that even illegal constructions built over a storm water drain can be regularized by paying a fine under the akrama-sakrama rules. A government participant also said that there is a limit to how much the government can spend on remedial measures, e.g. lake restoration (flattening, garbage removal, de-silting and plantation) is expensive to do repeatedly. Awareness raising and enforcement are required. The blockage of first and second order streams was added to the model as a key problem after Dr Sudhira's presentation.

## 3. Solutions

The **community should contribute to and access data** on natural resources (e.g. surface water or ground water) and on land use (e.g. property developments). A **common database or reporting system** could be created which allowed contributions from anybody – with weights or rating to indicate data quality. A common data platform is a concrete solution beyond creating forums for different actors to come together. The state has never before been more open to data sharing.

The **websites of urban local bodies could make available information to citizens** that would facilitate transparent governance. For example, in planning layouts, the BDA does not use the BBMP's drainage map. People should know about whether the plot they are planning to purchase is built on a lake bed or storm water drain otherwise they may legally acquire a property without realising its implications.

A government participant said that **raising awareness of individuals** is very important for ensuring compliance with existing laws e.g. waste segregation at source, rainwater harvesting.

**Storm water drains should be separated from sewage lines** in the older established parts of the city.

In newer areas of the growing city, there is a need to **understand the topography and the presence of first and second order streams** to prevent encroachment of lakebeds or drainage channels.

**Price incentives** are important but for rainwater harvesting to work, top-down subsidies are needed.

Urban planning is not new but there are gaps in incorporating trends in socioeconomic drivers and in physical and ecological hazards into coding. **Ecologically based zoning** is required as urban development and sprawl cannot be ad hoc and cannot be left to developers and their powerful lobbies. But such zoning requires inter-disciplinary expertise in municipal planning agencies. Perhaps there is need for a distinct government agency on adaptation and resilience, which is staffed by people with knowledge of ecological complexity and the necessary technological expertise.

Norms are easy to formulate but implementation is difficult. However, the **RTI** (right to implementation) has made governance reforms possible. If **people are held accountable under law**, the agency will transform itself.

**Multiagency coordination** is a characteristic of large firms and is not a new issue. Management science has explored interesting ways of addressing this issue by applying basic principles of organizational behaviour.

### ***Delhi Workshop report***

#### **Policy Dialogue on Operationalizing Adaptive Governance in India**

**20<sup>th</sup> August, 2014**

**TERI (The Energy and Resources Institute), New Delhi**

**Navarun Varma, Associate Fellow, TERI** opened the workshop with a mention of the floods in Assam and requested Dr P G DharChakravarty to welcome the participants.

**Dr P G Dhar Chakrabarty, Distinguished Fellow, TERI** remarked on the uniqueness of the policy dialogue – while adaptation is frequently discussed in India, adaptive governance is rarely discussed. Human beings have always creatively adapted to changing circumstances, but often these are not well planned. To meet the challenge of climate change, autonomous adaptation may not be enough but a very systematic approach will be needed. There are a lot of uncertainties about climate change – there is no other alternative but to adapt – and a very conscious strategy is required. What should be the adaptive governance structure?

With respect to flood management, there have been unintended impacts of structural measures, so there is need for a multi-disciplinary discussion to identify suitable participatory governance measures in light of changing climate risks and the complex systems where physical and social systems are interlinked.

#### **Session 1- River basins as complex systems**

**Mr. Ashok Jain, Advisor, Planning Commission** chaired the session on river basins as complex systems. Explaining the statistics about utilizable water resources in India, he highlighted the importance of groundwater: about two-thirds of irrigation and 80% of domestic consumption comes from ground water. Management of groundwater resources and recharge of aquifers is an equally important dimension of flood management. (The government has a major programme to map groundwater aquifers in the country). Climate change will only add to this challenge.

Flood management requires not just structural measures but also non-structural measures that engage society. In cities like Bangalore and Hyderabad, which had hundreds of water bodies which would retain rainwater and recharge groundwater, water bodies are shrinking due to debris dumping and encroachment, which is leading to increasing flooding and waterlogging of low-lying areas when heavy rainfall occurs. This is exacerbated by increase in paved surfaces due to urbanization. In flood management, the proper treatment of the catchment area is of critical importance (including rainwater harvesting).

Mr Jain also mentioned the river interlinking programme and rainwater harvesting programme of the government. Though water is a state subject, the Parliament empowers ... River Board Act 1956 was enacted but remained non-operational. Under this Act a River Basin Authority can be constituted only if



a state requests for it. Recently, however, Krishna and Godavari basin authorities were constituted under Andhra Pradesh state re-organization.

In conclusion, he emphasized that water resources have to be managed on river basin scale with equal attention to both ground water and surface water.

**Navarun Varma** presented an overview of the APN project and the findings from the two workshops organized previously in Guwahati and Bangalore. Climate model projections show that while total rainfall is expected to increase, so is the rainfall from extreme events. The state actions plans on climate change identify various adaptation needs to address these potential impacts e.g. need for water storage infrastructure in drought prone areas or need for augmentation of storm water drainage capacity in urban areas. But actual implementation does not always match the identified needs.

In the Assam context, there are increasing instances of embankment breach and land loss, possibly due to:

- Finance does not arrive in time for timely
- Maintenance of embankments.
- Wilful damage by villagers and protest for compensation
- Upstream construction interventions increasing the sediment load.

In the Bangalore context, there is frequent water logging, attributed to:

- Inadequate solid waste management
- Increase in built up area
- Ignorance of linkages between ecological resources/services and urban planning

Soft systems modelling allows for more holistic thinking. Multiple conceptual models of these contexts can be developed, as was done in the Bangalore and Guwahati workshops. Navarun explained the methodology of the workshops and how they led to evolving models and thinking.

We learnt three things from the two contexts:

1. Lack of coordination and transparency between responsible agencies

e.g. In Assam, the water resource department is responsible for flood control, while the revenue department controls land and is responsible for relief and rehabilitation. But there is little awareness of the guidelines for land acquisition at lower levels. In Bangalore, the urban development authority does not refer to the city corporation's drainage map in planning new layouts.

2. Misdiagnoses and mistrust

e.g. erosion is not recognized as a disaster, violation of buffer zones around wetlands in cities

3. Exclusion and lack of shared vision

e.g. flood disaster has led to political struggle in the local tribe. In Bangalore, peri-urban actors are not included in urban planning.

### **Discussion by Guwahati and Bangalore participants**

**Suparna Katayini, IIT Guwahati** discussed major issues that emerged in the Guwahati workshop in discussions across stakeholder groups – and how trust developed towards the end of the workshop.

- displacement
- vulnerability
- multi-dimensional poverty

Flood affected communities are struggling with food security, water security (including sanitation), health security, and major focus on livelihood security because of loss of agricultural land due to sand deposition.

**Mirza, IIT Guwahati** said that floods used to be celebrated in Assam earlier but have now become a misery. We need to analyse the reasons for this. There is need for a stronger science –policy interface and a stronger engineering-humanities interface to grapple with these issues. There is a need to see how consultative mechanisms are shaped up – there is need for a robust consultative mechanism but also a sensitive mechanism – then only the kind of issues identified in the workshops can be taken forward / operationalized.

**Priyanka Bora, WRD, Guwahati** said that flood can be managed but erosion should be recognized as a disaster so that funds can be availed from the state disaster management fund.

**Dr. Veena Srinivasan, Fellow, ATREE** took a river basin approach for Bangalore –  
Upper catchment – severe water stress and groundwater depletion (600-1200 feet now)  
Bangalore – both water stress and flooding  
Lower catchment – severe issues of untreated domestic/industrial water sewage and water quality problems

Some specific governance breakdowns emerge when this approach is taken.

1. Disconnect between groundwater and surface water – e.g. secular decline in TG halli flows - one clear reason is ground water pumping and disappearance of shallow water aquifers. Groundwater and surface water is managed completely separately – fragmentation of jurisdiction. And there is no agency structure that allows this issue to be addressed.

2. Misdiagnosis

Community outreach and water literacy campaigns are required. Farmers say it is raining less but rainfall records do not show this. Perhaps they do not want to admit that it is due to increased ground water pumping. But this needs to be handled sensitively by showing them evidence and looking for alternative diagnoses.

3. Both urban flooding and water stress in Bangalore – lakes are seen as a solution

BBMP interested in lakes for storm water drainage

LDA – concerned with ecological aspects

BWSSB – lake management but not interested in using them as water source

Groundwater dept see lake as groundwater recharge structure

Another view – amenities, parks, etc.

So lack of shared vision and consistency of objectives

### **Comments from participants from New Delhi**

- **Mr Vijay Kumar, Distinguish Fellow, TERI** said that rural water bodies have become embedded in urban areas due to urban expansion. These water bodies are not taken into account in urban planning.
- **Upasana Sharma, Faculty, IIT Delhi** highlighted the **real estate price driver**. Does water need to be priced higher?
- **Kanchan Chopra, Faculty, Teri University** -Presentations brought out contradictions in our policies. Water sources in city are rarely considered – instead look to bringing water from

distant rivers. Deliberative processes in governance – awareness creation is a way forward – but how will they work in unequal power equations. Whenever a structural intervention is considered, the social-ecological context must be considered. We know the problems but how do we translate into adaptive governance at all levels of government. One way – water should be made a concurrent subject. How do you devolve power to the state and local bodies?

## **Session 2 – From Natural Resource management and disaster risk reduction to Adaptive Governance**

**Dr Dhar Chakrabarty** reiterated the problems identified in the first session and requested the participants to brainstorm about solutions. Is the existing governance mechanism good enough or do alternative mechanisms had to be sought?

**Arabinda Mishra, Prof., Teri University**, in his lecture on shared vision, introduced some questions for discussion:

Adaptive governance – what does governance need to adapt to? Changing circumstances or social processes – it is a dynamic world so governance processes need to change in response. Traditionally monitoring and evaluation mechanisms are built into policy implementation. Policymakers understand the importance of iteration, public consultation, and feedback loops. Then, when do we say that governance has become adaptive and shifted from the conventional?

- Traditionally, such M&E/feedback mechanisms are driven by the government and designed to capture the perspective of the dominant stakeholder. But there are multiple stakeholders / narratives (plurality of actors) – but the processes // mechanisms lack the intent to capture their perspectives – and towards building consensus. Willingness to accept at the institutional / government level to define a particular problem by recognizing multiple narratives around it.
- Social learning – to some extent science is linking up with policy (e.g. INCCA). The new element / question is whether learning leads to transformative change. Often (dilute) “mainstreaming” or an incremental approach to policy change is preferred rather than transformative change. Ability to go beyond existing mandates.
- What do we mean by shared vision? Any vision discussion that gets bogged down in discussions of how or mechanisms will not...What is the vision of Indian cities? Can we have a value based discussion of policy? If there are multiple actors, whose values? Can we decide on a common set of values rather than a common set of outcomes?
- Is consensus-based policy or shared vision required? In which problem contexts?
- Why is it so difficult to come up with a shared vision? Understanding the barriers is important to finding the solutions.
  - o Psychological / social barriers (e.g. denial, reframing/reinterpretation of problem e.g. climate change as opportunity, complete indifference)
  - o Cognitive barriers (e.g. due to past experience or action)
  - o Institutional barriers (e.g. due to sticking to institutional mandates)

### **Brainstorming on 4 key questions-Facilitated by Navarun Varma and Ulka Kelkar**

Given the 2 contexts, in order to realize the goal of shared vision among stakeholders, it was asked to the participants as how do we address barriers that arise due to following-?

1. Misdiagnosis- What can enable better diagnosis to inform decision making?
2. Communication- How do you think there can be better communication within line departments, across departments and government and citizens

3. Labeling- How do you think we can steer away from stereotyping and build better understanding of context for guiding decisions
4. Mistrust- What can be the best ways to build trust among diverse stakeholders

#### **Salient points from discussions-**

- Implementation is a problem due to lack of shared vision, there is a need to go from vision to strategies and strong evaluation for learning.
- A communication strategy of benefits of public sector projects is very important for people's acceptance to even endure during inconvenient times of the project.
- There is communication in lower levels of government and also among this level and citizens due to individual and community will but communication in higher level like between ministries is an issue.
- There is a need to look into existing values rather than incorporating definitions from the west.
- There has to be an excellent system of records keeping and access to such records, for that instance single window approach of Karnataka's government E-governance cell is an example.
- Many of the problems of misdiagnosis happen because of lock-in of institutional legacy.
- Situation analysis of resources within a context like a resource inventory of an area should be done instead of increasing transaction costs.
- Research should look into group modelling like in this project coupled with simulations for case studies to enhance shared vision.
- Lack of institutional framework and resources to incorporate recommendations from climate research in sub-national levels.
- There is a need of a common language across line departments and while communication with citizens in order to avoid plurality of interpretations.
- Communication strategies should be designed for an evolving context to understand changing aspirations and new meanings of ecosystems as they emerge.
- Instead of discarding studies from certain agencies outside the government, there is a need for compilation of all studies for a holistic understanding.
- Trust is required to maintain communication and that can come by meeting again and again. Thus an enabling environment is needed for such informal meetings in specific contexts instead of formal communication channels.
- An enabling environment is also required for the government officials to steer clear from motivated complaints for public service as this adds on to the mistrust from citizens.

- There is a need for respect of policy decisions, it has to be evaluated after implementation but questioning after formulation needs to be checked.
- There is a tendency of public agencies not trusting the inputs from the citizens because it is difficult to incorporate citizens' views unless it is statutorily required.
- Mistrust is a function of labelling as well as complexity; it is basically misdiagnosis and lack of knowledge that is driving mistrust
- Role of media, social media, community radio should be looked into for enhance the interface between government and citizens for reducing mistrust

**Dr. Dhar Chakrabarty** commented that few more workshops like this would be required to hammer the operational principles of such a new approach in India but this has been a good start as identifying barriers are the step for a solution. This was followed by a vote of thanks by **Ulka Kelkar**.

## Appendix 5. Glossary of Terms

ASDMA	Assam State Disaster Management Authority
ATI	Administrative Training Institute
ATREE	Ashoka Trust for Research on Ecology and the Environment
BCAS	Bangladesh Centre for Advanced Studies
BDA	Bangalore Development Authority
BMRDA	Bangalore Metropolitan Region Development Authority
CCA	Climate Change Adaptation
CGWB	Central Ground Water Board
CWC	Central Water Commission
DRR	Disaster Risk Reduction
EMPRI	Environmental Management and Policy Research Institute
ERDAS	Earth Resources Data Analysis System
ESG	Environment Support Group
FCC	False Colour Composite
GLOFs	Glacial Lake Outburst Floods
ICIMOD	International Centre for Integrated Mountain Development
IIASA	International Institute of Applied Systems Analysis
IIHS	Indian Institute for Human Settlements
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
LandSat	Land Satellite
LDA	Lake Development Authority
LULC	Land Use Land Cover
MAC	Mishing Autonomous Council
MDI	Management Development Institute
MSS	Multi Spectral Scanner
NIDM	National Institute of Disaster Management
NWDA	National Water Development Agency
PAC	Public Affairs Centre
PARC	Pakistan Agricultural Research Council
RVC	Rural Volunteers Cell
SAARC	South Asian Association for Regional Cooperation
SIUD	State Institute for Urban Development
TERI	The Energy and Resources Institute
WRD	Water Resources Department