APN

CAPaBLE

- Making a Difference –

Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

Final Report

Project Reference Number: CBA2014-04NSY-Divya Sharma

A Comprehensive Capacity Building Program on "Urban Climate Resilience in India"

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Final Report submitted to APN

OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

Lack of knowledge about climate impacts and the measures to address them is one of the main reasons for not addressing climate change challenges in Indian cities. Besides this, current vulnerability of urban areas like population pressures, inadequate infrastructure and services in India is so pronounced that cities are unable to prioritise climate change as one of their focus areas of action. Thus, there is a need for sensitising the city officials on addressing urban climate resilience through capacity building efforts. They not only need an understanding of climate science but also the linkages of climate impacts to city systems, such that this information could be logically applied to decision-making processes and could be inbuilt into the development paradigm. Urban climate resilience would not only prepare the cities to withstand climate change related gradual impacts like change in precipitation and temperature and sea level rise, but also equip the city equally to respond to disasters and extreme events. It would also drive cities towards sustainable development as it encompasses environmental benefits.

This project focused on designing and delivering a capacity building program on urban climate resilience to the following set of stakeholders: (i) Elected representatives; (ii) City officials and practitioners; (iii) Students and Researchers.

Keywords

Capacity-building, cities, climate science, urban climate resilience, urban planning

Objectives

The main objectives of the project were:

1. To sensitise the target audience on issues and impacts related to climate change and the importance of adaptation interventions for the urban areas
2. To bridge the science-policy divide by sensitizing the city and state level decision-makers about the application of climate change science
3. To facilitate dialogue to discuss opportunities in mainstreaming urban climate resilience agenda into planning

Amount received and number years supported

The Grant awarded to this project was:
US$ 34,995 for one year

Activities undertaken:

1. A one day orientation program for elected representatives and two day training programme for city officials on 'Building urban climate change resilience' in 4 states of India (Goa, Odisha, Maharashtra and Uttarakhand)
2. A two day seminar on urban resilience for post graduate students and early researchers at TERI University, New Delhi
3. A national conference to disseminate the key learning from the capacity building programs and to discuss the emerging needs for capacity building of Urban Local Bodies in India.

Results

A briefing paper titled '*Capacity building for building sustainable and smart urban India'* was published as an outcome of this study. It not only draws key messages from the project but also provides an overview of the training and capacity needs scenario at the Urban Local Body (ULB) level.

It calls for creation of mandates and planned mechanisms for fostering an environment of learning and skill building. It observes that continuous skill development of people who are responsible for addressing the urban challenges is an absolute necessity for bringing about requisite changes in existing urban governance and management systems.

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

The project directly contributes towards Goal 1 and 2 of the APN Third Strategic Plan. By focusing on the theme of urban climate change resilience and raising awareness on climate modeling science, methodologies for risk assessment, vulnerability analysis and preparation of resilience plans for the use of cities, this project addresses an important area of APN's Science Agenda: 'Climate Change and Climate Variability'.
The project contributed towards capacity development of multiple stakeholders in Indian urban context on the thematic area of climate change resilience. This matches to the core strategies of the APN that suggests:
1. Promote and encourage research that can improve understanding of global change and its implications for the region, and contribute to sound scientific basis for policy formulation and decision‐making;
2. Promote and encourage activities that will develop scientific capacity and improve the level of awareness on global change issues specific to the region; and
3. Identify and help address, in consultation with policy‐makers and other end users, present and future needs and emerging challenges.

Policy-relevance

As a response to the UNFCCC, the Government of India has come up with the National Action Plan on Climate Change with strategic actions to combat climate threats. The National Mission on Sustainable Habitats (NMSH) is one of the 8 missions that address special sectors that are necessary to be planned for climate action. TERI's project complements the capacity building objectives of the NMSH and is envisioned as a step towards bringing in awareness and knowledge towards the need of mainstreaming urban climate resilience into regular urban development planning paradigm in India.
Government of India recently launched the *Atal Mission for Rejuvenation and Urban Transformation* (AMRUT) and 100 Smart Cities Mission to drive economic growth and foster inclusive urban development. The basic aim of these schemes is to recast the urban landscape of the country to make urban areas livable, sustainable, smart and inclusive besides driving the economic growth of the country. Both these schemes define the National government's agenda to meet the challenges of growing urbanization in the country in a sustainable manner as well as ensuring the benefits of urban development to the poor through increased access to urban spaces and enhanced employment opportunities. While these schemes have ambitious and relevant agendas of the National government, in practice, the success of these schemes will depend on the cities' capacities, financial prowess, and preparedness to implement it. Extensive awareness generation and capacity building activities will be required to achieve the outlined objectives and to sustain progress in this field. The project is a key step in this direction as it targeted the city managers and decision makers and oriented them towards the knowledge on: impacts of climate change on their systems and cities and the means to address the same.

Self-evaluation

The proposed project activities were successfully carried out and the project team is overall satisfied with the outcomes of the project. The training programs on urban climate change resilience were well received by the target participants- elected representatives and city/ municipal officials. The

participants have requested for similar programs in future and have suggested more focused programs revolving around technical subjects. The team foresees a scope for updating and upgrading the current course modules. The team shall incorporate and utilise the learning derived from these training programs while designing and executing similar programs in future.

Potential for further work

The program received an encouraging response from the targeted stakeholders. At the national level, there is a scope for collaborating with the State Administrative Training Institutes for designing and delivering similar programs. There is also a lot of demand and interest from the city officials for an e-learning program on the subject. The modules and training lectures developed for this program can be updated and improved in order to scale up and market a dedicated course on 'Building urban climate change resilience in India'.

Publications

TERI. 2015. *Capacity building for building sustainable and smart urban India*. Available from: http://www.teriin.org/eventdocs/files/capacity-Briefing-paper.pdf

Acknowledgments

TERI is grateful to the collaborating institutes and departments in each State where it conducted this program. The project team would like to extend their gratitude to Department of Urban Development, Government of Uttarakhand; Directorate of Municipal Administration, Government of Goa; The Gopabandhu Academy of Administration, Government of Odisha and Yashwantrao Chavan Academy of Development Administration (YASHADA), Government of Maharashtra. We thank TERI University for hosting the seminar for students and researchers. The team would also like to acknowledge the valuable contribution of all the guest speakers, local experts and resource persons who assisted the core team members in delivering the training programs. The program could not have been successful without their participation and inputs.

Project Website

http://www.teriin.org/projects/apn/

TECHNICAL REPORT

Preface

Lack of knowledge about climate impacts and the measures to address them is one of the main reasons for not addressing climate change challenges in Indian cities. The current vulnerability of urban areas like population pressures, inadequate infrastructure and services is so pronounced that cities are unable to prioritise climate change as one of their focus areas of action. Sensitising the city officials on addressing urban climate resilience through capacity building efforts would prepare our cities to withstand climate change related impacts and respond to disasters and extreme events. These efforts will also go a long way in driving the cities towards sustainable development.

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1.0 Introduction

The knowledge on climate science and the ability to predict future climate through climate models has developed immensely over the years, yet this knowledge is not available to practitioners, urban managers and decision makers to base their decisions. However, cities are experiencing great losses already due to climate impacts. There is a strong need to equip the planning mechanisms in urban areas to withstand, adapt and become resilient to such changes. To be able to do so, the practitioners and various stakeholders in the urban space not only need an understanding of climate science but also the linkages to climate impacts to city systems, such that this information could be logically applied to decision making processes and could be inbuilt into the development paradigm. Several studies point towards the need for awareness generation and capacity building activities to support local authorities in building urban resilience. Communities who have access to timely hazard information are better able to respond to climate threats (Moser & Satterthwaite, 2010). Local authorities in all countries have a critical role in mitigating and adapting to climate change (Satterthwaite (2008) cited in (Jabareen 2011)). Institutional structures that foster learning and change are important tools to build agent capacity (Berkes *et al* (2007) cited in Tyler and Moench (2012)). Thus, awareness generation, capacity building and knowledge networks play a key role in building urban resilience across communities. It is hypothesized that a more resilient city is one with inclusive decision making processes in the realm of planning, open dialog, accountability, and collaboration. It is one in which people and local stakeholders, including the private sector, various social groups, communities, civil society and grassroots organizations participate (Jabareen, 2011).

TERI's project activity was formulated with the objective of strengthening the science and policy interface by building the capacity of different set of stakeholders on climate change impacts on urban areas; tools and methods available for climate proofing the cities; role of governance- policy and institutions for mainstreaming urban climate change resilience. The choice of audience for this program was based on the fact that the capacity towards a new goal like that of climate change has to be inculcated at all levels of governance so that the decisions are based on the need to plan for climate resilience and are understood and implemented by the executing machinery at the grass-root level to its true intent.

1.1 Objectives

i) To sensitise the target audience on issues and impacts related to climate change and the importance of adaptation interventions for the urban areas

ii) To bridge the science-policy divide by sensitizing the city and state level decision-makers about the application of climate change science

iii) To facilitate dialogue to discuss opportunities in mainstreaming urban climate resilience agenda into planning

1.2 Importance of capacity building in Asian cities

The Asian Cities Climate Change Resilience Network (ACCCRN) was an initiative launched in 2008 by the Rockefeller Foundation to help cities strengthen their capacity to prepare for, withstand, and recover from the projected impacts of climate change. The initiative began with 10 cities in Vietnam, India, Indonesia, and Thailand and is now expanding to 50 new cities and two additional countries-Bangladesh and the Philippines. Several studies have been conducted highlighting key insights from this initiative and capacity building features as one of the key areas of interventions. For instance, one assessment highlights the need for capacity building at city government level, particularly in relation to urban planning in the context of climate change uncertainty (Kernaghan and da Silva, 2013). Another study observes that if the cities have to lead resilience building efforts, then it is essential to build the capacities of various stakeholders. It recommends capacity building, dialogue and dissemination of ACCCRN and other international experiences for building the awareness and

knowledge base in cities and to facilitate the expansion of this process to more cities (Sharma, et al., 2014).

1.3 Developing the CAPaBLE program on capacity building on urban resilience

As part of ACCCRN's activities in India, TERI, in the capacity of National Policy Advisor has prepared a policy synthesis review for the program to help identify entry points for facilitating resilience planning in India. It has also worked on mainstreaming the resilience strategies and options into the development planning processes in selected cities in India; namely Gorakhpur in Uttar Pradesh and Guwahati in Assam; in Guwahati, additionally conducting a risk and vulnerability assessment exercise and preparing a climate resilience strategy. In 2013, it conducted an assessment of methodologies adopted for urban resilience in 7 Indian ACCCRN cities. The need for capacity building emerged as one of the key findings from this assessment. During the course of this study, interaction with key city officials revealed that if resilience planning is to be attempted in other cities and the cities have to lead the effort by themselves, the first step would be to build the capacities of various stakeholders extensively. This became the basis for conceptualising the current project and associating with the CAPaBLE program. It was felt that there was a strong need to share the knowledge generated through this network with policy makers, practitioners, students and researchers.

1.4 Overview of Project Activities

Under the CAPaBLE programme, The Energy and Resources Institute (TERI) designed and delivered capacity building programmes on urban climate resilience in four states of India—Goa, Uttarakhand, Odisha, and Maharashtra. It included a day-long orientation programme for elected representatives of the ULBs of the selected states and a two-day long training programme for city officials and practitioners. In addition to this, a two day seminar for students and early career researchers was also conducted in association with TERI University. The program concluded with a national conference to disseminate the key learning from the capacity building programs and to discuss the emerging needs for capacity building of ULB's in urban India. A key outcome of the project is a briefing paper titled: 'Capacity building for building sustainable and smart urban India' which was released during the national conference by Mr Sanjay Kothari, Secretary, Department of Personnel and Training (DoPT), Ministry of Personnel, Public Grievances and Pensions, Government of India.

Table 1: List of project activities

Name	Date	Venue	Number of Participants
TERI-APN's Training program on Building Urban Climate Change Resilience	22-23 January, 2015	Hotel Taj Vivanta, Panaji, Goa	55
TERI-APN Seminar - Building climate resilient cities: Exploring theories, practices and prospects	16-17 February 2015	TERI University, New Delhi	59
TERI –APN-Government of	8-10 April, 2015	Hotel Pacific,	64

Uttarakhand -Training program on Urban Climate Change Resilience		Dehradun	
TERI –APN Training program on Building Urban Climate Change Resilience	20-22 April, 2015	Gopabandhu Academy of Administration, Bhubaneswar	34
TERI –APN-Government of Maharashtra Training program on Urban Climate Change Resilience	18-19 May, 2015	Yashwantrao Chavan Academy of Development Administration (YASHADA), Pune	24
National Conference: Capacity building and experience sharing for enhancing sustainability in urban India	June 3, 2015	Juniper Hall, India Habitat Centre, New Delhi	78

2.0 Methodology

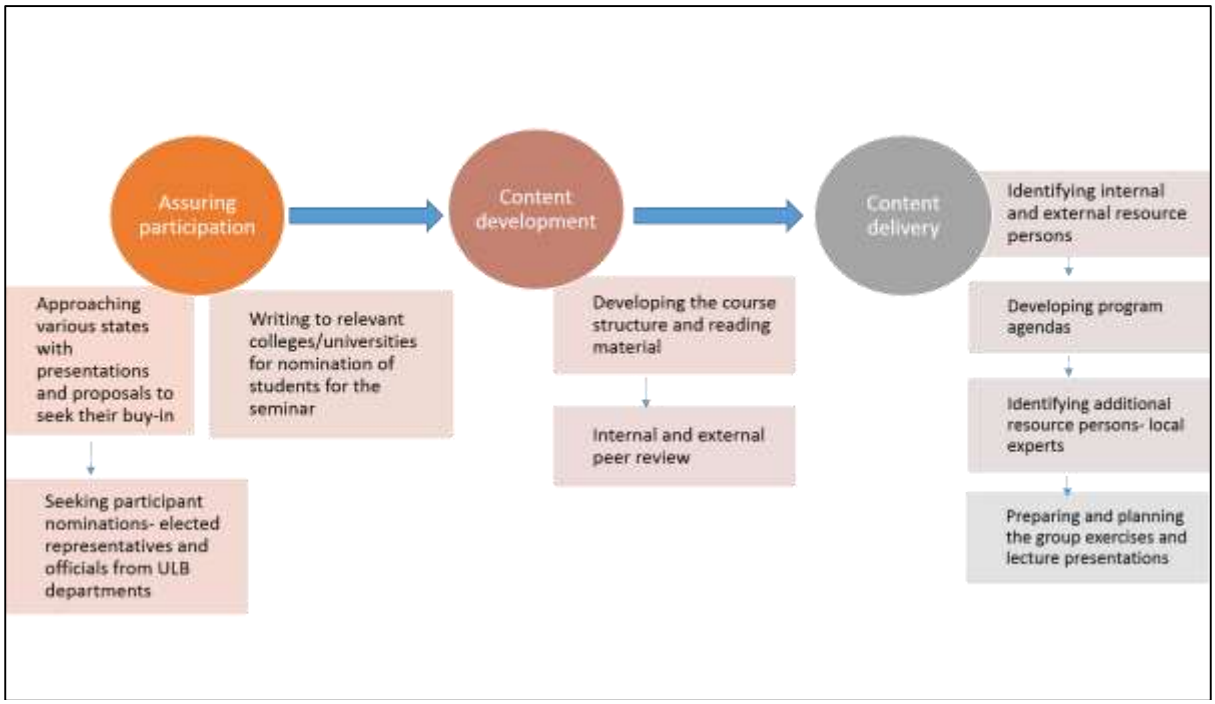

Figure 1: Study Methodology

2.1 Assuring participation

The first step was to approach various states in India with a proposal to collaborate for conducting a training program on urban climate change resilience (See Appendix A for the proposal). The proposal included a request for seeking nominations of city level officials and elected representatives for the programme. The proposals were targeted at the Principal Secretary of the urban development department in each state. The approvals and confirmations from the states took 4-5 months of time. The selected states and collaborating institutions were as follows:

The Department of Urban Development, Government of Uttarakhand

The Directorate of Municipal Administration, Government of Goa

The State Administrative Training Institute (ATI) of Odisha- Gopabandhu Academy of Administration, Bhubaneswar

The State ATI of Maharashtra- Yashwantrao Chavan Academy of Development Administration (YASHADA), Pune

Similarly, for the seminar in TERI University, nomination for student participants from varied background like urban and regional planning, environment and development, climate science policy, geo-informatics, architecture, etc. were sought from several colleges and universities.

2.2 Content development

The next step was to prepare the course structure and reading material which was then sent for internal and external reviews (See Appendix B for reading material). According to the different sections in the modules, internal and external resource persons were identified (See Appendix C for list of resource persons). The agenda for the capacity building programs was then chalked out in consultation with each State (See Appendix D for program agendas).

2.2.1 Overview of sessions

Figure 2: Speakers presenting during a training program

The lectures and sessions during the training programs were designed with the objective of introducing the urban managers to the key concepts behind the theme of urban climate change resilience (See Appendix E for some of the presentations from the key sessions). The purpose was also to initiate a dialogue and to discuss opportunities in mainstreaming urban climate resilience agenda into the urban development and urban planning paradigm. The training programs included a day-long session for elected representatives which was followed by a separate two day program for city officials and officials from ULBs. The training program comprised of the following key sessions:

Climate change and its impact on cities

This session introduced the context of the program by highlighting the emerging urbanisation challenges and the resulting vulnerability of cities to impacts of climate change. The session explained the direct physical risks of climate change on cities. The session highlighted the impacts of each kind of risks on urban systems.

Challenges and opportunities for building resilience in Indian cities – Role of political leadership

This session introduced the concept of 'resilient cities', the need for initiating planning in this area and how these were different and better. The session gave the participants an overview of the key steps required for planning climate resilience; the role of various stakeholders; examples of international programs supporting resilience as well as examples of Indian cities and the initiatives

undertaken so far highlighting the key challenges and enablers. This session was prepared especially for the elected representatives.

Risk and Vulnerability Assessment methodologies- Concepts and Application

The session introduced key terminologies, concepts and procedures behind conducting city level risk and vulnerability assessments. The session not only explained these processes and frameworks but also showcased how these were applied in different cities through various case studies.

Introduction to climate modelling and its role in city assessments

The session gave an overview on climate science and associated modelling covering concepts of the drivers of the climate, different factors governing climate, basic interactions between the climate system components that are responsible for its variability. The session touched upon the need of undergoing such exercises for planning purpose. The session shared the latest global climate projections from the IPCC 5th Assessment Report and specific India wide projections from latest scientific literature. It included case studies and examples of regions that had utilized climate modelling output in arriving at various policy recommendations and sectoral impacts assessments

Financing mechanisms for implementing urban resilience

The session introduced the key issue of how fast economic growth and growing population have led to huge demand-supply infrastructure deficit. It highlighted the status of urban services and service level gaps in each sector. The session provided an overall financial scenario of the Indian ULBs and the key challenges faced by them. It made the participants aware of various financial instruments/funding available to the ULBs like: Pool finance development fund, State and Central finance commission fund, State level urban infrastructure fund, municipal bonds, PPP etc.

Role of governance- policy and institutions for mainstreaming urban climate change resilience

The session introduced the concept of mainstreaming climate resilience into the development agenda. The session highlighted the various channels through which the climate resilience agenda could be dovetailed into existing governance framework, who are the critical actors, what are the enabling mechanisms, while also understanding about what a new policy on urban climate resilience should be addressing.

Application of GIS tools and techniques for better urban planning

Key concepts of Remote sensing and GIS (Geographical Information System) highlighting their role in urban planning and for city level vulnerability assessment studies were explained in this session. For instance, land-use, land cover change modelling and case studies of GIS application in vulnerability assessments conducted in Panaji and Visakhapatnam were shared with the participants.

2.2.2 Special sessions

In each state, in addition to the core sessions, the program was contextualised to include sessions from local experts and resource persons to discuss the pressing challenges in that State. For instance, in Goa coastal erosion is an emerging environmental concern. Recognising this, Dr Antonio Mascarenhas, Former Scientist, National Institute of Oceanography (NIO), was invited to deliver a special session on 'Rehabilitation of sand dunes as an adaptation measure for arresting coastal erosion'. Similarly, in Maharashtra and Odisha a session on 'Integrating climate resilience into green building initiatives' was conducted by green building experts. In Odisha, Mr Meghnad Behera, City coordinator of the climate risk management project, Odisha State Disaster Management Authority (OSDMA) was invited to conduct an interactive session with the participants on 'Orissa's disaster risk reduction strategy'. In Uttarakhand, a similar session was conducted by the Executive Director, Department of Disaster management, Government of Uttarakhand.

2.2.3 Content for the Seminar for students

Figure 3: Students during a group exercise during the seminar

One of the key project activities was a two day seminar on "Building climate resilient cities: Exploring theories, practices and prospects" which was organised in TERI University, New Delhi. The seminar was organised with the objective of sensitizing post graduate students and early career researchers on the impacts of climate change on cities. The seminar introduced the participants to the key concepts of urban climate change resilience and covered subject areas like: Application of GIS and climate modelling tools for climate proofing the cities; role and functions of various institutions and public agencies in building urban climate resilience, case studies of risk and vulnerability exercises, policy and regulatory measures for mainstreaming urban climate change resilience, etc. The seminar was highly interactive and included a special session on 'Role of communicating climate change' where the students were introduced to a climate change communication toolkit developed by BBC Media Action.

2.3 Content delivery

The internal and external resource persons prepared detailed course presentations which were delivered in an interactive and non-technical format. The lectures were delivered in a manner where the focus was on highlighting examples, case studies and application of assessment techniques. The local experts were invited to deliver special guest lectures in the regional languages so as to connect with the participants and make them comfortable with the training programs. This also ensured a two way communication process as these sessions were highly interactive.

Figure 4: Participants during a group exercise

The training program also provided an opportunity for the study team to identify the challenges that the city officials face while addressing climate change issues. This was achieved by designing a feedback session in the form of a group exercise (See Appendix F). During the training program, the participants also took part in a group exercise on hazard mapping. Each group had to identify the key risks due to climate impacts and the vulnerable sectors for their selected municipality/municipal corporation.

The training programs utilised the audio-visual tools by screening documentaries on the subjects which helped participants to co-relate to the theme of the program. These documentaries[1] showcased case studies of Indian cities which had already initiated urban resilience planning and thus the participants were exposed to action based projects which made them co-relate to the overall theme of the program and its larger objective. Certificates were awarded to all participants upon successful completion of the training programs. This acted as an incentive especially incase of elected representatives (See Appendix G for list of participants).

[1] *Tales of Gorakhpur* showcases the work of TERI and other ACCCRN partners in the ACCCRN city of Gorakhpur. It speaks about the current vulnerability of Gorakhpur and questions whether the city is prepared for dealing with the future climate change impacts. Can be viewed here: http://bit.ly/1K8N0i6
Losing Ground highlights the climate vulnerability of two Indian coastal cities: Panaji and Vishakhapatnam. The film maps out the vulnerability of infrastructure services in these two cities and highlights TERI's approach

3.0 Results & Discussion

In order to conduct any successful training program, it is crucial to target the right participation. The major learning was in terms of tying up with the right institutions and departments to conduct the state level programs. The collaboration was required for ensuring participation since the invitations seeking nominations were circulated from their end. The training programs were designed in a way that included a mix of pedagogy tools like technical sessions, guest lectures, group exercises documentary screenings that added variety to the program. The documentary screenings broke the monotony of back to back lectures and sessions and since they highlighted the case studies of Indian cities who have initiated climate resilience planning, they were effective in motivating the participants to apply the knowledge gained during the program on field.

3.1 Learning from the training programs

The experience and learning from this project have been documented in a briefing paper titled 'Capacity building for building a sustainable and smart urban India' (See Appendix H). The findings from the feedback of the participants from the training programs have been synthesised below:

Language

Language is an important consideration while designing a training programme in Indian cities. Unlike the common belief, English may not work in every situation and the local/regional language is the preferred mode. Hindi works better than English in some states, but a pre-assessment of language requirement goes a long way in increasing the effectiveness of the programme. Since it might not be possible for experts to know all languages, it is also advisable to prepare short and crisp reading materials in the regional language. Inviting local resource people and keeping a good mix of external and local experts help in covering a range of topics.

Figure 5: A lecture being conducted in the regional language (Odisha)

Duration

Duration of the training programme is an important factor. If the training is organized for various ULBs and for a particular set of audience, for example, engineers, the training could be more technical in nature and could be planned for a longer duration. While a training programme for a mix group will have to compromise on the technicalities, but it could focus on broader issues related to the subject and have to be shorter than the one that is designed for a focused group. The duration of the training programme would also depend on the location. For example, in Uttarakhand, not all municipalities could attend the training programme because they found Dehradun too far to go for a two-day training programme. Some of the participants, particularly elected representatives travelled for an average of six hours to attend a day-long training programme. It was suggested that the duration and location have to be a major consideration while planning a programme.

Figure 6: Group photograph with the elected representatives in Uttarakhand

Audience/Participants

Keeping two separate programmes for elected representatives and municipal officials turned out to be a good decision because of the clear distinction of roles and responsibilities of the two groups and also the level of understanding of the topic of training. However, it was suggested that for matters related to ULBs, a day should be dedicated only for interaction and collective learning between the elected representatives and city officials—something that is not possible under the regular protocols of municipal administration and hence, there is great communication gap between the two levels of functionaries.

Content

While the subject matter was found interesting and new, and the overall reaction to the training programmes was positive, yet it was suggested that the training modules should give direct examples from the day-to-day functioning. Subjects like climate change and climate resilience, even, disaster management are not directly related to the functions of the officials. While the officials were very interested in knowing about the theme, they wanted sector specific solutions to be presented along with the problems, risks, and vulnerability. Though the group exercises were appreciated, it was suggested that there should be more avenues for involvement and interaction for the participants, with their roles in the respective projects being discussed. It was also discussed how their role in the projects could be streamlined towards building climate resilience.

Besides these, demonstrations and site visits to projects were suggested to be more effective than classroom teaching. The participants also suggested that if these training programmes have to become practical and something that they could use in their regular working, then these should also provide information on how projects to build climate change resilience can be brought into the cities and where officials should apply to bring such projects to their municipality. It was also advised that information should be provided on what each department specifically should do to build climate change resilience in the cities.

Figure 7: One of the participants sharing his experience (Uttarakhand)

The sessions should focus on more practical and ground-level implementable solutions such as Sewage treatment plants (STP)s, Biogas, Rainwater Harvesting and use of renewable energy. This programme should also be open to different planning department heads of local bodies, such as Executive Engineers, Assistant Engineers, Medical officer for Health , staff like Junior Engineers and staff looking at Municipal solid waste (MSW), block level officers, Nagar Parishads, Jal Nigam, electricity department, development authority, PWD and the environment department.

It was suggested that the content of the training programme should be designed to be context specific, for example, adaptation solutions specific to hill states in Uttarakhand. It was also suggested by the participants that they would prefer training programmes that equip them best to deal with their day to day activities and learn new things in the area of their work. They will be more interested in learning new things if it adds value to their current responsibilities and the training programme is designed, such that they can relate functionally to the subject. So, the modules should be streamlined and aligned to such needs.

Sustainability and Regularity of the Capacity Building Programmes

TERI–APN programme was organized in association with the state government and the State ATIs of participating states. This helped in planning the date, duration, and venue for the programmes

besides ensuring participation. Participants suggested that similar training programmes should be organized at regular intervals. A state level training calendar where municipal officials are trained on various topics of relevance on a regular basis will help in skill building a well as in inculcating a culture of education and learning.

Dedicated Programmes for Targeted Group of Officials

This was a general suggestion across the four states, that training programmes for specific group of officials, for example, junior engineers, etc., should be designed and conducted as these officials work on ground and deal with day-to-day challenges and has the least opportunity for skill building.

3.2 Learning from the Seminar for Students

The students suggested that the duration of the programme could be extended to accommodate more technical subjects and demonstration projects. It was suggested that subjects like climate resilience and associated technical modules should be mainstreamed into their course curriculum. The students also suggested inclusion of hands-on training exercises for some of the tools available in the knowledge domain.

3.3 National Conference

The final project activity was a national conference on 'Capacity Building and Experience Sharing for Enhancing Sustainability in Urban India' which was organised on June 3, 2015 in New Delhi.

Figure 8: Release of a briefing paper as a key outcome of the TERI-APN project

Since the key messages from the program went beyond the theme of the training programme itself, the conference was organized to deliberate on the bigger issues such as the current scenario for skill building and capacity development in urban local bodies. It attempted to explore the processes and approaches developed and implemented so far and deliberate upon the successes and challenges and need for building stronger knowledge and capacity building networks. The conference was also a platform for the release and dissemination of the briefing paper which was prepared from the learning of the project. Mr Sanjay Kothari, Secretary, Department of Personnel and Training (DoPT), Ministry of Personnel, Public Grievances and Pensions, Government of India delivered the inaugural address during the conference. He spoke about several planning-related problems and challenges related to capacity building from his field experience.

The conference was attended by practitioners, academicians, multilateral/bilateral organizations, stakeholders from state governments, peer organizations, and by professionals working in the field of urban development, climate change, and knowledge sharing among others.

3.4 Achievements

1) Partnerships and collaborations were established with key institutions and departments in each State which was helpful in ensuring targeted participation

2) Certificates endorsed by TERI and APN were awarded to all the participants of the training programs which incentivised them and increased the credibility of the program

3) Through this program, the team was able to understand and highlight the larger issue of the present capacities of the cities and the need for fine tuning urban governance, management systems and skill building at all levels to address various challenges. This resulted in a comprehensive briefing paper on the theme of capacity building for Indian urban local bodies.

Figure 9: Certificate being awarded to a participant (Goa)

4) The program offered an opportunity of mutual learning between the researchers and practitioners who were working on the ground. This not only enriched the overall experience but also facilitated new and improved collaborations between the cities and the research institutes.

5) The team is currently working on a policy research study in two of the states where the training program was conducted- Goa and Uttarakhand. The experience and learning in these two states will provide key inputs for this ongoing program which will result in a roadmap for a dedicated State level policy on climate change resilience.

6) The team received positive as well as constructive feedback from the participants of the training programs. These will be utilised for developing new programs on the subject. For instance, the municipal officials demanded more technical sessions and favourably agreed to e-learning programs on the subject.

7) The seminar which was organised for post graduate students and early career researchers was positively received and there was a demand for more such programs as well as requests for integration of some of the subjects into their course curriculum.

4.0 Conclusions

TERI's program on building urban climate change resilience was successful in terms of sensitising the target audience on issues and impacts related to climate change and the importance of adaptation interventions for the urban areas. Initially it seemed challenging to introduce new concepts and ideas that were not currently falling under the mandate of the ULBs. However, during the course of the 2-3 day training program, it was observed that the participants were able to understand and co-relate the impact of climate change on the urban systems in their cities. This was specifically observed during the group exercises where the participants presented a clear understanding of the key climatic problems and risks faced by their municipalities. Thus, it was observed that through well planned capacity building programs, the gap between science-policy and action can be reduced. These programs were also successful in terms of providing a platform to initiate a dialogue on mainstreaming the climate resilience planning objectives into urban development planning.

5.0 Future Directions

The capacity building program on urban climate change resilience introduced several new concepts and themes to the participants. However, it was observed that during the course of these training programs, the participants were able to co-relate the impacts of climate change on their cities and also were able to link this to their day to day urban development planning activities. During the

feedback session, the participants cited their challenges as well as expressed keen interest in understanding this area in-depth by means of focused and regular programs.

There is a scope for updating and upgrading the current course structure to incorporate the suggestions of the participants. The revisiting and revamping of the modules could result in an e-learning program that the city officials could access at ease. Collaboration with State ATIs could be one step in this direction. Since there is a strong need to equip the students, practitioners and future urban planners with an understanding on the subject, the seminar on 'Building climate resilient cities' can be continued and scaled up by collaborating with more universities and colleges.

Figure 10: Group photograph with the participants of the seminar (TERI University)

As an immediate step, the learning from the program in Goa and Uttarakhand will be integrated into an ongoing project activity where the project team is preparing a roadmap for a policy on climate change resilience in these two States. Capacity building is one of the key areas of research under this program and the experiences from the TERI-APN program will be relevant and useful.

References

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Glossary

ACCCRN	Asian Cities Climate Change Resilience Network
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
APN	Asia Pacific Network for Global Change Research
ATI	Administrative Training Institute
DoPT	Department of Personnel and Training
GIS	Geographical Information System
IPCC	Intergovernmental Panel on Climate Change
MSW	Municipal Solid Waste
NIO	National Institute of Oceanography
NMSH	National Mission on Sustainable Habitat
OSDMA	Odisha State Disaster Management Authority
PPP	Public Private Partnership
PWD	Public Works Department
STP	Sewage Treatment Plant
TERI	The Energy and Resources Institute
ULB	Urban Local Body
UNFCCC	United Nations Framework Convention on Climate Change
YASHADA	Yashwantrao Chavan Academy of Development Administration

Messages from Team Members

Name: Dr. Divya Sharma, Fellow, Sustainable Habitat Division, TERI

Role: Project Lead and Resource Person

Contact Details: divyas@teri.res.in

"The program came out to be a successful collaboration with the state governments and the city officials and opened up a platform for mutual learning and opportunities for future collaborations and efforts towards updated and improved mechanisms for skill and capacity building in Indian cities."

Name: Ms Rozita Singh, Research Associate, Sustainable Habitat Division, TERI

Role: Co- Project Lead and Resource person

Contact Details: rozita.singh@teri.res.in

"This program was conceptualised with a lot of passion and hard work. The vision of the team members was to share the knowledge generated on the theme of urban climate change resilience. The knowledge sharing was envisioned as part of a capacity building program, and our endeavour was to sensitise the city managers and decision makers so that research and science could be translated to policy and action. It was a dream team to work with and I wish to thank each one of them for their passion, support and very valuable contributions. Big thanks to APN for granting us this project and giving an avenue for making our vision a reality. As a resource person, I gained immense insights and learnt a lot through this project. Each training program was a new learning experience and it strengthened my own determination to work in the area of climate change adaptation. The seminar conducted for students gave me immense satisfaction."

Name: Ms Raina Singh, Associate Fellow, Sustainable Habitat Division, TERI

Role: Team member and Resource person

Contact Details: raina.singh@teri.res.in

"As a training resource person for the state level workshops in Bhubaneswar (Odisha) and Pune (Maharashtra), I got an opportunity to interact with city planners and engineers, which was a learning experience in terms of understanding the on-ground challenges and entry-points for building climate resilience in cities. The program has also given me an insight to existing local knowledge and skills when it comes to addressing climate change in these parts of India in the context of urban areas, which is the focus of my current research."

Name: Ms Riya Rahiman, Research Associate, Sustainable Habitat Division, TERI

Role: Team member and Resource person

Contact Details: Riya.Rahiman@teri.res.in

"As part of the team organizing the training programs and as a resource person this project sensitized me to the knowledge and capacity needs of the elected leaders, city officials and students in the area of urban climate change resilience. The training programs strongly brought out the need for active and continual sensitization of city leaders and officials on integrating climate change considerations into city planning. Further the knowledge imparted by the different resources persons also exposed me, to various aspects of climate change resilience and urban development and enhanced by knowledge as a research professional."

Name: Mr Saurabh Bhardwaj, Associate Fellow, Earth Sciences and Climate Change Division, TERI

Role: Team member and Resource person

Contact Details: saurabh.bhardwaj@teri.res.in

"My involvement in the project was in terms of a team member. I contributed towards the course development in terms of leading the climate modelling component write-up. Also, I contributed towards lectures and presented on the "Introduction to climate modelling" and it's utilization towards sub-scale specific climate projections at Bhubaneswar, Dehradun, Goa and Teri University, Delhi. It was both an enjoyable as well as learning experience for me. I enjoyed interacting with students at the university and was glad to see the inquisitiveness to learn about technicalities of modelling and associated implications. Also, it was a pleasant experience interacting with various government officials and elected representatives of different states. I got to know the diversity of the issues that they currently face albeit belonging to a similar governance setup. I particularly enjoyed the climate finance lecture since it was not only enriching but also gave good insights to everyone about relevant funding sources for implementing climate resilience projects. I congratulate the PI and the team for organizing such enriching training programs and hope they continue to organize such programs in future."

Name: Dr Kamna Sachdeva, Assistant Professor, Department of Natural Sciences, TERI University

Role: Team member and Resource person

Contact Details: Kamna.Sachdeva@teri.res.in

"My involvement in the project was in terms of contributing to the module as well as planning the seminar in TERI University. It was a wonderful experience being associated with young stalwarts, who have a great potential to be leaders of tomorrow. I myself have learned many things through the student seminar. Sometimes it was difficult to satisfy them with typical answers. I thank APN for giving me the opportunity of being student seminar coordinator. "

Feedback from external resource persons

Name: Mr. Alok Shiromany, Expert, Urban Finance

Contact Details: alokshiromany@gmail.com

"It was a great experience working as a resource person with the young, energetic and efficient team that provided excellent inputs and trained the municipal and government officials immaculately. The team was extremely passionate, hardworking and deeply committed to the assignment. The team was led by a very efficient team leader with both technical and interpersonal skills. I look forward to continue to work with them in future."

Name: Mr. Anup Karanth, Associate Director, TARU Leading Edge Ltd, Delhi

Contact Details: akaranth@taru.org

"I was involved in the APN initiative as a resource person for training of elected representatives and municipal officials at Dehradun. Participants and resource persons shared a wide range of issues and options for urban management in hill areas. As a resource person, it was a great learning experience. The feedback from the participants was equally encouraging and they requested for organizing more in-depth orientation/training on the subject of climate resilience and risk management in urban areas".

Name: Ms Garima Jain, Senior Associate, Indian Institute of Human Settlements

Contact Details: gjain@iihs.ac.in

"I was contacted by the TERI team for a session on urban risks, and it was wonderful to be able to contribute to not just the session, but also to the student seminar. It was a good learning exercise for me as much, not just from the other experts who presented, but also from the students themselves and their insights from planning and environmental sciences. It was a well managed programme, and kudos to the team who conceptualized and delivered it."

Appendix A- Program proposal to State

Background

The knowledge on climate science and the ability to predict future climate through climate models has developed immensely over the years, yet this knowledge is not available to practitioners, urban managers and decision-makers to base their decisions. There is a strong need to equip the planning mechanisms in urban areas to withstand, adapt, and become resilient to climate change impacts. To be able to do so, the practitioners and various stakeholders in the urban space not only need an understanding of climate science but also the linkages to climate impacts to city systems, such that this information could be logically applied to decision-making processes and could be inbuilt into the development paradigm.

The 'Capacity building program on urban climate change resilience in India' is sponsored by the 1. Under their CAPaBLE programme, The Energy and Resources Institute (TERI) will be designing and delivering a capacity building program on urban climate resilience to the following set of stakeholders in 4 states in India:

(i) Elected representatives; (ii) Policy-makers; (iii) City officials and Practitioners; (iv) Students and Researchers.

The project endeavours that the goal of building urban climate change resilience is inculcated at all levels of governance and is implemented to its true intent.

Project website: http://www.teriin.org/projects/apn/

Need for a capacity building program in cities

Lack of knowledge about climate impacts and the measures to address them is one of the main reasons for not addressing climate change challenges in Indian cities. Besides this, current vulnerability of urban areas like population pressures, inadequate infrastructure and services in India is so pronounced that cities are unable to prioritise climate change as one of their focus areas of action. Thus, there is a need for sensitising the city officials on addressing urban climate resilience through capacity building efforts. Urban climate resilience would not only prepare the cities to withstand climate change related gradual impacts like change in precipitation and temperature and sea level rise, but also equip the city equally to respond to disasters and extreme events. It would also drive cities towards sustainable development as it encompasses environmental benefits.

About the program

TERI's proposed capacity building program on "Urban Climate Change Resilience in India", supported by the Asia-Pacific Network for Global Change Research (APN) aims to sensitise the city stakeholders on the impacts of climate change on cities and the need for urban climate resilience planning. The approach would be to organise a three-days training programme in collaboration with the Urban Development Department of the State on the theme. The training programme will cover subject areas like: tools and techniques for climate proofing the cities; role and functions of various institutions and public agencies in building urban climate resilience, policy and regulatory measures for mainstreaming urban climate change resilience, etc. Pedagogy will focus on video screenings, lectures, interactive sessions and group exercises.

Proposed Module structure:

Modules	City officials and practitioners	Elected representatives	Students & Researchers
Concepts- a) Introduction to climate science; b) Impact of climate change on urban areas	✓	✓	✓
Case studies	✓	✓	✓
Assessment frameworks; tools and methodologies for climate proofing urban areas:			
a)Broad knowledge			✓
b) Risk and vulnerability analysis and sector specific assessments	✓		✓
c) Climate modelling	✓		✓
Governance			
a) Policy analysis for mainstreaming climate resilience planning	✓	✓	✓
b) Implementation support and finance	✓	✓	
c) Institutionalisation	✓	✓	
Modes of training	**3 day Training Programme in four states**	**Included within the 3 day Training Programme**	**2 day Seminar**

Target Audience and duration of the program

TERI seeks support for organizing a three day training programme in four states in India, during January-February 2015. The capacity building program targets to train the following stakeholder groups:

1. City Officials and practitioners- A 2 day training program for 35 participants comprising Assistant commissioners, city engineers and officers from various line departments, of the state; and State and city level parastatals providing services to the cities.
2. Elected representatives- A half a day training program (on Day 3) for 10 participants comprising Mayors/ Deputy Mayors and ward councillors of various cities in the state.

Benefits of the training programme

1. The training programme will build the capacity of key officials of the state on the concept of urban climate change resilience and will facilitate dialogue between stakeholders from various cities in the state to discuss opportunities in mainstreaming urban climate resilience agenda into city planning. The participants will be awarded a certificate upon successful completion of the program.
2. The deliberations and feedback from the participants will help in identifying challenges and problems that the city officials face while addressing climate change issues. These will help in framing a policy brief which will draw from these learnings and would be taken forward to national government through a national conference.

The following components are covered under the program:

- Travel and accommodation of all the resource persons
- Hall rental for three days (including AV arrangement and signages/backdrop)
- Lunch and certificates for 45 participants [35- Day 1 and Day 2; 10- Day 3]

What we require from the State Academy of Administration

No financial support is required for any of the activities under the program. Only administrative support in terms of sending invitations, follow-ups and participation for the training program are required. Support is required in the following way:

1. Confirming the date of the three day training program (in the month of February 2015)
2. Ensuring and supporting the participation of relevant city level officials in the training programme from various cities in the state.
3. Ensuring Participation from the elected representatives of the cities of the state.

About APN CAPaBLE program

APN is a network of 22 Member Country governments, including India, which promotes global change research in the region through science-based adaptation strategies, effective science and policy linkages, and capacity development. The CAPaBLE programme focuses on enhancing scientific capacity in developing countries to improve decision-making in focus areas of global change and sustainable development.

Appendix B- Reading material for training programs

Building Urban Climate Change Resilience

For more information

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Table of contents

Course Introduction and Objectives

The knowledge on climate science and the ability to predict future climate through climate models has developed immensely over the years, yet this knowledge is not available to practitioners, urban managers and decision-makers to base their decisions. There is a strong need to equip the planning mechanisms in urban areas to withstand, adapt, and become resilient to climate change impacts. To be able to do so, the practitioners and various stakeholders in the urban space not only need an understanding of climate science but also the linkages to climate impacts to city systems, such that this information could be logically applied to decision-making processes and could be inbuilt into the development paradigm.

TERI's capacity building program on "Urban Climate Change Resilience in India", supported by the Asia-Pacific Network for Global Change Research (APN) aims to sensitise the city stakeholders on the impacts of climate change on cities and the need for urban climate resilience planning. This knowledge will be imparted through sensitisation cum capacity building programs to the following set of stakeholders in 4 states in India:

(i) Elected representatives

(ii) Policy-makers

(iii) City officials and Practitioners

The project endeavours that the goal of building urban climate change resilience is inculcated at all levels of governance and is implemented to its true intent.

About APN CAPaBLE program

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Contributors:

Dr. Divya Sharma, Fellow, Sustainable Habitat Division,

Dr Kamna Sachdeva, Assistant Professor, Department of Natural Sciences, TERI University

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

Ms Riya Rahiman, Research Associate, Sustainable Habitat Division, TERI

Reviewers:

Ms Mili Majumdar, Director, Sustainable Habitat Division, TERI

Dr Diane Archer, Researcher, Human Settlements Group, International Institute for Environment and Development (IIED), UK

1. Introduction to Climate Change Science

The section will provide you the basic understanding of key scientific concepts of climate change, covering concept of greenhouses gases, global warming, radiative forcing, climate change and variability, concept of sources and sink etc. Warming of the climate system is unequivocal, the atmosphere and ocean have warmed, sea level has risen, and the snow has melted and the concentrations of greenhouse gases have increased, hence it is important to have science based understanding of natural and anthropogenic drivers of climate change to have robust policy decisions for future planning. It will also cover the basic terminologies used in climate change science based on IPCC document. The unit also provides a two case based exercises that will help stakeholders to understand the problem more appropriately with respect to their local area. For additional reading, resources are provided containing case studies related to the module.

Upon completion of this module, the participants will be able to:

- Differentiate between climate change, climate variability and global warming
- Understand about greenhouse gases and, their sources and sink
- Extreme weather events and its consequences
- Understand how and why a science based knowledge is important for policy planning and decision making at each level

1.1 What is climate variability climate change and global warming?

- Climate variability climate varies over seasons and years instead of day-to-day like weather. Yearly fluctuates of climate above or below a long-term average value is known as climate variability.
- Climate change refers to the long term average changes in the weather variables of a particular place. In other words it's a change in the temperature, rainfall, wind profiles that extend over several decades, more precisely for more than 30 years.
- Global warming is the increase in global average temperature of Earth's surface due to increase concentration of greenhouse gases. Global warming represents only one aspect of climate change and other aspect could be global cooling. Both the aspects are bad as humans are not able to deal with extreme weather, hence need of coping mechanism at place is utmost important.

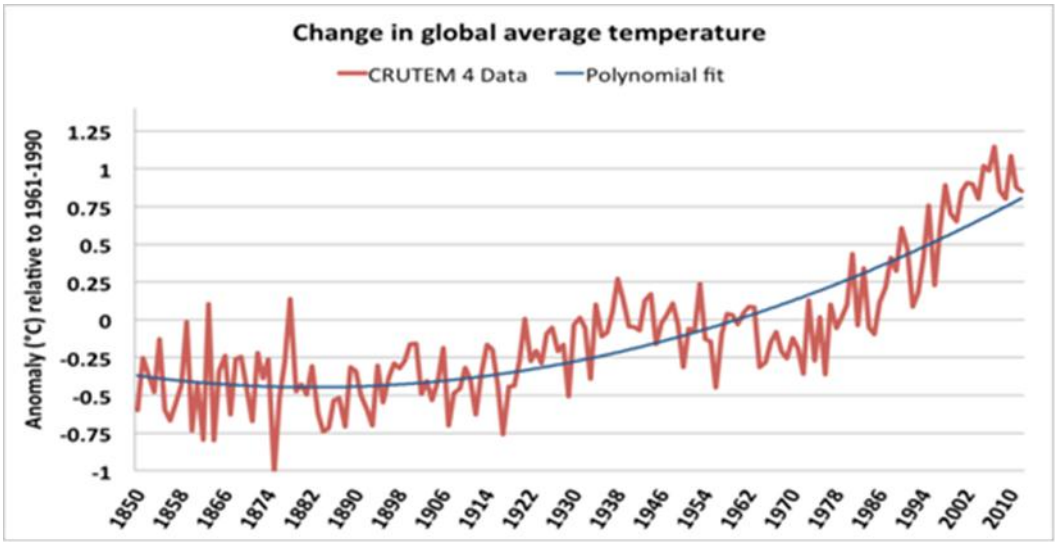

Figure 1.1: Depicting global average temperature change. The y-values of this graph represent air temperature *anomalies* (i.e. the change in temperature from readings during the reference period—the reference period being the years 1960-1990.) Thus, this graph shows the increase in global temperatures since the 1850s. *Source: Climate research unit, University of East Anglia*

1.2 Greenhouse gases and effect

As the Sun's rays reach the Earth, they heat up the planet's surface. When the ground gets warm, it starts to emit heat as infrared radiation. Some gases in the atmosphere, such as CO_2, ozone, methane, water vapour, and nitrous oxide trap the heat of the Sun like a blanket. These gases are called greenhouse gases and phenomenon is known as greenhouse effect.

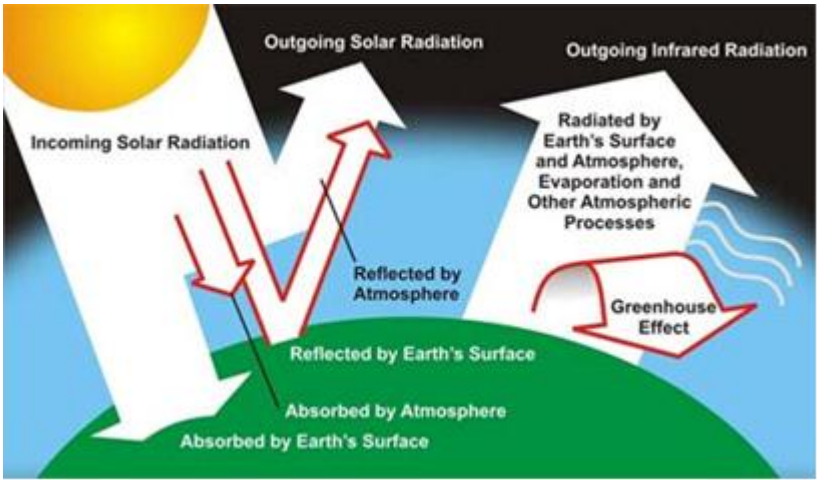

Figure 1.2: Depicting phenomenon of Earth's greenhouse effect.

Source: Environment Canada

1.3 The greenhouse gases

Water vapour (H_2O) is the most common greenhouse gas and is responsible for about 2/3 of the natural greenhouse effect. The amount of water vapour stored in the atmosphere increases as surface temperatures rise, because higher temperatures increase both evaporation and the capacity of air to hold air vapour. Changes in atmospheric water vapour are therefore considered a feedback in the climate system; human activity is not a direct influence to any significant degree.

Carbon dioxide (CO_2) is released to the atmosphere through the natural processes of plant and animal life, decay, and the burning of fossil fuels and other materials. It is removed from the atmosphere by the photosynthesis of plants and absorption by the oceans.

Methane (CH_4) is not as common in volume as H_2O or CO_2, but is more effective at trapping heat, making it a very powerful greenhouse gas. It is primarily created when matter decays in an oxygen-free environment. The main sources are wetlands, rice paddies, animal digestive processes, fossil fuel extraction and decaying garbage.

Nitrous oxide (N_2O) comes mostly from soils and the oceans. Some is released by burning fossil fuels and organic material. Soil cultivation and fertilizer use add to the amount of (N_2O) in the atmosphere.

Ozone (O_3) exists naturally in the upper atmosphere where it plays an important role in shielding the Earth from the sun's harmful ultraviolet rays. However, only small traces of ozone occur naturally in the lower atmosphere. In fact, most of the ozone now found at ground level is the result of chemical reactions involving pollutants produced by human activities.

Halocarbons are a group of human-made chemicals containing a halogen (e.g. bromine, chlorine, and fluorine) and carbon. They are present in the atmosphere at very low concentrations, but many are powerful greenhouse gases that remain in the atmosphere for decades to centuries.

What emits greenhouse gases?

Our day to day activities emit greenhouse gases. For example, CO_2 is released when we burn solid waste, wood, and fossil fuels like petrol and diesel. On the other hand, industrial activities and chemical fertilizers emit nitrous oxide. When organic waste like food leftovers, grass, and vegetable peelings decompose, methane is emitted. This gas is also released during spraying of artificial fertilizers. As a greenhouse gas, methane is 25 times more harmful to the environment than CO_2 over a 100-year period and 72 times more harmful over a 20-year period.

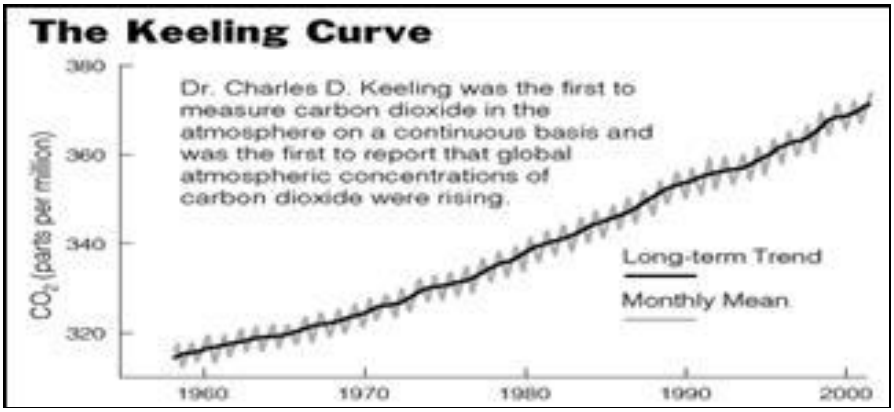

Figure 1.3: Keeling curve: showing diurnal fluctuations in carbon dioxide concentrations observed at Mauna Loa observatory at Hawaii.

1.4 Radiative forcing and climate response

Radiative forcing means change in the radiative balance of the earth, which is use as a proxy to understand the climate change. A climate forcing can be any influence on climate that comes from outside the natural system itself. The major component of Earth's climate system is: oceans, land surface, cry sphere, biosphere, and atmosphere.

Examples of external forcing include:

- Changes in surface albedo (occur due to changes in land use in urban area)
- Excessive release of GHG gases in the atmosphere
- Additional of anthropogenic aerosols (black carbon, dust aerosols etc.)

Climate is intrinsically variable and can change even in the absence of external forcing, the unforced changes can be sometimes refereed as natural forcing caused by natural agents. [1]Elnino and La lina events are such events which contribute to natural forcing. Bothe the events are responsible of transporting heat from oceans to atmosphere or vice a versa hence contribute to change in radiative balance.

Climate forcing must generate a response, a positive radiative forcing cause heating of the climate and negative forcing leads to cooling. Warming and cooling remains continue until a new balance is achieved between energy gained and lost at the top of the atmosphere.

Understanding climate forcing this is a state of imbalance due to the forcing imposed on you. Your natural reaction is to readjust your posture to push back (and avoid falling over).

[1] **Foot note: El Niño and La Niña are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle. The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific (approximately between the International Date Line and 120 degrees West). La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These deviations from normal surface temperatures can have large-scale impacts not only on ocean processes, but also on global weather and climate.
El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. They often begin to form between June and August, reach peak strength between December and April, and then decay between May and July of the following year. While their periodicity can be quite irregular, El Niño and La Niña events occur about every three to five years. Typically, El Niño occurs more frequently than La Niña. Source: NOAA

If the person keeps pushing, you will need to keep pushing back. The forcing is the initial push, your reaction is the response

1.5 Carbon sinks

A carbon sink is anything that absorbs more carbon than it releases. The two biggest natural sinks are oceans and forests. Both absorb carbon dioxide and store it for long time. Plants breathe in CO_2 and, via the process of photosynthesis, breathe out oxygen. When plants die and decompose, some of the CO_2 gets retained in the soil as carbon.

It is estimated that worldwide, about 80 per cent of forests have been cleared, fragmented, or degraded (WRI). In India, farming, mining, industrialization, and urbanization have led to large forest tracts being destroyed. Creating new forests is also not easy because of meeting the goals of food security and development.

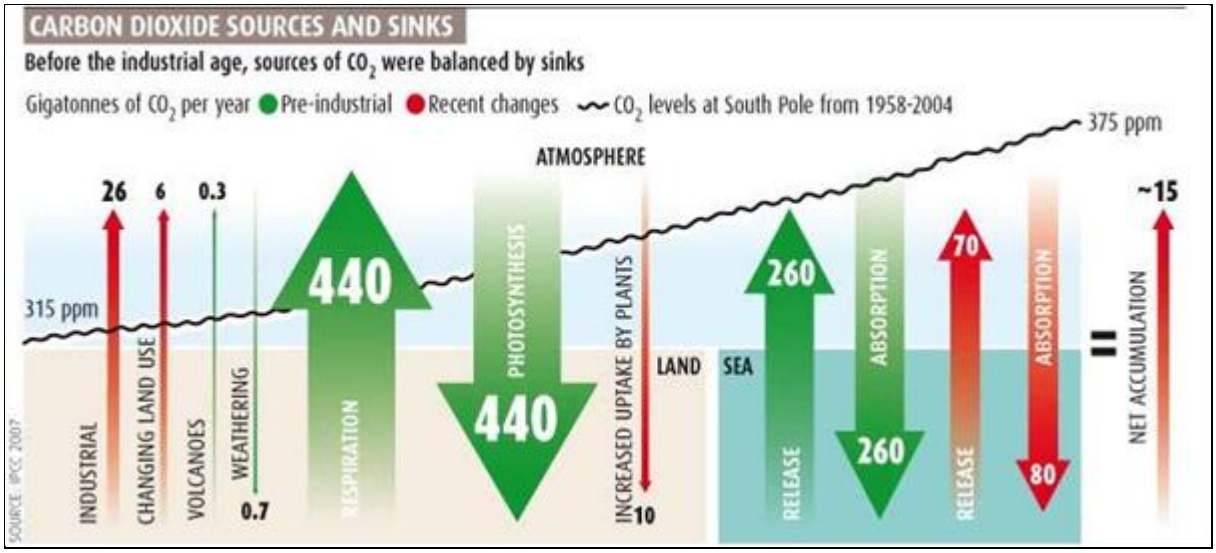

Figure 1.4: shows different carbon dioxide sources and sinks and comparing it with present and past records.

Source: New Scientist magazine: climate Myths: human CO_2 emissions are too tiny to matter.

1.6 Climate Variability and Extremes

Extreme meteorological events are good markers/indicators of climatic change or variability, so it is important to keep good records of such extremes.

Examples of climate events and extremes

Tropical cyclones: Tropical cyclones are areas of very low atmospheric pressure over tropical and sub-tropical waters which build up into a huge, circulating mass of wind and thunderstorms up to hundreds of kilometres across.

Droughts: The primary cause of any drought is a less rainfall and rainfall variability is attached with climate change. Drought is different from other hazards in that it develops slowly, sometimes over years, and its onset can be masked by a number of factors. Drought

can be devastating: water supplies dry up, crops fail to grow, animals die and malnutrition and ill health become widespread

Floods: Floods can occur anywhere after heavy rains. All floodplains are vulnerable and heavy storms can cause flash flooding in any part of the world. Flash floods can also occur after a period of drought when heavy rain falls onto very dry, hard ground that the water cannot penetrate. It is predicted that due to climate variability this kind of flash flooding will become major challenge in all the urban areas (file:///D:/reading%20resources/7.pdf).

Heat waves: Heat waves are most deadly in mid-latitude regions, where they concentrate extremes of temperature and humidity over a period of a few days in the warmer months. The oppressive air mass in an urban environment can result in many deaths, especially among the very young, the elderly and the infirm.

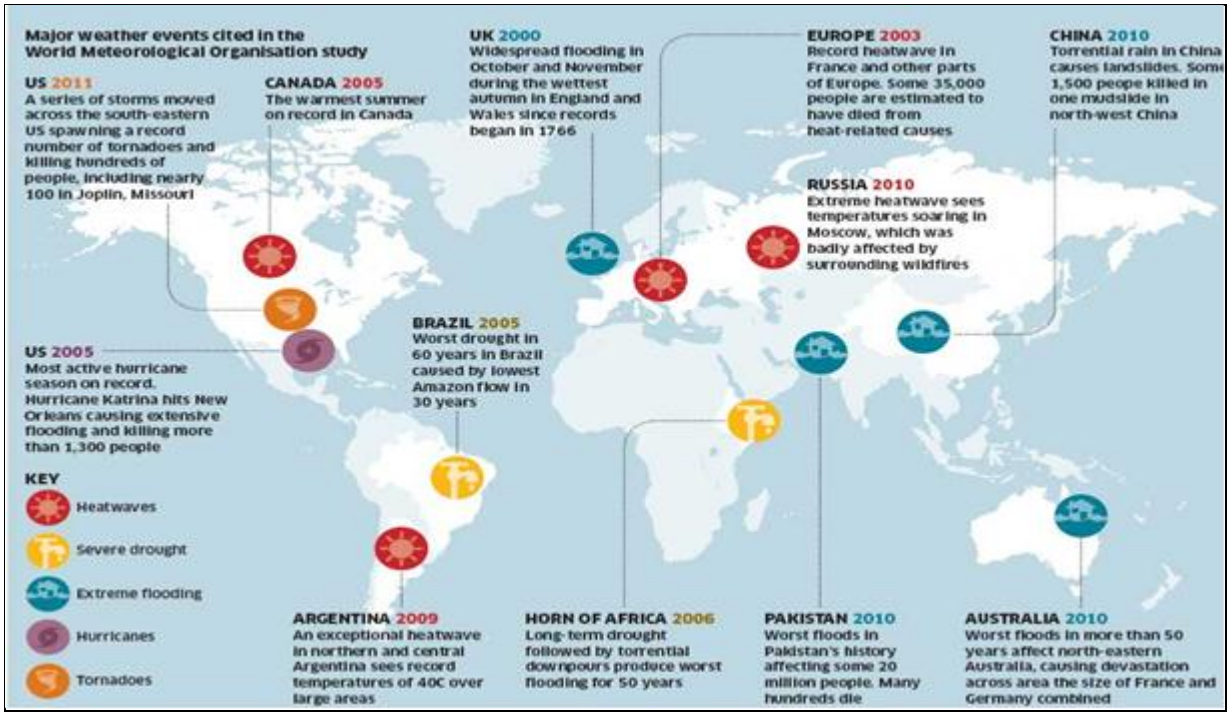

Figure 1.5: major extreme weather events with location.

Source: WMO

1.7 Summing up

As the climate change is now an accepted fact, we need to gear up for protecting ourselves from "natural" disasters like flooding and hurricanes. Furthermore changing climate is forcing cities to deal with such acute challenges as storms, heat waves and water shortages. It also imposes a wide array of long term impacts such as droughts, the spread of diseases and the demise of historically important places and monuments. The basic overview of scientific concepts which applies to climate change is very important to understand and tackle the above mentioned problems.

Governance is the key in order to achieve carbon neutral urban development, for that municipalities need to rely on the involvement of various local stakeholders. The community, private actors, non-governmental organizations, research institutes and other

actors need to come together to find possible solutions and put them into practice. A better scientific knowhow will definitely provide an edge while performing any action, in context of climate change science based awareness of causes and consequences will help local governments to think long-term and deal climate change and urbanisation challenges. The main message of the module is that; climate change is a hard core reality which is endorsed by hard core science and research.

1.8 Key Terminologies

Anthropogenic: Resulting from or produced by human beings.

Anthropogenic emissions: *Emissions* of *greenhouse gases*, greenhouse gas *precursors*, and *aerosols* associated with human activities. These include burning of *fossil fuels* for energy, *deforestation*, and *land-use* changes that result in net increase in emissions.

Atmosphere The gaseous envelop surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen (78.1% *volume mixing ratio*) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium, and radiatively active *greenhouse gases* such as *carbon dioxide* (0.035% volume mixing ratio) and *ozone*. In addition, the atmosphere contains water vapor, whose amount is highly variable but typically 1% volume mixing ratio. The atmosphere also contains clouds and *aerosols*.

Capacity building In the context of *climate change*, capacity building is a process of developing the technical skills and institutional capability in developing countries and *economies in transition* to enable them to participate in all aspects of *adaptation* to, *mitigation* of, and research on climate change, and the *implementation* of the *Kyoto Mechanisms*, etc.

Carbon dioxide (CO_2) a naturally occurring gas, and also a by-product of burning *fossil fuels* and *biomass*, as well as *land-use changes* and other industrial processes. It is the principal *anthropogenic greenhouse gas* that affects the Earth's *radiative balance*. It is the reference gas against which other greenhouse gases are measured and therefore has a *Global Warming Potential* of 1.

Climate in a narrow sense is usually defined as the "average weather" or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). These relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the *climate system*.

Climate prediction A climate prediction or climate forecast is the result of an attempt to produce a most likely description or estimate of the actual evolution of the *climate* in the future (e.g., at seasonal, inter-annual, or long-term *time-scales*). See also *climate projection* and *climate (change) scenario*.

Deforestation conversion of *forest* to non-forest. For a discussion of the term forest and related terms such as *afforestation*, *reforestation*, and *deforestation*, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000b).

Emissions In the *climate change* context, emissions refer to the release of *greenhouse gases* and/or their *precursors* and *aerosols* into the *atmosphere* over a specified area and period of time.

Energy balance Averaged over the globe and over longer time periods, the energy budget of the *climate system* must be in balance. Because the climate system derives all its energy from the Sun, this balance implies that, globally, the amount of incoming *solar radiation* must on average be equal to the sum of the outgoing reflected solar radiation and the outgoing *infrared radiation* emitted by the climate system. A perturbation of this global radiation balance be it human-induced or natural, is called *radiative forcing*.

Equivalent CO_2 (carbon dioxide) The concentration of *carbon dioxide* that would cause the same amount of *radiative forcing* as a given mixture of carbon dioxide and other *greenhouse gases*

Exposure The nature and degree to which a system is exposed to significant climatic variations

Food insecurity A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity may be chronic, seasonal, or transitory.

Extreme weather event an extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called extreme weather may vary from place to place. An extreme *climate* event is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season).

Global surface temperature The global surface temperature is the area-weighted global average of (i) the sea surface temperature over the oceans (i.e., the sub-surface bulk temperature in the first few meters of the ocean), and (ii) the surface air temperature over land at 1.5 m above the ground.

Global Warming Potential (GWP) An index, describing the radiative characteristics of well-mixed *greenhouse gases*, that represents the combined effect of the differing times these gases remain in the *atmosphere* and their relative effectiveness in absorbing outgoing *infrared radiation*. This index approximates the time-integrated warming effect of a unit mass of a given greenhouse gas in today's atmosphere, relative to that of *carbon dioxide*.

Sink Any process, activity or mechanism that removes a *greenhouse gas*, an *aerosol*, or a *precursor* of a greenhouse gas or aerosol from the *atmosphere*.

Source Any process, activity, or mechanism that releases a *greenhouse gas*, an *aerosol*, or a *precursor* of a greenhouse gas or aerosol into the *atmosphere*

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2. Impact of Climate Change on Cities

This section seeks to explore the threats of the impacts of climate change on urban areas. With the world urbanizing at an unprecedented rate it is important to develop a distinct understanding of the impacts, associated threats and future risks of climate change on cities. The section throws light on the direct physical risks of climate change like sea level rise, increase in temperatures, changes in precipitation levels and increase in tropical cyclone events which urban areas are exposed to. Further the concomitant impacts of these physical risks of climate change on physical infrastructure, buildings, economic assets, health and livelihoods have also been explored.

2.1 Vulnerability of cities

Cities are the centres of economic growth which house more than half of the world's population, trade, businesses, economic activities and built assets, generating more than 80% of the global GDP (McKinsey Global Institute, 2011). People are most often attracted to move to cities due to the immense economic opportunities and improved quality of lives they have to offer. Thus the growth of cities is inevitable. As per UN predictions over 60% of the world's population will live in cities by the year 2030. Urbanization and economic growth go hand in hand. As cities are economic giants they are responsible for a significant share of the GHG emissions and consequent climate change. With urbanisation witnessing an accelerating pace, urban poverty is framing up to become one of the major challenges. The urban poor usually put up in in hazardous sites like flood zones, low-lying dry season river beds, swamps, marshes, steep slopes, garbage landfills etc. Further with poorly built structures and the lack of access to services, the impact of climates change on the urban poor are compounded, thereby increasing their vulnerability.

As the urban areas have a high concentration of people, economic activities, business, property and livelihood it is only likely that cities will be hit hard by impacts of climate change. Therefore with the unprecedented rate of urbanization it is imperative to understand and delve into the impacts of climate change on cities.

Climate change presents a unique challenge for cities. The direct physical risks that cities are exposed to due to climate change are sea level rise, increase in frequency and intensity of tropical cyclones, increase in heavy precipitation events, increased frequency of extreme heat events, increase in drought affected areas. Over 90% of urban areas are coastal regions thus exposing most cities of the world to the risks of flooding due to sea level rise and high intensity storms. The impacts of climate change goes way beyond these direct physical risks. The associated risks due to climate change that cities face are flooding, landslides, damage to life, property and physical infrastructure, heat island effect, coastal erosion, salt water intrusion, increased vulnerability of urban poor. Hence climate change poses a challenge of managing of risks that affect people, infrastructure and ecosystems.

2.2 Direct Physical Risks of Climate Change on Cities

Sea Level Rise

Sea level rise refers to the increase in the mean level of the ocean (IPCC, 2001a). Sea level rise represents one of the primary risks associated with climate change. The average sea levels have been rising over time around the world but with regional variations. The new IPCC estimates for global mean sea level rise are between 26 and 98 cm by 2100; this is higher than the 18 to 59 cm projected in AR4 (Revi, 2014). The thermal expansion of ocean water as temperature rises can be attributed to sea level rise. The melting of ice can also be a more likely threat in the future due to the rising temperatures. Coastal and port cities will be the first ones to be hit hard by sea level rise. By 2070's a 0.5m of sea level rise will increase the risk of the population and economic assets of large port cities to coastal flooding by 3 times and 10 times (Hanson et al., 2011). The associated hazards of flooding, coastal and river bank erosion, salt water intrusion, a dearth of fresh water supplies and heightened storm surges will impact the population, economic assets and ecosystems especially of coastal and port cities. It is only evident that coastal cities are highly vulnerable to flooding due to sea level rise and if the existing provisions for drainage are not sufficient the situation will only be aggravated. The other probable indirect impacts of sea level rise are the changes in the functioning of coastal ecosystems. The loss of natural flood barriers like mangroves, coral reefs, wetlands and swamps will further intensify the impacts of heightened storm surges.

Figure 2.1: Mumbai, India is one of the coastal cities threatened by rising sea levels. (Getty Images)

Source: http://www.thestar.com/news/the_world_daily/2013/04/tackle-four-pollutants-to-combat-rising-sea-level-says-study.html

Increase in frequency and intensity of cyclones

Tropical cyclones are weather systems associated with thunderstorms and strong winds that are characterized by their wind circulation patterns around a well-defined centre[2]. Evidence suggests that the intensities of storms are increasing which can be associated to climate change. Although the relation between increased temperatures and occurrence of storms is

[2] Definition from the National Weather Service Glossary *of National Hurricane Center Terms*, National Weather Service.

not clearly understood, there is certainly a correlation between rise in temperature and the increased occurrence of cyclonic activities. Also it is predicted that with the rising temperatures the intensity of the cyclonic activities will increase. Cities are confronted with significant consequences due to the increased frequency and intensity of cyclone activities. Large scale destruction of lives, property and assets and ecosystems are usually experienced due to powerful cyclonic storms. Further the power shutdowns and inundation due to cyclonic storms disrupt normal lives, business, and economic activities for several days. The financial burden the cities have to incur to bring the city back to normalcy is very heavy. Also post cyclone the city becomes highly vulnerable to the outbreak of water borne diseases which poses further threats to human health and lives. The urban poor are usually the most vulnerable lot and this can be attributed to their poor living conditions.

Figure 2.2: Increase in frequency and intensity of tropical cyclones

Source: http://blogs.toorakcollege.vic.edu.au/katec1/2012/09/22/cyclone-yasi/

Increase in heavy precipitation events

Heavy precipitation events are defined as the percentage of days with precipitation that exceeds some fixed or regional threshold compared to an average reference period of precipitation from 1961-1990 (IPCC, 2007b). Observations over the past several years have shown an increase in heavy precipitation events and this trend is to continue in the 21st century (Easterling et al, 2004). With the frequency of heavy precipitation events the cities are exposed to the risks of flood hazards and landslides. Incessant downpour will disrupt normal lives as most cities usually do not have sufficient provisions and coverage for storm water drainage leading to inundation and water logging of low lying areas. This further creates an environment conducive to spread of water borne diseases. Again it is the urban poor who are most exposed to the vagaries of climate change as their settlements are located in areas most prone to natural hazards like floods, landslides etc. Further the lack of basic amenities and poor living conditions adds to their vulnerability. Floods a direct consequence of heavy precipitation events is one of the most damaging and costly disasters and impairs a city for several days.

Figure 2.3: Floods in Jammu and Kashmir

Source:http://www.livemint.com/Politics/5Pq6ov9rVifupnpxQJUo1O/Jammu-and-Kashmir-has-had-a-long-history-of-flooding.html

Increase in extreme heat events

Heat waves are defined as extended periods of hotter than average temperatures, with the precise timing and temperature differentials varying regionally (Robinson, 2001). The incidences of extreme heat event are predicted to increase in intensity, frequency and affect larger areas due to rise in temperatures due to climate change. Increased occurrence of heat events/hot days will be responsible for compounding urban heat island effect, an occurrence where the temperatures of dense urban areas are higher by 4- 5°C in comparison to their adjoining rural and urban hinterlands. Increased temperatures will also increase the demand for energy and resources which is required for maintaining thermal comfort and climate control. Urban population will also be exposed to the threat of heat related health problems. Also the overall human productivity and efficiency is low during extreme hot spells.

Figure 2.4: Increase of extreme heat events

Source:http://www.ndtv.com/article/cities/heat-wave-in-odisha-death-toll-rises-to-nine-214504

Increase in drought affected areas

Droughts can be defined as a phenomenon where precipitation levels are significantly below normal, which leads to hydrological imbalances which further impact land resources and production systems (UN Habitat, 2011). Evidence points out that drought have become more common in the tropics and subtropics since 1970 (Bates et al, 2008). Presently about 1 per cent of land area is considered to be under extreme drought conditions and it is predicted that by 2100, this could increase to about 30% (Bates et al, 2008; Burke et al, 2006).

Droughts have severe social and economic implications on urban areas. Water shortages due to changes in precipitation, decline of water quality and increased water demand will create water stress. Due to the dearth of clean water supply, people will be forced to resort to using contaminated water thus increasing the incidences of water related diseases. Currently around 150 million people live in cities with perennial water shortage, defined as less than 100 liters per person per day of sustainable surface and groundwater flow within their urban extent (IPCC, 2014)/(Revi, 2014). Drought conditions will severely impact agriculture. Reduced food supplies will raise food prices and bring about food insecurity. Also cities where hydropower is the source of electricity will have to face frequent power outages.

2.3 Complexity of Urban Systems

Urban areas consist of complex interdependent systems. Hence the impact of climate change on cities goes way beyond its direct impacts. As urban systems are interconnected the impacts of climate change will be visible within and across multiple sectors. Climate change will impact a broad spectrum of city functions, infrastructure and services and can also be responsible for aggravating the existing stresses in the city. Climate change will impact physical infrastructure-buildings, road & transportation networks, water supply networks, drainage systems, energy systems etc. Disruption of physical infrastructure impairs the functioning of the city eventually affecting the living conditions, economic activities and livelihood of the city. The damage will be particularly severe in low lying coastal cities

where most of the worlds' largest cities are located. Significant damage to buildings, residences and property is often witnessed with the increased occurrence of climate change induced hazards and events with floods being one of the most destructive hazards. As heavy precipitation events are only increasing cities are posed with the risk of urban flooding. Most cities have no sufficient coverage of storm water drainage leading to the immediate inundation of cities. Further with increased concrete and paved surfaces there is very little provision for seepage of the surface run off. Urban floods are capable of collapsing urban systems like water, sanitation, energy, transport and communication systems and severely impacting all aspects of urban life. The impacts of flood hazard are often more worsened due to the haphazard and uncontrolled development of the city and also due to the lack of sufficient coverage of service delivery like storm water drainage system, solid waste management, water supply and sanitation. Water supply in urban areas can be severely compromised due to climate change. Changes in precipitation pattern, reduction in river flows and groundwater tables all affect water supply. Salt water intrusion will further affect the quality of ground water resources in coastal cities. Additionally coastal erosion and salt water intrusion due to sea level rise can also damage buildings. Cities being centres of economic growth consume a lot of energy and resources. Climate change will impact both the demand and supply of energy resources. With the increasing temperatures and burgeoning urban population the energy demand for cities are bound to increase. Frequent storms and flooding can disrupt energy transmission systems affecting economic activities, trade and business.

2.4 Summing Up

Cities are centers of economic growth and the increasing incidences of extreme climate change induced events will have profound impacts on economic activities, trade, business and livelihoods. The direct economic consequences of climate change are damage to buildings, infrastructure and other economic & building assets. The secondary impacts are the delays and interruptions in economic activities, trade and business due to impacts of climate change on transportation & communication networks, infrastructure & power systems. The cascading impacts of climate change on urban infrastructure systems, built environment and ecosystems will eventually severely impact the urban economies and population. In India currently cities contribute close to 60% to the GDP and this is expected to increase to 70% by 2030[3]. Therefore the development of infrastructure which plays an integral role in functioning of a city becomes more pronounced. As the urban systems are interlinked, in the event of extreme climate induced events, the damage and destruction of physical infrastructure leads to the complete breakdown of the urban functions, hence the city. Hence it is imperative to tackle the impacts of climate change on cities and direct the focus on developing climate resilient urban systems.

[3] http://www.business-standard.com/article/economy-policy/-cities-to-contribute-70-to-gdp-by-2030-111110300048_1.html

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3. Introduction to Climate Modelling

The module gives an overview on climate science and associated modelling covering concepts of the drivers of the climate, different factors governing climate, basic interactions between the climate system components that are responsible for its variability which needs to be assessed for understanding the extent of change due to different forcing. The module also touches upon the basic terminologies used in climate modelling and the need of undergoing such exercises for planning purpose. Latest global climate projections from the IPCC fifth assessment report and specific India wide projections from latest scientific literature have been included. The unit also provides a reference to few case studies examples that have utilized climate modelling output in arriving at various policy recommendations and sectoral impacts assessments.

Upon completion of this module, the participant will be able to:

- Define weather, climate and modelling
- Identify and describe the basic components and interactions in the climate system
- List different types of climate model currently being used in around the world
- Understand how and why a climate modelling exercise helps in policy planning processes at various scales (district, state, nation and global) under a changing climate regime and issues

3.1 Climate Science

Weather is defined as the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness at a given time. In other words, it's an instantaneous report of the atmospheric conditions at a particular place. Climate on the other hand, is a long term average of such weather conditions over a particular location. A period of 30 years is generally considered to be a typical period that defines a climate cycle or the period of average taken for weather over a location. For example: the weather of Delhi is cold and chilly for winter months whereas climate of Delhi is temperate and extreme.

There are many factors that influence the climate of a place. Few of the main factors are:

1. Incident solar radiation/latitude: This is considered as the most important factor governing the climate over a particular region. As seen from Figure 1, the latitude belt from 35^{o}N to 35^{o}S (tropical regions) receives a surplus of solar radiation due to curvature of Earth and hence have greater average temperatures than the subtropical (above 35^{o}N and below 35^{o}S) regions. Hence, it is observed that climate of tropics is warmer than subtropics.

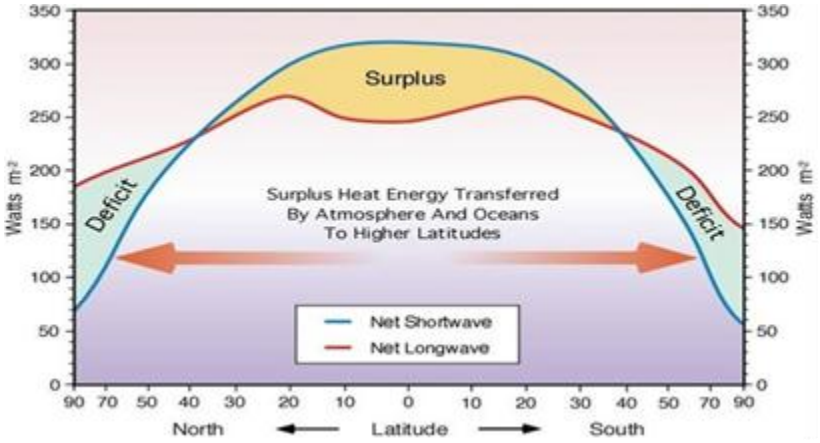

Figure 3.1: Global heat balance showing annual values of average incoming solar radiation (shortwave) and outgoing radiation (longwave).

Source: Pidwirny, 2006

2. Closeness to large water bodies: The distribution of land and water bodies also governs the climate over a particular region. The closeness to water bodies brings more moisture to the neighbouring land areas thereby changing the climatic conditions over the place.
3. Mountain barriers: Mountains act as a climatic barrier and thus governs the climatic conditions over the windward and leeward side. The typical example is climate of Mumbai and Pune. During monsoons, Mumbai which falls on the windward side receive relatively more rainfall than Pune that lie on the leeward side , due to Western Ghats acting as a barrier to most of the rain bearing winds and clouds from Arabian Sea.

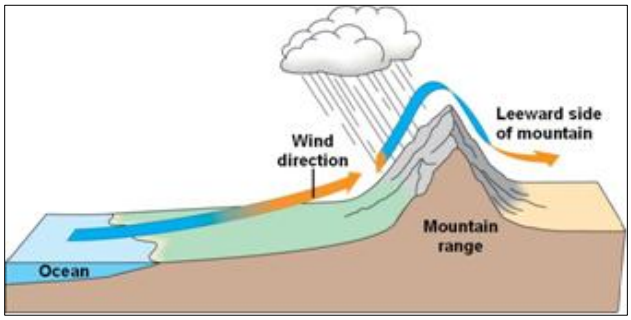

Figure 3.2: Illustration of windward and leeward side producing a rain shadow; drier area.

4. Altitude: The height of a place above mean sea level also governs the climate of the place. Most of the places that are located at higher altitudes experience a relatively cooler climate than the adjoining locations that are at lower altitudes.
5. Ocean Temperature and currents: This can be best explained by the example: climate in N.W. Europe (UK) is much mild than the Canada and N.E. America which is located at similar latitudes. This is due to the gulf stream which results in temperature difference between ocean at the two locations.

As seen from Figure 1, the tropical regions receive a surplus of radiation but we do not see the region getting indefinitely hotter and the subtropical/polar regions getting indefinitely

cooler. The atmospheric and ocean circulations help in distributing the heat and maintaining the global heat balance. Apart from the global circulations, each system in the climate is interacting with one other non-linearly. Any change or forcing in one of the system results in a non-linear change in other systems. This makes the climate system a complex problem and also results in disrupting the global heat balance circulations. The non-linear interactions among the climate components lead to climate variability at a range of spatial and temporal scales. The response of the climate system to any forcing is complicated by the feedbacks and the different response time of these components. The only means available to calculate the response is by using numerical models of the climate system.

3.2 Climate Model

A climate model is one such numerical model which is used to quantify responses of the climate system to any perturbations. It is defined as a mathematical representation of the physical process that determine climate. We need climate models to create an understanding of the processes governing various dynamics in the climate, to create plausible scenarios reflecting the current state of scientific understanding and hence to have a better plan for the future. The physical components in a climate system, with their coupling and interactions are defined in terms of numerical and mathematical equations in a model. Such relationships over a realistic 3-D domain is represented as a grid box in the model which integrates it over the entire global domain, resulting in a complete numerical representations of the atmospheric and oceanic (climatic) conditions as a 3-D grid boxes (figure 3). Such model representing the climate conditions for the entire globe are called Global Climate Models (GCMs).

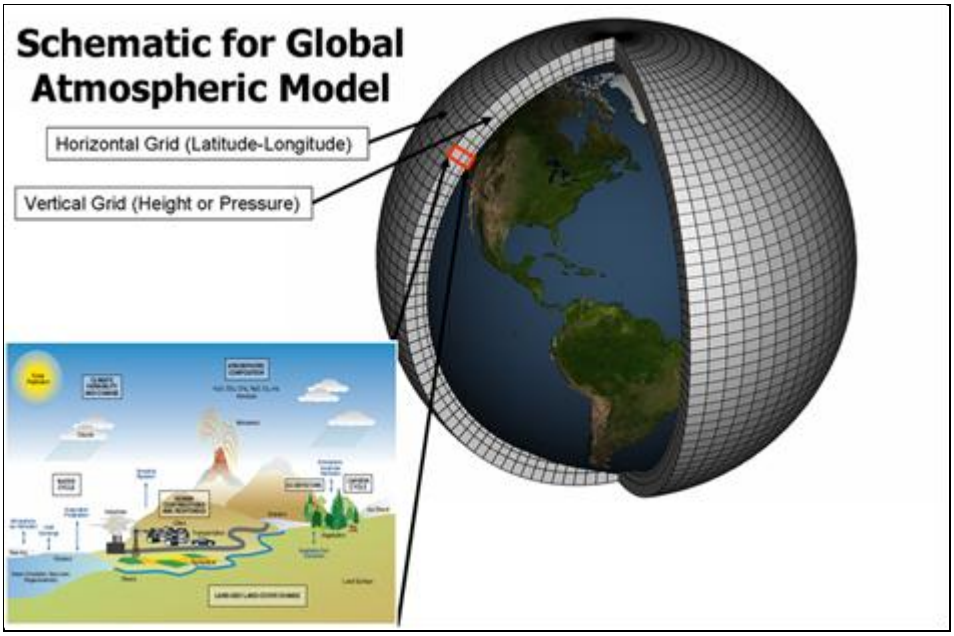

Figure 3.3: Depiction of climate system as a grid box over the globe. The physical processes occurring in the climate system are resolved at individual grid and coupling occurs at the boundaries of such grid boxes.

Source: NASA[4]

[4] NASA: National Aeronautics and Space Administration

A climate model consists of main components on radiations, dynamics, surface processes and resolution that exist in all the main modules of ocean, atmosphere, bio-sphere, chemistry and carbon cycle that are defined in it. Figure 4 shows the process of model simulation in which the first step is the *model development*. Observations are used to define the basic approximations, parameterizations and various physical, biological principles of the laws governing the dynamics at a particular region. The second step is the *model simulation* under which the initial conditions obtained by the observations are used as the driving forcing to simulate a climatic condition of a particular time frame. The result thus obtained is first validated by using the set of observations for a reference period or the baseline period. Once the efficiency and test of skill of the model is established, it is used to simulate future climate projections and other research activities. This forms the third and the final step of *analysis of the result*. It is hence seen that the observations form an integral part in all steps of model simulation process and as a result the success of a climate modelling experiment depends upon the quality, quantity, length and type of the climate observations that are available over that particular region.

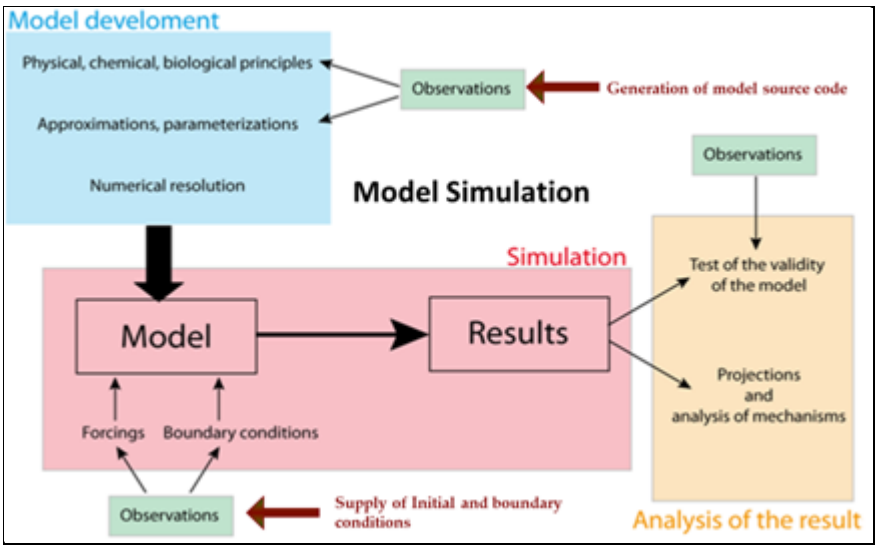

Figure 3.4: Process of a typical modelling experiment underlying the importance of observations.

Source: Goosse et.al. online textbook http://www.climate.be/textbook

Apart from the observations, uncertainty can also be introduced in a modelling experiment due to resolution used. A global model having a horizontal resolution of 1°-5° (100-500 kms) is incapable of resolving regional scale climate phenomena due to its coarse resolution. Hence, it's imperative to downscale the data which will result in much finer resolution thereby making small scale climate analysis possible. The downscaling is done by two methods: statistically and dynamically. Although statistical downscaling is easier and computationally inexpensive to apply but since it assumes fixed relationships between various parameters across spatial scales it is not preferred. In most of the research centers worldwide, high resolution modelling is done by making use of Regional Climate Models (RCMs) that are able to capture more complexity, provide a better dynamic assessment, are scientifically more robust but are computationally expensive to run. Common grid resolution of a RCM is around 50km or lesser and hence they are relatively more sensitive to

smaller scale factors such as mountains, lakes etc. Since RCMs are very sensitive to GCM input and parameterizations used, to minimize any uncertainties that may arise in RCMs, an ensemble approach is used by climate scientists. It involves using more than one model with similar initial conditions but different climate physics thereby arriving at a range of plausible scenarios for the future. Such approach has also been suggested in various scientific assessment reports been brought out by IPCC[5] in the past few years.

Instrumental records over the past century have shown that Earth's temperature has warmed and have also corroborated the findings from IPCC that each of the past three decades has been successively warmer than the previous ones. Also, incidences of climate extremes have risen in the past 50 years and sea level rise have also accelerated due to melting sea ice, glaciers and polar ice caps (figure 5). Since 1990s, IPCC have been bringing out scientific reports which have tracked the development of climate change science and have concluded in each report with progressively increasing level of confidence that climate change have been caused primarily by anthropogenic factors. The recent reports have also concluded that the warming of the climate system is unequivocal (IPCC, 2007, 2013). Almost ninety seven per cent of climate scientists agree that climate-warming trends over the past century are very likely (90-100 % probability) due to human activities (Anderegg, 2010, Doran, 2009 and Oreskes, 2004). Around 200 scientific organizations[6] across the world in the field of climate science have also issued public statements repeatedly endorsing the human induced climate change. Basically there is a worldwide consensus both at national and international level on global warming due to climate change and its attribution to man-made causes. Climate models are at the centre of these attribution studies.

3.3 Climate Projections

Global projections from the IPCC latest fifth assessment reports:

- Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was likely the warmest 30-year period of the last 1400 years in the Northern Hemisphere, where such assessment is possible (medium confidence).
- Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m. The rate of sea-level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (high confidence).
- It is very likely (90-100% probability) that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale.
- There are likely (66-100% probability) more land regions where the number of heavy precipitation events has increased than where it has decreased.
- Global surface temperature change for the end of the 21st century is likely (66-100% probability) to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios (see box 1) except RCP2.6. It is likely to exceed 2°C for RCP6.0 and RCP8.5, and more likely than not (>50-100%) to exceed 2°C for RCP4.5.

[5] IPCC: Intergovernmental Panel on Climate Change http://www.ipcc.ch/
[6] List can be found at http://opr.ca.gov/s_listoforganizations.php

Global mean sea-level rise will continue during the 21st century, very likely (99-100%) at a faster rate than observed from 1971 to 2010.

For 21st century, the contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions.

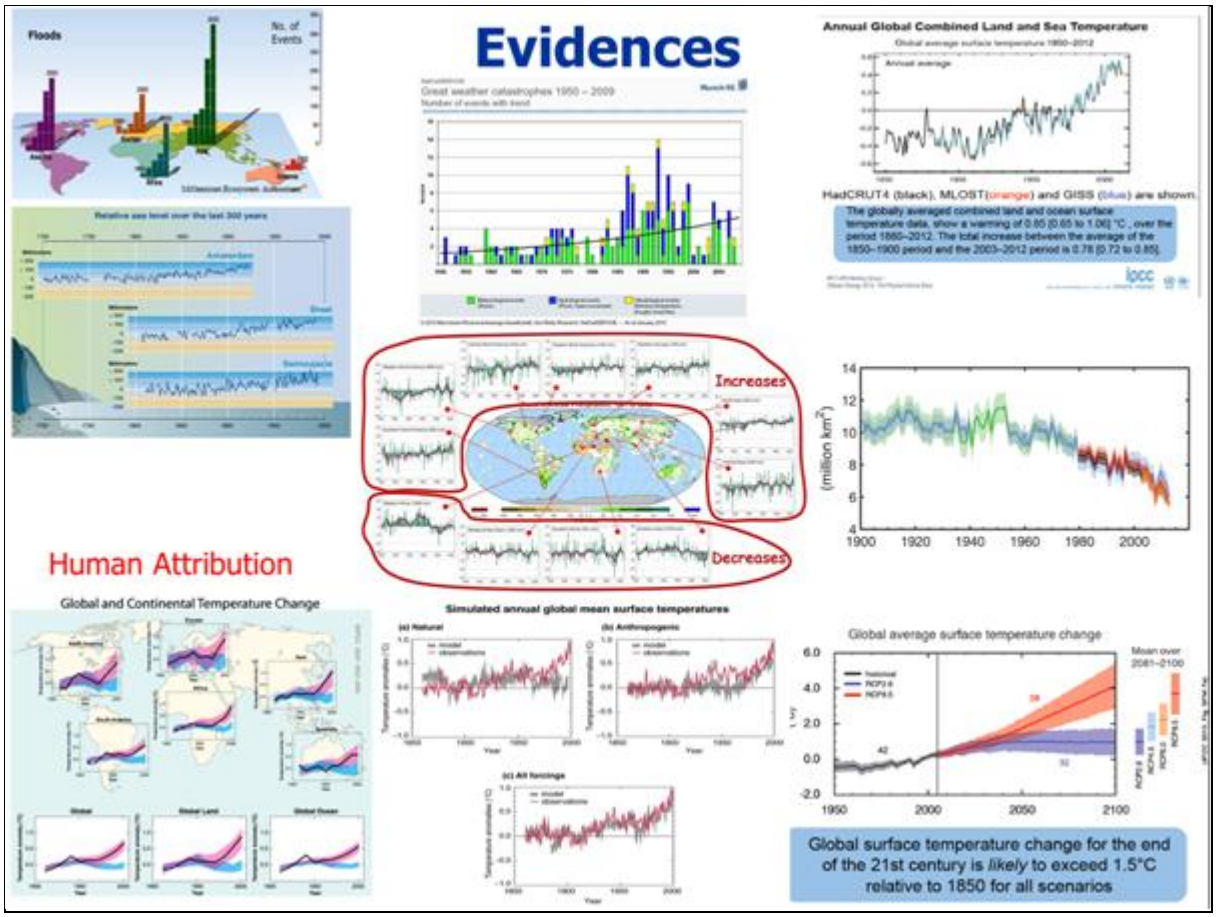

Figure 3.5 A collage of various observational and modelling assessment showing the increasing trends of global warming, extreme events, sea level rise, decreasing sea ice, variable trends in rainfall and attribution towards human activities.

Source: Multiple

Box 1. Representative Concentration Pathways (RCP) Scenarios

These are four time series of concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008, van Vuuren et al. 2011) that describes four possible climate futures. RCP 2.6, RCP 4.5, RCP 6 and RCP 8.5, are the different types of RCPs named after a possible range of radiative forcing (difference of incoming to outgoing solar radiation) values in the year 2100 relative to pre-industrial values of 2.6, 4.5, 6.0 and 8.5 W/m^2 respectively. RCP 2.6 is the low level warming scenario, and then followed by medium level RCP4.5, RCP 6.0 and RCP 8.5 considered to be the most extreme one.

3.4 Projections over India

Significant warming trend (0.51°C/100yrs) have been observed for all India annual mean temperatures for the period 1901-2007 (Hingane et.al., 1985 and Kothawale et.al., 2010). Many scientific studies (Rupa Kumar et al., 1994, 2002, Kothawale et al., 2005, 2010, MoEF, 2010) and IMD reports (Attri and Tyagi, 2010 monograph 01/2010) have also reported a significant rise of mean annual temperatures with accelerated warming by 0.21°C/10yrs been observed for the recent period of 1971-2007. For India as whole and in particular homogenous regions of East coast, West Coast and Indian peninsula show a significant increasing trend in frequency of hot days as well as decreasing trends in frequency of cold days during the pre-monsoon season over the period 1970-2005 (Kothawale and Rupa Kumar, 2005). Although Indian monsoon rainfall is trendless and randomly fluctuates over a long period of time on all India scale (Parthasarthy, 1994, Pant and Kumar, 1997), many studies have brought out notable regional trends in the rainfall over India (Rupa Kumar 1992, Guhathakurta and Rajeevan, 2008, Krishna Kumar, 2010).

The modelling assessment for the future climate over India also shows a warming trend. As reported by Krishna Kumar et.al., 2010 and 2011, along with a significant rise in the annual mean temperature (~4°C for 2071-2098 period), a substantial rise in day and night temperatures and increase in frequency and intensity of extremes is projected for the 2071-2100 time period relative to 1961-1990 reference period. Although the change in rainy days for the future time period is non-uniform over the country, the models project a modest increase in seasonal mean monsoon rainfall with a possible increase in frequency and intensity of extreme rain events.

As indicated by MoEF's INCCA[7,8] report specific to Himalayan region, the net increase in temperature is projected to be in the range from 1.7°C to 2.2°C in 2030s relative to 1970s. For Western Ghats this increase is between 1.7°-1.8°C whereas in coastal and North-eastern region the range is between 1.6°-2.1°C and 1.8°-2.1°C respectively. Projected percentage increase in precipitation in 2030s relative to 1970s for the Himalayan, Western Ghats, Coastal and North-Eastern region is between 5%-13%, 6%-8%, 0.2%-8% and 0.3%-3% respectively. All these regions are also projected to face an increase in temperature and precipitation extremes in future. Although the coasts of India will face less number of cyclones in future, the intensity of any cyclone occurring in the future will be more intense with respect to 1970s.

Without appreciable mitigation efforts globally and nationally, the projected anthropogenic climate change is likely to have large impacts on key socio-economic sectors like agriculture, health which may in turn have many cascading negative effects throughout the country.

3.5 Case Studies

For designing a climate smart policy planning framework, national or state level action plan for climate change or a robust climate risk assessment strategy it is imperative to have a clear understanding of the past and future climate risk over the study domain area. To understand the past climate risk, a trend analysis of historical climate data over the region is carried out which is essential for understanding the climate and its variability. Also, to

[7] MoEF: Ministry of Environment and Forest, Government of India
[8] INCCA: Indian Network for Climate Change Assessment

arrive at future climate risk profile a high resolution modelling study is utilized. Many such activities over specific regions and states in India have been carried out and are currently underway (eg: Bhardwaj S., 2014: Climate variability for Jalna, TERI-2012: Coastal Vulnerability study for West Bengal, TERI-2014: Climate Change vulnerability and adaptation strategies for Maharashtra state, TERI-2014: Planning for climate resilient coastal cities: Case study for Panaji and Visakhapatnam, TERI-2014: case studies on climate resilient infrastructure services for Panaji and Visakhapatnam, TERI-2013: City resilience strategy for Guwahati) that not only provide a high resolution dataset to the practitioners but also help the policy planners and decision makers in devising sector specific adaptation plans and policies under a changing climate scenario over India.

3.6 Specifics for Policy planning

It may be noted that all the studies involving modelling assessments are probabilistic which provide us the best indicator on how the climate has been evolving in the past and in coming future. The degree of certainty depends on many factors like input data and the boundary forcing used, the parameter being modelled, the type of models used, resolution and domain utilized.

For doing any climate assessment over a smaller region like a state or a district, high resolution observational dataset should be available over that area. This results in bringing down the uncertainty of modelling exercise by not only giving robust historical trends analysis but also helping in validation and tuning of modelling outputs over the area.

Also, proper communication of scientific outputs to relevant stakeholders is also very important since scientific dissemination involves a two-step action: capacity building of stakeholders to help them comprehend the scientific terminologies and one on one discussion for explanation of each scientific result to the policy makers.

Reading Resources

IPCC Assessment report 5, working group 1, http://www.ipcc.ch/report/ar5/wg1/

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TERI. 2014 Climate resilient infrastructure services - case study brief: Panaji New Delhi: TERI Available at: http://www.teriin.org/eventdocs/files/Case-Study-Panaji.pdf

4. Mainstreaming urban climate resilience into the urban development paradigm

Climate resilience is fast recognised as an area for concern as it relates to urban planning, management and infrastructure design .Globally the changing climate is already being felt with shift in seasons, change in precipitation, change in temperature , incidences of temperature and rainfall extremes, and disasters like cyclones, storms and floods.

However internationally , while the governments have starting mainstreaming climate resilience into their development agenda and practices, developing countries like India are far from even building adequate capacity and awareness at every level of the governance on the same.

The module would capture the following:

1. An introduction to climate resilient cities- why a change in perspective in governance is needed
2. Introduction on what is mainstreaming
3. Reasons to mainstream climate resilience
4. Contextualizing resilience within institutional and theoretical frameworks
5. integration points for mainstreaming climate resilience

Learning objectives:

The participant would understand the nuances of mainstreaming climate resilience into development agenda. They would understand the various channels through which the climate resilience agenda could be dovetailed into existing governance framework, who are the critical actors, what are the enabling mechanisms, while also understanding about what a new policy on urban climate resilience should be addressing.

4.1 Climate Resilient cities: a change in perspective

The level of resilience of our cities and towns is dependent on the quality and performance of the overall urban system. Adaptation to climate change and disaster risk reduction is becoming increasingly relevant as the negative impacts of climate change increase. *"There needs to be a shift, in both adaptation to climate change and disaster risk reduction, from a singular and specific focus on affected infrastructures and locations towards a more integrated focus on overall risks, development conditions, and local area performance*[9]*"*.

This calls for :

1. Mainstreaming climate and disaster risk reduction to become factors in conventional planning processes, project design and development decision making.
2. Developing specialized financial instruments for the risk-oriented components of these projects that cannot be addressed via mainstreaming measures.

[9]Source: "ICLEI, 2011, Financing the Resilient City: A demand driven approach to development, disaster risk reduction and climate adaptation - An ICLEI White Paper, ICLEI Global Report"

3. Building local institutional capacity to prepare, structure and manage large scale redevelopment

4.2 What is mainstreaming

Mainstreaming climate resilience is the iterative process of integrating considerations of climate change into policy making, budgeting, implementation and monitoring process at national, sector and subnational levels.

It is multiyear, multi stakeholder effort grounded in the contribution of climate change to human well-being, pro-poor economic growth and achievement of the MGDs. It entails working with a range of government and non-government actors, and other actors in the development field10.

4.3 Why do we need to mainstream climate resilience

1 Recent calamities in Uttarakhand, Kashmir, and Visakhapatnam have brought out the need for building climate resilience into development systems and planning

2 Climate change in urban areas interferes with a wide range of existing and emerging policy challenges, among them poverty eradication, water supply and sanitation, scarcity of food and water, and population growth.

3 Climate change, therefore, should no longer be considered a solely environmental challenge, addressed in isolation from other social and economic issues

4 Cities need to consider impacts of slow onset climate change as well as vulnerability to extreme events in their planning decisions, infrastructure planning and land use planning

5 A strong policy mandate and regulatory backing is needed to start this integration.

6 When climate change is embraced as an integral part of these challenges, solutions can be designed to more adequately reflect and address myriad impacts upon cities

4.4 Contextualizing resilience within institutional and theoretical frameworks

In 2009, TERI conducted an in-house study on designing a city adaptation framework for Indian cities (TERI b, 2009) and synthesized the various spheres of urban planning in India, including public and private agencies as well as individuals that are involved in framing, planning for and responding to climate change. Table 1 adopted from TERIb, 2009 attempts to categorize their mandates and demonstrates the multiple layers of actors and institutions involved. The activities in Table 1 have been clubbed as 'proactive' and 'reactive' to indicate whether actions are being carried out in advance of anticipated impacts or in response to actual climate impacts. By definition, all "proactive" activities are strategic to some extent, but the table attempts to distinguish between efforts in which climate change considerations are explicitly driving the creation of strategic plans and policies versus efforts to 'climate-proof' ongoing policies and programmes.

[10]Definition adopted from the definition of mainstreaming climate change adaptation in mainstreaming climate change adaptation into development planning-a guide for practitioners(www.unpei.org)

Table 4.1: Contextualizing adaptation within institutional and theoretical frameworks (TERIb, 2009)

Sphere	Driver of action	Approach to resilience planning and action			
		Reactive (driven by current understanding of hazards/extreme events)		**Proactive (driven by future-oriented climate scenarios/models)**	
		Disaster response/ recovery	Measures to reduce hazard risk/vulnerability, based on present hazards	Development priority-driven "climate proofing"	Climate forecast scenario-driven strategic planning to build resilience
Public	Central climate change office ("climate czar" or integrated high-level task force) at national, state and/or city level		Centrally coordinated hazard reduction measures in response to major storm event	Climate considerations built into city spatial/master planning processes	National or state level: NAPAs; state climate change strategies City level: City-wide integrated strategic climate adaptation planning
	Sectoral ministry or agency (e.g. Environment, Urban, Agriculture, etc.) at national, state and/or city level	Disaster relief support in wake of climate events (major floods, drought-induced famines, etc.)	Hazard management agency driven disaster-response planning (not traditionally looking at climate projections)	Agency-specific climate mainstreaming to integrate climate change considerations into sectoral policies and planning processes	Sector-driven strategic climate adaptation plans (agriculture, water resources, etc.) Environmental agency research efforts
	Private developer/ insurer	Coping/ recuperating losses in wake of an extreme event		Project-level climate proofing activities	Insurance premiums and other market tools to incentivize private development away from high-risk areas
Private	Neighborhood and household level	Coping in the wake of an extreme event	Actions to reduce future household-level vulnerability following experience with extreme event	Community or NGO-led activities to weatherize homes, reduce energy use, etc.	Neighborhood level planning and monitoring on energy/water consumption

4.5 Challenges

1 Lack of understanding of the impacts of climate change and the fact that adaptation interventions are best employed and covered at local level.

2 Creating awareness amongst the local government that adaptation is synonym to their functions and their development goals

3 Already pressing development pressures might overlook adaptation issues

4 Integrating adaptation at municipal level would be difficult because of the perception of contest for budget.

5 Lack of capacity within the local government.

6 Development plans of cities do not factor climate change related factors in a targeted way.

7 Translation of global impacts of climate change to local level (downscaling) has been missing

8 Lack of data and modelling framework at the city level

4.6 Key Enablers

1 Policy and mandate at national and state level

2 Integration of climate agenda with city development agenda

3 Institutionalization of urban climate resilience planning.

4 Use and involvement of local expertise to generate context specific locally driven solutions

5 Capacity building and awareness generation to generate momentum and facilitate action at all levels

6 Access to knowledge on climate variability and change

7 Data management and updating to facilitate decision making

4.7 Integration points for mainstreaming

There are various channels through which a policy could be integrated

Action to address climate change in urban areas should be multi-level, involving national, state, and city-level governments, as well as multi-sectoral including sectors such as infrastructure and services, urban planning, transport, disaster risk reduction, and housing and construction. For cities to internalize resilience planning into the urban development process, an effective policy will be that which:

1 Provides for capacity building, mainstreaming, facilitating data, tools, and techniques to enable risk assessment and climate projections.

2 The policy should bring forth the importance of and need to introduce urban climate resilience into the urban planning framework, draw out a structure of the institutions and regulations needed to implement the same, and identify windows for financing the actions.

3 The policy should begin with facilitating the preparatory actions on which the cities would base their actions towards resilience. This includes a risk and vulnerability analysis of cities to potential climate impacts in the near future, i.e., in the next 15–30 years. This requires past climate data and future projections of climate and various other sectoral datasets, to help assess the vulnerability, and coping capacity of city systems to climate events. This also requires engagement and communication among various institutions, departments, and stakeholders to complement the multi-sector needs and requirements of such an exercise.

4 The second important milestone in this discourse is to provide for need-based area-specific training for officials at all levels to enable planning for climate resilience and preparedness for dealing with any climate-induced emergency situation. In addition to building capacity of relevant stakeholders, the policy should call for raising awareness of citizens about the need to include climate resilience in the urban development planning process.

To facilitate all the above, a strong regulatory and institutional backing is required which also draws out financing mechanisms to support the cause.

An important point of consideration is the fact that resilience requires multi-sectoral and cross-sectoral interventions and may not fit into the present divisions of institutional responsibilities. Therefore, while the policy can guide the overall mechanisms to support resilience mainstreaming into urban development discourse, it should also identify various entry points within existing institutional mechanisms and regulatory framework.

The urban climate resilience policy should address a number of factors. These have been explained in the Sections A to E.

A. Making a case for climate-related actions and investment

The policy must make a case for cities to conduct risk and vulnerability analyses to understand their specific requirements for resilience building and develop city-specific strategies for adaptation and mitigation. This would also include response mechanisms and coping strategies, particular to the city's context. The policy should also call for exploring inter-linkages with the existing disaster management set-up in the country and facilitate response mechanisms and preparations for any unforeseen disaster events.

This stage requires specific datasets such as socio-economic data, climate trends, and sector-specific datasets to enable formulation of resilience strategies:

- *Climate projections*

  Climate resilience is based on parameters related to climate, its variability and change. Studying past climate trends and developing climate projections therefore are essential components of risk and vulnerability assessments. Climate modelling is a specialized field which requires capacity building and technical expertise, which could be achieved by forming a repository of institutions and experts at the state or national level to act as resource persons for cities obtaining climate projections.

- *Data*

  Most cities in India lack the proper information systems required for addressing the various aspects of climate change impacts; e.g., data on weather anomalies,

frequency, and extent of urban floods. Integrating resilience planning in the urban planning process requires very specific data sets on various local and regional climate parameters. Hence, maintaining a repository of city and region specific data using Management Information Systems (MIS) would be an essential step, which could be used to develop time-series and spatial data bases in this regard.

B. Capacity building

Climate resilience is a new concept in India, requiring specific technical know-how and data for cities to draw up their resilience plans. It also needs awareness generation to be built among civil society to foster interest and support.

The policy to facilitate action to climate-proofing cities must ensure capacity building, competence, and adaptability at various levels of urban governance that would eventually be dealing with mitigation and/or adaptive practices on ground. The Mission on Sustainable Habitat discusses overall climate resilience of urban centres in India through adaptation and mitigation approaches. However, there is a need for *creation and dissemination of knowledge* that penetrates from local to federal level of governance, across communities to sensitize various stakeholders and facilitate action towards climate resilience.

A perspective policy must make adequate Human Resource Development plans for all the levels of urban governance. Designing specific training programmes to suit local variations and availability of adequate resources for the training programmes would be a prerequisite.

The target stakeholder for these would include city planners, decision makers and practitioners, political representatives, sector experts, city managers, engineers, and citizens. The broad objectives of the capacity building would be to:

- Generate awareness about climate change impacts on urban areas
- Acquaint stakeholders with the principles of resilience planning and its benefits for the cities' sustainability and development
- Develop techniques, methods, and tools for assessment of climate risks and vulnerability to climate change in cities. Customized material such as toolkits, guidelines, and case studies can be developed for use in resilience planning.
- Strengthen the role of institutions and governance in fostering climate-resilient development.

C. Multi-level engagement

Resilience planning is successful and apt when an integrated approach to various urban sectoral needs is followed through continuous stakeholder consultations, inter-departmental and institutional coordination, and community participation. The policy should establish a mechanism to institutionalize the process of this multi-stakeholder engagement; e.g., the national government could incorporate climate resilience in the reforms agenda and resource planning under national schemes, and bring in incentive mechanisms for states and cities. They could also facilitate partnerships with international and non-government actors for technical and implementation support.

The state government should support the national government's interventions towards the goal of resilient urban systems by integrating climate resilience into state-level laws and regulations, budgeting for climate resilience, and initiating and implementing capacity-building programmes at the state and city levels. Cities would need to assess and understand their vulnerability and develop responses to climate-proof urban systems.

D. Integrating climate resilience into urban development laws and regulations

Considering that the resilience options are not independent of the regular sustainability goals and planning needs of the city, it is pertinent to dovetail climate resilience to the urban development framework. This means integrating:

- Climate-related issues and addressing them through the state-level acts and regulations. E.g., the State Town Planning Acts could have clauses that integrate climate parameters into master planning processes.
- Resilience interventions could be included into the development regulations of the cities, e.g., building by-laws, development controls, and zoning regulations.
- Integrating measures to bring in climate resilience into national and sub-national schemes and plans such as the town planning schemes and City Development Plans (CDPs) of the cities.

There is merit in establishing a nodal body at the city level; e.g., the Municipal Corporation, that would have the statutory authority to coordinate and direct the resilience planning and implementation efforts with relevant officials, semi-official, and non-governmental agencies operating there. Capturing local communities' interest and involvement could be one of the responsibilities of the nodal body.

E. Financing urban resilience

Reinforcing and climate proofing existing infrastructure would require additional funds. Therefore, financial allocation for resilience building and adaptation projects would also be an integral part of the proposed policy. Establishing national- and state-level climate funds and resource planning under various national schemes such as the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) can go a long way in this direction.

4.8 Case studies

4.8.1 Rotterdam Climate Change Initiative

Rotterdam being situated in the lowest delta in Europe will consequently be confronted with:

1 Rising river, sea and groundwater levels

2 Increased precipitation

3 Greater risks of heat stress in the city

Rotterdam Climate Change Initiative (RCI) is an initiative which aims to realize 50% reduction of CO_2 emissions by 2025 and to make the city 100% climate proof in the same year. The Climate Change Initiative aims to develop Rotterdam into an attractive, clean, accessible and safe port city.

The Rotterdam Climate Initiative is a partnership between:

1 The City of Rotterdam

2 The Port of Rotterdam,

3 DCMR Environmental Protection Agency Rijnmond,

4 Deltalinqs (representation of the corporate sector in Rotterdam)

The Initiative also participates in the C40 Climate Leadership Group, a worldwide alliance of large cities all over the world collaborating on the issues of climate change. The RCI closely cooperates with the Clinton Climate Initiative and also with cities such as New York, Shanghai, Singapore, Jakarta, Hong Kong, London and New Orleans. A strong network on local, regional, national and international level is in place to ensure that good plans are actually carried out

Aim and Objectives of Initiative:

The Climate Initiative aims towards 50% reduction of CO_2 emissions and 100% climate proof. The key objectives of RCI are concentrated in two programmes. The broad objectives under each of the programmes are elaborated below:

i) 50% reduction of CO_2 emissions

Rotterdam will reduce the emissions of CO_2 by targeting the following areas:

- **Rotterdam – sustainable city:** The emission of CO_2 of all homes and buildings in the city should be reduced by at least 50% and this is to be achieved by saving energy and applying sustainable energy
- **Rotterdam – energy port:** Aims towards an energy efficient port. Rotterdam should become the energy port for low-CO_2 energy sources and products.
- **Rotterdam – sustainable traffic and transport:** Promote sustainable transport by road as well as by water. Cleaner fuels and alternative vehicles should be adopted for cleaner air.
- **Rotterdam – Energizing City:** A clean and sustainable city of Rotterdam can only be achieved with the participation and cooperation of citizens, companies and organizations. Environmental education programmes in schools, an energy conservation programme for companies, and publicity campaigns to persuade citizens to adopt new ways of responding to the climate change issue are measures taken towards this goal.
- **Rotterdam – Innovation Lab:** Rotterdam welcomes innovative initiatives and supports their implementation to take up a leading position in energy knowledge and developments.

ii) 100% climate proof

By means of the climate adaptation programme 'Rotterdam Climate Proof', the Rotterdam Climate Initiative targets to make the city climate proof through the following key aims:

- **Flood safety:** Ensure all water defences will be sufficiently strong by 2025.
- **Accessibility:** A climate change resilient transport infrastructure for both the city and the port.
- **Adaptive building:** By 2025, the existing areas outside the levees (including the waterfront and port area) will be flood-proof, and new construction will be restricted to adaptive building.
- **Urban water system:** To avoid situations where the capacity of the surface drainage water system doesn't suffice for the surface run off, the excess rainwater needs to be retained in reservoirs. Also in times of drought, freshwater supply needs to be safeguarded.
- **City climate:** Aim is to improve the living environment in the city by means of shaded and cool public areas and climate proof parks and green spaces such as green roofs.

Implementation

Implementation of the programme is a joint activity of two Rotterdam departments:

- The Municipal Public Works Department
- The Department of Urban Development.

In addition there is active collaboration with the Municipal Health Service (GGD), Sports and Recreational Department, Water Boards and various government bodies, NGOs and knowledge institutes. They report to the Municipal Executive. The RCI board are jointly responsible for the coherence, quality and progress of the programme.

Structure of Organization

- A small-scale project office is responsible for streamlining the activities of the Rotterdam Climate Initiative. For this purpose, the four partners make funds, manpower, knowledge and networks available. A management team including representatives of the four partners takes the decisions.
- The management team reports to an Independent Board. The Board consists of the highest level representation of the four partners. Mayor of Rotterdam is the Chairman.
- The Board of the Rotterdam Climate Initiative is provided with advice, on request or otherwise, by a council. The members are top specialists in their field of expertise. Former Prime Minister of the Netherlands, Ruud Lubbers, is the chairman of this RCI council

The Rotterdam Climate Initiative creates a movement in which government, organizations, companies, knowledge institutes, and citizens collaborate to achieve a 50 per cent reduction of CO_2 emissions, adapt to climate change, and promote the economy in the Rotterdam region.

In the area of adaptation, the Rotterdam Climate Proof programme participates in the Rotterdam Climate Initiative, collaborating with knowledge institutes and companies from the water management sector and, the water boards in the Rotterdam region.

4.8.2 The Quito Climate Change Strategy

Quito the capital of Ecuador, being situated at 2800 MSL and on the Andes mountains is characterized by steep slopes, ravines and gorges and is prone to:

- Recurrent floods
- Earthquakes
- Landslides

Also it was estimated that Climate change has increased the mean temperatures in Quito between 1.2°C and 1.4°C over the last 100 years causing significant changes in weather patterns and the consequent impacts.

In response to the anticipated adverse climate change impacts in the future, the Municipality of Quito through its Metropolitan Council adopted the Quito Climate Change Strategy in 2009.

The QCCS was established to integrate the adaptation and mitigation policies into Quito's planning policy to address climate change. It establishes guidelines, criteria and principles which the citizens of Quito are expected to adopt in order to address climate change under one comprehensive strategy. olution the QCCS in a nutshell.

Figure 4.1 below captures the evolution the QCCS in a nutshell.

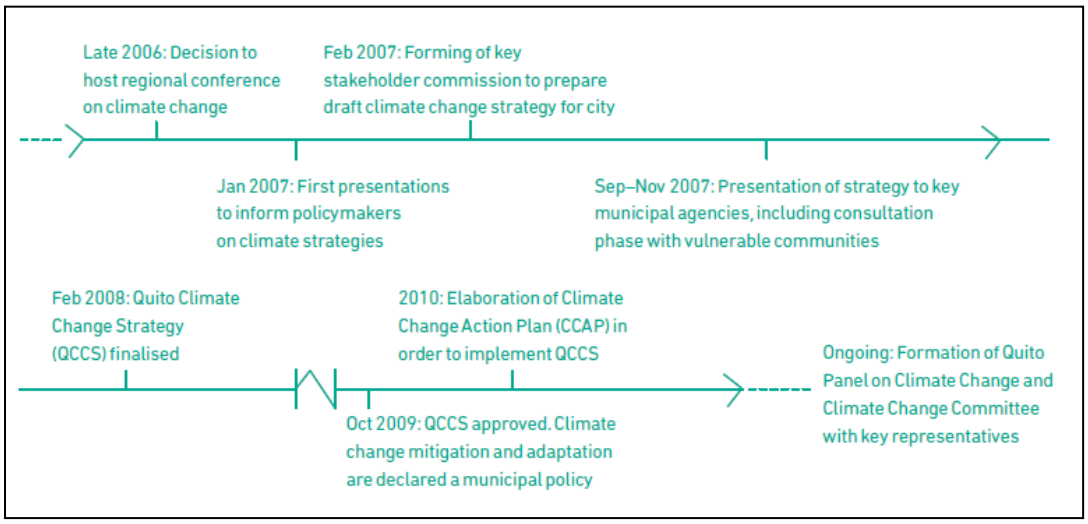

Figure 4.1: Timeline of Evolution Quito's Climate Change Strategy

Source: (ELLA: Evidence and Lessons from Latin America, n.d.)

Objectives

To develop a comprehensive and integrated policy that ensures the implementation of adaptation and mitigation measures required to address Climate Change. QCCS aims to realize this by creating appropriate methodologies and management instruments for research and provision of relevant information with effective participation of stakeholders and decision makers in the Metropolitan district of Quito.

The QCCS focuses on four strategic areas which comprises of eight strategic objectives and 25 proposed management programs

Strategic Area 1: Information, Generation and Management: Identifying and managing a relevant climate change database for vulnerability assessments and further risk management. The objectives under these are:

- Research and Information Gathering
- System of Environmental Information
- Management of Risks and Extreme Climate Events

Strategic Area 2: Use of clean technology and good environmental practices for climate change adaptation and mitigation. The objectives under this area of intervention are:

- Reduction of Emissions

- Mitigation and Adaptation

Strategic Area 3: Focus on communication, education and citizen participation. The objectives under this area are:

- Communication and Citizen Participation.
- Education: Design and implementation of education programs to sensitize the citizens to face climate change

Strategic Area 4: Strengthening institutional capacities for climate change adaptation. The objective under this objective is:

- Institutional Capacities: Aimed at including Climate Change considerations into planning and regulatory institutional frameworks.

Implementation

The Secretariat of Environment under the Municipality of the Metropolitan District of Quito is the nodal agency responsible for the overall management of the Climate Change Adaptation Strategy. Their responsibility includes effective coordination of the various stakeholders, actors and decision makers that play a role in the implementation of QCCS.

The Municipal Government is responsible for the design of the adaptation policies. The implementation and execution of these adaptation policies are further delegated to the respective concerned agencies such as Municipal Secretariats, City Agencies and Public Companies. The required Climate data and information are provided through an extensive interdisciplinary network which includes the Nation Institute of Meteorology and Hydrology, Municipal Corporation for Air Improvement and the Quito Observatory Meteorological station. The funds for the implementation of this Climate Change strategy is mainly mobilized though the city's own financial resources. Public Companies like Quito Water Supply and Sanitation Company execute their adaptation policies through the funds mobilized from the incremental levies and taxes. Further there is also a presence of International donors to complement the financial resources of the city.

Quito's action towards Climate Change adaptation and mitigation is now combined under the Quito Climate Change Strategy (QCCS) and Climate Change Action Plan (CCAP). Programs are being implemented under risk management, recovering urban forests, promoting climate resilient agriculture, water resources management and capacity building. The QCCS highlights the need to mainstreaming Climate Change adaptation at city level planning and to integrate it into the city's development strategies.

4.8.3 Climate Change Act Philippines

Owing to the location and geography of Philippines it is highly prone to rising sea levels and increased occurrence of severe tropical cyclones. In response to the projected impacts of Climate Change and with an aim to increase the climate change resilience of Philippines and to mainstream climate resilient development planning at the local level the Climate Change Act was implemented in 2009.

The Climate Change Act of 2009, states that "it is the policy of the State to afford full protection and the advancement of the right of the people to a balanced and healthful

ecology… to fulfill human needs while maintaining the quality of the natural environment for current and future generations."

This Climate Change Act also outlines the following:

- The establishment of a Climate Change Commission, which will be an autonomous body under the office of the President. It will be the sole policy-making body entrusted to coordinate monitor and evaluate the strategies and action plans of the government that addressing climate change.
- The Climate Change Commission shall comprise of the President of the Republic of Philippines serving as the Chairman of the Commission and three commissioners appointed by the President.
- Local Government Units to be in the forefront in the inception, formulation, execution and implementation of climate change action plans and strategies in their respective areas. LGUs to formulate their Local Action Plan in compliance with the local government code of conduct and the National Climate Change Action Plan.
- Mainstreaming climate resilience into government mandate across all sectors.

Structure and Implementation

The structure of Climate Change Act was envisaged to ensure that the highest political authority of the country- The President is accountable for the Climate Change Action, by making the President the Chairman of the Climate Change Commission. The Climate Change Commission also consists of three commissioners assisted by a Climate Change office, a National Panel of Technical Experts and an Advisory Board.

The Advisory Board comprises of representatives from several government agencies and local government units (LGUs), also representatives from academia, business and non-government organisations. The Act requires at least one representative from the disaster risk reduction community.

In order to monitor the implementation of the Act there also exist a Joint Congressional Oversight Committee which is composed of five senators and five house representatives.

The Climate Change Commission must submit annual progress reports to the President and to both Houses of Congress. However the Oversight Committee has the powers to request a report at any point of time.

The Framework Strategy and the Action Plan:

The Climate Change Commission has developed:

A National Framework Strategy on Climate Change in 2010- A roadmap for improving the adaptive capacity and resilience of the ecosystems and the effective utilization of mitigation and finance opportunities.

A National Climate Change Action Plan in 2011- Provides for Climate Change adaptation and mitigation action plans. Identifies the vulnerable sections of the society in the context of Climate Change and reflects on the differential impacts on women, children and marginalized section of the society. This Action plan focuses on seven target areas:

- Food Security
- Water Sufficiency

- Ecosystem and environmental Stability
- Human Security
- Sustainable Energy
- Climate Smart Industries
- Knowledge and Capacity development

The Action Plan also outlines the guidelines to be followed by the LGUs for formulating and implementing the Local Climate Change Action Plans (LCCAP) in tune to the issues and challenges faced by the local population.

The climate resilience funding for the LGUs is provided by the Commission. However the LGUs are also required to redirect a portion of their annual revenues towards climate resilient planning. Further the Government agencies need to allocate a part of their annual budget for Climate Change programs. Technical and financial support needs to be provided to the LGUs, by the Government to implement the Local Climate Change Action Plans. The Government financial institutions also required to provide LGUs with preferential loan packages for climate change action and strategies.

The Climate Change Act therefore aims to realize the need to address climate change through actions and strategies that integrate environmental, social and economic development by mainstreaming climate resilience policy across government sectors and local government units through a central nodal coordination.

Reading resources

Climate change and cities: first assessment report of the Urban Climate Change Research Network (ARC3) (2011), Cambridge University Press, Cambridge and New York. Eds Rosenzweig C., Solecki, W. D., Hammer, S. A. And Mehrotra, S. P238

Mainstreaming Climate Change Adaptation into Development Planning: A Guide for Practitioners. 2011. UNDP-UNEP Poverty-Environment Initiative.www.unpei.org.

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Rotterdam Climate Initiative 2013,Climate Proof- Rotterdam Climate Change Adaptation Strategy,Available at: http://www.rotterdamclimateinitiative.nl/en/

Rotterdam Climate Inititaitve 2007,The World Capital of CO_2 free energy, Available at: http://www.rotterdamclimateinitiative.nl/documents/021ProgRCIEngherdr.pdf

Secretriat of the Environment-of the Municipalityof the Metropolitan District of Quito 2009,Quito Climate Change Strategy,Available at: http://www.quitoambiente.gob.ec/

TERI. Policy brief on Climate Proofing Indian Cities 2013, Available at (http://www.teriin.org/policybrief/docs/Urban.pdf)

UNDP-UNEP.2011. Mainstreaming climate change adaptation into development planning-a guide for practitioners

UNDP-UNEP Poverty Environment Initiative (www.unpei.org)

5. Implementation support and finance

An important element for implementation of climate resilience projects identified by the cities would be financing. Although at present the urban infrastructure financing is carried out by various central government schemes like JNNURM, UIDSSMT, BSUP, RAY etc; since there is no clear mandate on addressing climate change, there is no means and mechanisms to fund resilience projects at an urban level.

It is however to be noted that the National Mission on Sustainable Habitat, one of the flagship missions under the National Action Plan on Climate Change (NAPCC) does recommend actions towards climate adaptation and mitigation. The Mission is yet to take off and once it starts will bring in activities for addressing climate change in cities.

The Smart Cities Scheme of the government is yet to be announced. However, it is hoped that the smart cities agenda would have climate resilience and disaster risk reduction as one of its components and will bring in mandates and funding to support climate resilience projects.

Some of the important work on financing the resilient cities has been conducted by ICLEI. The report "Financing the Resilient City: A demand driven approach to development, disaster risk reduction and climate adaptation", calls for "*mainstreaming climate and disaster risk reduction to become factors in conventional planning processes, project design and development decision making. It also recommends developing specialized financial instruments for the risk oriented components of these projects that cannot be addressed via mainstreaming measures and building local institutional capacity to prepare, structure and manage large scale redevelopment*".

Dr David Satterthwaite[11] enlists points to facilitate financing climate change adaptation in urban areas:

- Climate change funds should allow for local level action, joining the community and the local government into a jointly managed fund where the community has a choice of selecting their adaptation project.
- Banking upon the local adaptation techniques and history of adaptation that is present within the community to plan and fund adaptation projects.
- The international and national funds should target to fund local processes instead of projects
- Including climate change adaptation in the local development processes, mainstreaming
- The larger international climate funds should be working with local governments

Various international initiatives are gearing up their mandates to support local government and facilitate climate resilient development. Some of the important ones are:

1. **The City Development Initiative of India (CDIA)** [12] **-** By using innovative approaches and tools, CDIA helps the cities to identify and develop urban

[11] http://www.iied.org/8-points-financing-climate-adaptation-urban-areas

[12] https://www.giz.de/en/worldwide/14338.html

investment projects as part of their existing development plans. Emphasis is placed on one or more of the following key areas:

i. Urban environmental improvement
ii. Urban poverty reduction
iii. Climate change mitigation or adaptation
iv. Good urban governance

To facilitate these activities within the municipalities, CDIA works directly with the cities and with national organizations that support urban management. The initiative provides expertise and a range of capacity development measure, including activities in the following areas, depending on each city's needs:

i. Advice to help strengthen institutional capacities for planning and prioritizing infrastructure investments
ii. Advice on preparing pre-feasibility studies for priority infrastructure investment projects
iii. Identification of potential private sector involvement in infrastructure financing
iv. Capacity development related to municipal infrastructure investment planning
v. Advice on marketing local investment proposals to potential financiers

2. **Global resilience partnership**[13]-With an initial commitment of $150 million from the Rockefeller Foundation, USAID, and Sida the Global Resilience Partnership is building systemic approaches to addressing climate and population change. The objectives of the partnership are:

i. Identify critical capacity gaps
ii. Catalyze alliances across all sectors
iii. Enable regional and global learning
iv. Advance data-driven analytics and measurements
v. Design flexible financial mechanisms, such as micro-finance and risk insurance

3. **100 Resilient Cities Challenge**[14]**-**Pioneered by the Rockefeller Foundation (100RC) is dedicated to helping cities around the world become more resilient to the physical, social and economic challenges that are a growing part of the 21st century. 100RC supports the adoption and incorporation of a view of resilience that includes not just the shocks – earthquakes, fires, floods, etc. – but also the stresses that weaken the fabric of a city on a day to day or cyclical basis. Cities in the 100RC network are

[13] http://www.globalresiliencepartnership.org/
[14] http://www.100resilientcities.org/pages/about-us

provided with the resources necessary to develop a roadmap to resilience along four main pathways:

i. Financial and logistical guidance for establishing an innovative new position in city government, a Chief Resilience Officer, who will lead the city's resilience efforts;

ii. Expert support for development of a robust resilience strategy;

iii. Access to solutions, service providers, and partners from the private, public and NGO sectors who can help them develop and implement their resilience strategies; and

iv. Membership of a global network of member cities who can learn from and help each other.

4. **Urban Climate Change Resilience Trust Fund(UCCRTF)[15]-**

A new multi-donor trust fund, the Urban Climate Change Resilience Trust Fund (UCCRTF) has been established under the Urban Financing Partnership Facility (UFPF). The UCCRTF will help build resilience to the effects of climate variability and climate change within medium-sized cities in Asia, particularly to reduce the vulnerability of the urban poor. It will use a systems-centred approach that supports making climate change a central element of city planning. This will be linked to the implementation of infrastructure and policy or institutional interventions, as well as strong knowledge, capacity building, and networking components. All developing member countries will be eligible for UCCRTF support.

[15] http://www.adb.org/documents/establishment-urban-climate-change-resilience-trust-fund-under-ufpf

Concerned divisions / project related brief note to be included here

The Energy and Resources Institute

www. teriin.org

Appendix C- Resource persons for training program

Goa	
Challenges and opportunities for building resilience in cities – Role of political leadership Mainstreaming Climate Resilience planning into the urban development paradigm	Dr. Divya Sharma, Fellow , Sustainable Habitat Division, TERI
Climate change and its impact on cities	Ms Riya Rahiman, Research Associate, , Sustainable Habitat Division, TERI
Climate Modeling and its application in cities	Mr Saurabh Bhardwaj, Associate Fellow, Earth Sciences and Climate Change Division TERI
Risk and Vulnerability Assessment methodologies- Concepts and Application.	Mr G.K. Bhat, Director, TARU
Rehabilitation of sand dunes as an adaptation measure for arresting coastal erosion.	Dr Antonio Mascarenhas, Former Scientist, National Institute of Oceanography (NIO), Goa
Financing mechanisms for implementing urban resilience in India.	Mr. Alok Shiromani Expert, Urban Finance
Overview of TERI's activities in Goa	Ms Ashwini Pai Panandiker, Associate Fellow, TERI, Goa
Uttarakhand	
Climate change and its impact on cities	Ms Rozita Singh, Research Associate, Sustainable Habitat Division, TERI
Challenges and opportunities for building resilience in cities – Role of political leadership. Role of governance- policy and institutions for mainstreaming urban climate change resilience.	Dr. Divya Sharma, Fellow , Sustainable Habitat Division, TERI
Climate Modeling and its application in cities	Mr Saurabh Bhardwaj, Associate Fellow, Earth Sciences and Climate Change Division TERI
Application of GIS tools and techniques for better urban planning	Dr. P.K. Joshi, Professor and Head, Department of Natural Resources, TERI University
Implementation support and finance for building urban resilience	Mr. Alok Shiromani Expert, Urban Finance
Risk and vulnerability assessment methodologies- concepts and applications	Mr. Anup Karanth, Associate Director, TARU Leading Edge Ltd, Delhi
Disaster Risk Reduction in urban areas	Mr. Piyoosh Rautela, Executive Director, Department of Disaster Management, Government of Uttarakhand
Odisha	
Climate change and its impact on cities	Ms Rozita Singh, Research Associate, Sustainable Habitat Division,TERI

Database Management for Climate Resilience Planning: Case study of Panaji and Vizag	
Challenges and opportunities for building resilience in Indian cities – Role of political leadership. Role of governance- policy and institutions for mainstreaming urban climate change resilience	Dr Divya Sharma, Fellow , Sustainable Habitat Division, TERI
Introduction to climate modeling and its role in city assessments.	Mr Saurabh Bhardwaj, Associate Fellow, Earth Sciences and Climate Change Division TERI
Urban resilience planning and mainstreaming approach- Gorakhpur and Guwahati cities	Ms Raina Singh, Associate Fellow, Sustainable Habitat Division, TERI
Climate Change Impacts and Vulnerability Assessment for Coastal Orissa	Dr P K Mohanty Professor, Department of Marine Sciences, Berhampur University
Disaster Risk reduction in Urban areas	Dr. Taradatt Additional Chief Secretary, Revenue and Disaster Management Department, Government of Odisha
Integrating climate resilience into green building initiatives	Ms Sudipta Singh Project Coordinator, PMU for Energy Conservation Cell, Department of Energy, Government of Odisha
Financing mechanisms for implementing urban resilience	Mr. Alok Shiromany Urban Finance Expert
Orissa's disaster risk reduction strategy	Mr Meghnad Behera City coordinator of the climate risk management project Odisha State Disaster Management Authority (OSDMA)
Making urban services more climate resilient: The case of Bhubaneswar	Dr. Piyush Ranjan Rout, Co-Founder and Executive Director of Local Governance Network
Maharashtra	
Urban Climate Resilience: Climate Change Impacts on cities and systematic approaches to address them	Ms Riya Rahiman, Research Associate, Sustainable Habitat Division, TERI
Challenges and opportunities for building resilience in Indian cities – Role of political leadership	Ms Raina Singh, Associate Fellow Sustainable Habitat Division, TERI
Introduction to climate modeling and its role in city assessments – MMRDA case study	Ms Aditi M Phansalkar, Research Associate, TERI- Western Regional Center (WRC)

Introduction to TERI's activities in Maharashtra/ Introduction to climate modeling and its role in city assessments – MMRDA case study	Dr. Anjali Parasnis Associate Director TERI- Western Regional Center (WRC)
Role of governance- Policy and institutions for mainstreaming urban climate change resilience	Dr Divya Sharma Fellow Sustainable Habitat Division TERI
Climate resilience in building design and Urban Heat Island Effect	Ms Priya Bangle Professor Masters in Sustainable Architecture, Bharti Vidyapeeth Deemed University Pune
Financing mechanisms for implementing urban resilience	Mr. V N Alok Urban Finance Expert and Professor, Indian Institute of Public Administration
Seminar for students	
The building blocks for urban resilience: Introduction to the key theme for the seminar	Dr Divya Sharma, Fellow, Sustainable Habitat Division, TERI
Introduction to Climate Modeling	Mr Saurabh Bhardwaj, Associate Fellow, Earth Sciences and Climate Change Division, TERI
Introduction to Climate Change Science and its impact on urban areas	Dr Kamna Sachdeva, Assistant Professor, Department of Natural Sciences, TERI University
GIS techniques for city level assessments- Case studies of Panaji and Visakhapatnam	Dr P.K. Joshi, HoD and Professor, Department of Natural Sciences, TERI University
Institutionalization of climate resilience planning	Dr Arabinda Mishra, Dean and Professor, Department of Policy Studies, TERI University
Integrating climate resilience into green building initiatives	Ms Mili Majumdar, Director, Sustainable Habitat Division, TERI
Importance of building data inventories in cities- Demonstration of DBMS developed for coastal cities	Ms Rozita Singh, Research Associate, Sustainable Habitat Division, TERI
Integrating DRR into the resilience framework	Mr G Padmanabhan, Emergency Analyst and Officer in Charge DM Unit, UNDP
Financing mechanisms for implementing urban resilience	Mr. Alok Shiromany, Expert, Urban Finance
Role of communicating climate change- The climate change communication toolkit	Ms Rishika Das Roy, Project Officer, Resilience and Climate Change, BBC Media Action
Tools and Methodologies for risk and vulnerability assessments	Ms Garima Jain, Senior Associate, Indian Institute of Human Settlements
Tools and Methodologies for risk and vulnerability assessments	Mr Mahesh Rajasekar, Director, TARU

Appendix D- Program Agendas

TERI-APN's Training program on Building Urban Climate Change Resilience
22-23 January, 2015
Venue: Hotel Taj Vivanta
Panaji, Goa

Day 1		
9:00 AM – 9:30 AM	**Registration for orientation program for elected representatives**	
9:30 -9:40 AM	Introduction to half day orientation program for elected representatives	Ms Ashwini Pai Panandiker, Associate Fellow, TERI, Goa
9:40- 9:50 AM	Welcome Address	Mr Elvis Gomes, Director of Municipal Administration, Government of Goa
9:50- 10:10 AM	Inaugural Address	Mr Francis D'Souza*, Deputy Chief Minister, Goa
10:10- 10:25 AM	Key Note Address	Mr. Keval Sharma Chief Secretary , Government of Goa*
10:25-10:40 AM	Climate change and its impact on cities	Ms Riya Rahiman, Research Associate, TERI
10:40-11:00 AM	Challenges and opportunities for building resilience in cities – Role of political leadership	Dr Divya Sharma, Fellow , TERI
11:00-11:20	Screening of TERI film	
11:20-11:30 AM	Vote of Thanks	Ms Ashwini Pai Panandiker
11:30-11:45 AM	Tea Break	
11:00 - 11:45 AM	**Registration for Training program for municipal officials**	
11:45-11:55 AM	Inaugural Address	Mr Elvis Gomes, Director of Municipal Administration, Government of Goa
11:55 AM- 12:15 PM	Introduction to TERI's activities in Goa	Ms Ashwini Pai Panandiker, Associate Fellow, TERI, Goa
12:15- 12:30 PM	Climate change and its impact on cities	Ms Riya Rahiman, Fellow , TERI
12:30-12:45 PM	Climate Modeling and its application in cities	Mr Saurabh Bhardwaj, Associate Fellow, TERI
12:45 – 12:55 PM	Q&A + Discussion	
12:55-1:30 PM	Lunch	
1:30- 2:00 PM	Risk and Vulnerability Assessment methodologies- Concepts and Application	Mr G.K. Bhat, Director, TARU
2:00 – 2:10 PM	Q&A + Discussion	
2:10-3:40PM	Group Exercise & Discussion (Breakaway team exercises followed by team presentations and discussions)	
3:40-3:50 PM	Summing up for the day	

Day 2		
9:30-10:00 AM	**Registration and Tea**	
10:00 AM- 10:10 AM	Welcome note to the participants and recap of Day 1	
10:10- 10:30 AM	Guest lecture session: Rehabilitation of sand dunes as an adaptation measure for arresting coastal erosion	Dr Antonio Mascarenhas, Former Scientist, National Institute of Oceanography (NIO), Goa
10:30-10:40 AM	Q&A + Discussion	
10:40AM- 11:10 AM	Mainstreaming climate resilience planning into the urban development paradigm	Dr Divya Sharma, Fellow, TERI
11:10-11:20AM	Q&A + Discussion	
11:20- 11:50 AM	Financing mechanisms for implementing urban resilience in India	Mr. Alok Shiromany Expert, Urban Finance
11:50AM-12:00PM	Q&A + Discussion	
12:00 PM- 12:40 PM	Group Exercise & Discussion	
12:40- 1:00 PM	Closing Session (Certificate distribution and Vote of Thanks)	
1:00 PM onwards	Lunch	

*To be confirmed

Student Seminar

Building climate resilient cities: Exploring theories, practices and prospects

Venue: L001, TERI University, New Delhi

Day 1: 16 February 2015 **Theme: Concepts and Application**	
8:30 – 9:30 AM	Registration
9:30 – 9:40 AM	Welcome Address *Ms Mili Majumdar, Director, Sustainable Habitat Division, TERI*
9:40- 9:50 AM	Inaugural Address *Dr Leena Srivastava, Vice Chancellor, TERI University*
9:50 – 10:20 AM	Keynote Address *Dr Kulwant Singh, Regional Advisor, UN-HABITAT*
10:20-10:30 AM	Tea break
10:30-11:00 AM	Movie screening- 'Losing Ground Two Cities and their Tryst With the Future'
11:00-11:20 AM	The building blocks for urban resilience: Introduction to the key theme for the seminar *Dr Divya Sharma, Fellow, Sustainable Habitat Division, TERI*
11:20 – 11:40 AM	Integrating DRR into the resilience framework- *Mr G Padmanabhan, Emergency Analyst and Officer in Charge DM Unit, UNDP*
11:40 AM – 11:50 AM	Q&A + Discussion
11:50 – 12:10 PM	Introduction to Climate Change Science and its impact on urban areas *Dr Kamna Sachdeva, Assistant Professor, Department of Natural Sciences, TERI University*
12:10 – 12:20 PM	Q&A + Discussion
12:20 – 12:50 PM	Introduction to Climate Modeling *Mr Saurabh Bhardwaj, Associate Fellow, Earth Sciences and Climate Change Division, TERI*
12:50 – 1:00 PM	Q&A + Discussion
1:00 – 1:30 PM	Lunch

1:30 PM – 2:00 PM	Application of GIS techniques for city level assessments- Case studies of Panaji and Visakhapatnam *Dr P.K. Joshi, HoD and Professor, Department of Natural Sciences, TERI University*
2:00-2:10 PM	Q&A + Discussion
2:10 – 3:10 PM	Tools and Methodologies for risk and vulnerability assessments *Presentations from Ms Garima Jain, IIHS and Mr Mahesh Rajasekar, TARU*
3:10- 3:20 PM	Q&A + Discussion
3:20- 3:30 PM	Tea Break
3:30 – 5:30 PM	Group exercises
Day 2: 17 February 2015 **Theme: Mainstreaming climate resilience planning**	
09:30-09:40 AM	Registration
09:40 – 10:00 AM	Welcome and Recap
10:00-10:10 AM	Movie screening- 'Tales of Gorakhpur'
10:10 – 10:30 AM	Institutionalization of climate resilience planning *Dr Arabinda Mishra, Dean and Professor, Department of Policy Studies, TERI University*
10:30- 10:40 AM	Q&A + Discussion
10:40- 11:10 AM	Group exercise presentations to Dr Divya Sharma, Dr Kamna Sachdeva
11:10- 11:20 AM	Q&A + Discussion
11:20 – 11:30 AM	Tea Break
11:30– 11:50 AM	Integrating climate resilience into green building initiatives *Ms Mili Majumdar, Director, Sustainable Habitat Division, TERI*
11:50 AM-12:00 PM	Q&A + Discussion
12:00- 12:40 PM	Importance of building data inventories in cities- Demonstration of DBMS developed for coastal cities *Ms Rozita Singh, Research Associate, Sustainable Habitat Division, TERI*
12:40- 12:50 PM	Q&A + Discussion

12:50 PM – 1:30 PM	Lunch
1:30 – 2:00 PM	Financing mechanisms for implementing urban resilience *Mr. Alok Shiromany, Expert, Urban Finance*
2:00 PM – 2:10 PM	Q&A + Discussion
2:10 PM – 2:40 PM	Role of communicating climate change- The climate change communication toolkit *Ms Rishika Das Roy, Project Officer, Resilience and Climate Change, BBC Media Action*
2:40 – 2:50 PM	Q&A + Discussion
2:50 – 3:50 PM	Group exercise + Discussion
3:50- 4:00 PM	Tea break
4:00- 4:30 PM	Vote of Thanks- *Dr Divya Sharma* Closing session (Certificate distribution)- *Dr Arabinda Mishra*

TERI –APN- Government of Uttarakhand
Training program on Urban Climate Change Resilience
8-10 April, 2015
Venue: Hotel Pacific, Subhash Road, Dehradun

Day 1(8.4.2015)- Day long orientation program for elected representatives		
10:00 AM - 10:45 AM	Registration	
10:45 AM - 11:00 AM	Opening ceremony	
11:00 AM - 11:15 AM	Welcome address	Ms Mili Majumdar Director, Sustainable Habitat Division, TERI
11:15 AM - 11:25 AM	Inaugural Address	Mr D S Garbyal Secretary, Urban Development Department, Government of Uttarakhand
11:25 AM - 11:40 AM	Special Address	Mr Vinod Chamoli Mayor, Dehradun
11:40 AM - 12:00 PM	Keynote Address	Mr Pritam Pawar Hon'ble Minister, Urban Development
12:00 PM - 12:30 PM	Group photograph followed by High Tea	
12:30 PM - 12:45 PM	Climate change and its impact on cities	Ms Rozita Singh Research Associate, Sustainable Habitat Division, TERI
12:45 PM - 1:00 PM	Challenges and opportunities for building resilience in Indian cities – Role of political leadership	Dr Divya Sharma Fellow and Area Convener, Sustainable Habitat Division, TERI
1:00 PM - 1:15 PM	Documentary screening	
1:15 PM - 2:00 PM	Lunch	
2:00 PM - 2:30 PM	Application of GIS tools and techniques for better urban planning	Dr Sandeep Maithani Scientist, Department of Urban And Regional Studies, IIRS, Dehradun
2:30 PM - 3:00 PM	Introduction to climate modeling and its role in city assessments	Mr Saurabh Bhardwaj Associate Fellow, Earth Sciences & Climate Change Division, TERI
3:00 PM - 3:30 PM	Risk and Vulnerability Assessment methodologies- Concepts and Application	Mr Anup Karanth Director, TARU Leading Edge Pvt. Ltd., Delhi
3:30 PM - 4:00 PM	Governance and Financing mechanisms for implementing urban resilience	Mr V N Alok Coordinator, Centre for Urban Studies and Associate Professor of Public Finance Indian Institute of Public Administration, Delhi
4:00 PM - 4:15 PM	Tea	
4:15 PM - 4:45 PM	Special guest lecture on Disaster management	Mr Piyoosh Rautela Executive Director, Department of Disaster management, Government of Uttarakhand
4:45 PM - 5:00PM	Vote of Thanks and Certificate distribution	

Day 2 (9.4.2015)- Capacity Building Program for Municipal Officials		
10:00 AM - 10:30 AM	Registration	
10:30 AM - 10:45 AM	Welcome address and Introduction to the TERI-APN program, TERI's work on urban resilience	Dr Divya Sharma Fellow, Sustainable Habitat Division, TERI
10:45 AM - 11:15 AM	Special Address	Mr D S Garbyal Secretary, Urban Development Department, Government of Uttarakhand
11:15 AM - 11:30 AM	Inaugural Address	Dr V Shanmugham Additional Secretary and Director, Urban Development Department, Government of Uttarakhand
11:30 AM - 11:45 AM	High Tea	
11:45 AM - 12:15 PM	Climate change and its impact on cities: Introduction to urban climate resilience	Ms Rozita Singh Research Associate, Sustainable Habitat Division, TERI
12:15 PM - 12:45 PM	Climate Modeling and its application in cities	Mr Saurabh Bhardwaj Associate Fellow, Centre for Global Environmental Research, Earth Science and Climate Change Division, TERI
12:45 PM - 1:00 PM	Group Photograph	
1:00 PM - 1:30 PM	Lunch	
1:30 PM - 2:00 PM	Documentary screening	
2:00 PM - 2:30 PM	Implementation Support and Finance for building urban resilience	Mr Alok Shiromani Urban Finance Expert, Delhi
2:30 PM - 3:00 PM	Risk and Vulnerability Assessment methodologies- Concepts and Application	Mr Anup Karanth Associate Director, TARU Leading Edge Ltd., Delhi
3:00 PM - 4:30 PM	Group Exercise & Discussion (Breakaway team exercises followed by team presentations and discussions)	
4:30 PM - 4:40 PM	Summing up for the day and introduction to day 2	Dr Divya Sharma Fellow, Sustainable Habitat Division, TERI

Day 3 (10.4.2015)- Capacity Building Program for Municipal Officials		
10:00 AM - 10:30 AM	Registration	
10:30 AM - 11:00 AM	Application of GIS tools and techniques for better urban planning	Dr P K Joshi Professor and Head, Department of Natural Resources, TERI University
11:00 AM - 11:20 AM	Role of governance- policy and institutions for mainstreaming urban climate change resilience	Dr Divya Sharma Fellow, Sustainable Habitat, TERI
11:20 AM - 11:30 AM	TEA	
11:30 AM - 12:00 PM	Disaster Risk reduction in Urban areas	Mr Piyoosh Rautela Executive Director, Department of Disaster management, Government of Uttarakhand
12:00 PM - 12:45 PM	Group Exercise & Discussion (Breakaway team exercises followed by team presentations and discussions)	
12:45 PM - 1:00 PM	Summing up for the day and Vote of Thanks	Dr P K Joshi Professor and Head, Department of Natural Resources, TERI University
1:00 PM - 1:30 PM	Distribution of certificates and Group Photograph	
1:30 PM	Lunch	

TERI –APN
Training program on Building Urban Climate Change Resilience
20-22 April, 2015
Venue: Gopabandhu Academy of Administration, Bhubaneswar

Day 1 (20.4.2015)		
9:30 – 10:00 AM	Registration	
10:00 -10:15 AM	Welcome address and Introduction to the TERI-APN program ,TERI's work on urban resilience	Dr Divya Sharma, Fellow, Sustainable Habitat Division, The Energy and Resources Institute (TERI)
10:15-10:30 AM	Opening Address	Director, Gopabandhu Academy of Administration
10:30- 10:45 AM	Inaugural Address	Mayor, Bhubaneswar Municipal Corporation
10:45- 11:00 AM	Climate change and its impact on cities	Ms Rozita Singh, Research Associate, TERI
11:00-11:15 AM	Challenges and opportunities for building resilience in Indian cities – Role of political leadership	Dr Divya Sharma, Fellow , TERI
11:15 -11:30 AM	Tea Break	
11:30 AM – 12:10 PM	Introduction to climate modeling and its role in city assessments	Mr Saurabh Bhardwaj, Associate Fellow, Earth Sciences and Climate Change Division TERI
12:10- 12:50 PM	Climate Change Impacts and Vulnerability Assessment for Coastal Orissa	Dr P K Mohanty Professor, Department of Marine Sciences, Berhampur University
12:50- 1:00 PM	Discussion	
1:00- 2:00 PM	Lunch	
2:00-2:30 PM	Film screening- Losing Ground: climate vulnerability of two coastal cities	
2:30 - 3:15 PM	Database Management for Climate Resilience Planning: Case study of Panaji and Vizag	Ms Rozita Singh, Research Associate, TERI
3:15-3:45 PM	Disaster Risk reduction in Urban areas	Dr. Taradatt Additional Chief Secretary, Revenue and Disaster Management Department, Government of Odisha
3:45-4:00 PM	Discussion	
4:00 PM	Tea	

(*TBC)

Day 2 (21.4.2015)		
9:30 – 10:00 AM	Registration	
10:00 -10:15 AM	Welcome Address for Day 2	Director, Gopabandhu Academy of Administration
10:15- 10:30 AM	Special Address	Director, Directorate of Municipal Administration
10:30- 11:00 AM	Urban resilience planning and mainstreaming approach- Gorakhpur and Guwahati cities	Ms Raina Singh, Associate Fellow, Sustainable Habitat Division, TERI
11:00-11:20 AM	Film screening-Tales of Gorakhpur	
11:20- 11:35 AM	Tea break	
11:35 AM-12:05 PM	Integrating climate resilience into green building initiatives	Ms Sudipta Singh Project Coordinator, PMU for Energy Conservation Cell, Department of Energy, Government of Odisha
12:05-12:15 PM	Discussion	
12:15 – 1:00 PM	Financing mechanisms for implementing urban resilience	Mr. Alok Shiromany Urban Finance Expert
1:00-1:45 PM	Lunch	
1:45- 2:15 PM	Database Management for Climate Resilience Planning: Case study of Panaji and Vizag	Ms Rozita Singh, Research Associate, TERI
2:15- 3:45 PM	Group Exercise & Discussion (Breakaway team exercises)	
3:45- 4:00 PM	Summing up for the day and introduction to day 2	Dr Divya Sharma Fellow Sustainable Habitat Division TERI
4:00 PM	Tea	

Day 3 (22.4.2015)		
09:30 – 10:00 AM	Registration	
10:00- 10:45 AM	Group exercise presentations and discussions	
10:45-11:15 AM	Role of governance- policy and institutions for mainstreaming urban climate change resilience	Dr Divya Sharma, Fellow , Sustainable Habitat TERI
11:15 AM -11:30 AM	TEA	
11:30 AM-12:00 PM	Orissa's disaster risk reduction strategy	Mr Meghnad Behera City coordinator of the climate risk management project Odisha State Disaster Management Authority (OSDMA)
12:00 - 12:30 PM	Making urban services more climate resilient: The case of Bhubaneswar	Dr. Piyush Ranjan Rout, Co-Founder and Executive Director of Local Governance Network
12:30 -12:45 PM	Discussion	
12:45-1:30 PM	Lunch	
1:30-2:30 PM	Discussion and Feedback	
2:30-3:00 PM	Distribution of certificates and Group Photograph	

(*TBC)

TERI –APN- Government of Maharashtra
Training program on Urban Climate Change Resilience
18-19 May, 2015
Venue: YASHADA, PUNE

Day 1 (18.5.2015)- Orientation program for elected representatives		
10:00 – 10:30 AM	**Registration**	
10:30 -10:45 AM	Welcome address and Introduction to the TERI-APN program ,TERI's work on urban resilience	Dr. Anjali Parasnis Associate Director TERI- Western Regional Center (WRC)
10:45- 11:00 AM	Opening Address	Shri Anand Limaye, Director YASHADA
11:00- 11:15 AM	Keynote Address	Shri Ravi Budhiraja (IAS -Retired) Chairman, Maharashtra Water Resources Regulatory Authority
11:15 -11:30 AM	Special Address	Shri Dattatray Dhanakawade* Mayor Pune Municipal Corporation
11:30 – 11:45 AM	**Tea**	
11:45 AM -12:15 PM	Climate Change Impacts on cities and systematic approaches to address them	Ms Riya Rahiman, Research Associate, Sustainable Habitat Division, TERI
12:15-12:45 PM	Challenges and opportunities for building resilience in Indian cities – Role of political leadership	Ms Raina Singh, Associate Fellow Sustainable Habitat Division, TERI
12:45 – 1:15 PM	Introduction to climate modeling and its role in city assessments – MMRDA case study	Ms Aditi M Phansalkar, Research Associate, TERI- Western Regional Center (WRC)
1:15- 2:15 PM	**Lunch**	
2:15- 2:45 PM	Climate resilience in building design and Urban Heat Island Effect	Ms Priya Bangle Professor Masters in Sustainable Architecture, Bharti Vidyapeeth Deemed University Pune
2:45 - 3:15 PM	Film Screening : "Losing Ground "	

3:15 -3:45 PM	Financing mechanisms for implementing urban resilience	Mr. V N Alok Urban Finance Expert and Professor, Indian Institute of Public Administration
3:45 - 4:00 PM	**Tea**	
4:00 - 4:30 PM	Introduction to TERI's activities in Maharashtra	Dr. Anjali Parasnis Associate Director TERI- Western Regional Center (WRC)
4:30 - 4:45PM	**Vote of Thanks and Group Photograph**	

* To be confirmed

Day 2 (19.5.2015)- Capacity Building Program for Municipal Officials		
9:30 – 10:00 AM	**Registration**	
10:00 -10:15 AM	Welcome address and Introduction to the TERI-APN program ,TERI's work on resilience	Dr Divya Sharma Fellow Sustainable Habitat Division TERI
10:15- 10:30 AM	Opening Address	Shri Anand Limaye, Director, YASHADA
10:30- 10:45 AM	Special Address	Shri Kunal Kumar* Commissioner of Pune Municipal Corporation, Pune
10:45 -11:00 AM	**Tea**	
11:00 – 11:30 AM	Urban Climate Resilience: Climate Change Impacts on cities and systematic approaches to address them	Ms Riya Rahiman, Research Associate, Sustainable Habitat Division, TERI
11:30 AM-12:00 PM	Introduction to climate modeling and its role in city assessments – MMRDA case study	Dr. Anjali Parasnis Associate Director TERI- Western Regional Center (WRC)
12:00-12:30 PM	Risk and Vulnerability Assessment methodologies- Concepts and Application	Ms Raina Singh, Associate Fellow Sustainable Habitat, TERI
12:30-1:15 PM	Group Exercise 1 (Breakaway team exercises followed by team presentations and discussions)	
1:15- 2:15 PM	**Lunch**	
2:15- 2:45 PM	Climate resilience in building design and Urban Heat Island Effect	Ms Priya Bangle Professor Masters in Sustainable Architecture, Bharti Vidyapeeth Deemed University Pune
2:45- 3:15 PM	Role of governance- Policy and institutions for mainstreaming urban climate change resilience	Dr Divya Sharma Fellow Sustainable Habitat Division TERI
3:15- 3:45 PM	Financing mechanisms for implementing urban resilience	Mr. V N Alok Urban Finance Expert and Professor, Indian Institute of Public Administration
3:45-4:00 PM	Film Screening: "Tales of Gorakhpur"	
4:00 - 4:15 PM	**Tea**	
4:15- 4:45 PM	Group Exercise 2 (Breakaway team exercises followed by team presentations and discussions)	
4:45 – 5:00 PM	Feedback	
5:00 – 5:10 PM	Summing up for the day and Vote of Thanks	
5:10 – 5:30 PM	**Distribution of Certificates and Group Photograph**	

Capacity building and experience sharing for enhancing sustainability in urban India

June 3, 2015,
Juniper Hall, India Habitat Centre, New Delhi

9:30 – 10:00 AM	Registration
10:00 – 10:10 AM	Welcome Address Dr Leena Srivastava, Acting Director General, TERI
10:10-10:20 AM	Inaugural Address Shri Sanjay Kothari, Secretary, Department of Personnel and Training, Ministry of Personnel, Public Grievances and Pensions, Government of India*
10:20- 10:35 AM	Keynote Address Shri Madhusudhan Prasad, Secretary, Ministry of Urban Development (MoUD), Government of India*
10:35-10:45 AM	Background presentation- Dr Divya Sharma, Fellow, TERI
10:45-10:50 AM	Release of TERI-APN briefing paper
10:50-11:05 AM	Vote of Thanks Ms Mili Majumdar, Director, Sustainable Habitat Division, TERI
11:05-11:35 AM	Tea break
Experiences from the States	
11:35- 11:50 PM	Introduction- Dr Syamal Kumar Sarkar, Distinguished Fellow, TERI
11:50- 12:10 PM	Dr. Taradatt , Director General, Gopabandhu Academy of Administration (Former Additional Chief Secretary, Revenue and Disaster Management Department, Government of Odisha)
12:10- 12:30 PM	Mr Navneet Pandey, Additional Director, Urban Development Department, Government of Uttarakhand

** Invited*

Panel Discussion: Capacity Building Initiatives, Practices and Experiences
The discussion will focus on the current scenario and status of capacity building measures. It will derive learning from the experiences of various capacity building programs and the current set up on training and capacity building in India.
(12:30-1:30 PM)
Chair: Prof Om Prakash Mathur, Senior Fellow and Head, Urban Studies, Institute of Social Sciences

Prof V.N Alok, Coordinator, Centre for Urban Studies and Associate Professor of Public Finance, Indian Institute of Public Administration (IIPA), New Delhi Mr Nabaroon Bhattacharjee, Team Leader, PMU, CBUD project at Ministry of Urban Development (MoUD) Dr. Anil K. Gupta, Associate Professor, Head of the Policy, Planning and Cross Cutting Issues Division & Training Cell, National Institute of Disaster Management (NIDM) Ms Rupali Gupta, Subject Expert, Urban Development, State Knowledge Management Center on Climate Change, Government of Madhya Pradesh	
1:30- 2:30 PM	Lunch
Technical Session: Knowledge Sharing Practices and Innovations The session would focus on the learning and experiences of the work being undertaken in the area of developing toolkits and knowledge products aimed at sensitizing various stakeholders on issues related to urban development and climate change adaptation.	
2:30- 2:50 PM	Knowledge network activities under the Asian Cities Climate Change Resilience Network (ACCCRN) initiative Prof Usha Raghupati, National Institute of Urban Affairs (NIUA)
2:50- 3:10 PM	Training on cities and climate change- Experience with ULBs Ms Vaishali Nandan, Senior Technical Expert, GIZ
3:10- 3:30 PM	Climate Change Communication toolkit Mr Ankur Garg, Senior Programme Manager, Resilience, BBC Media Action
3:30- 3:40 PM	Experience and learning from TERI-APN's capacity building program on urban climate change resilience Ms Rozita Singh, Research Associate, Sustainable Habitat Division, TERI
3:40 PM - 4:00 PM	Discussion
4:00- 4:10 PM	Summing up and Vote of Thanks

APPENDIX E

Training program presentations

IMPACT OF CLIMATE CHANGE ON CITIES

TRAINING PROGRAM ON
URBAN CLIMATE CHANGE RESILIENCE

20-22 April 2015
Bhubaneswar

Rozita Singh
Research Associate,
Sustainable Habitat Division
The Energy and Resources Institute

Urbanisation in India

- The urban population in India grew from 286 million in 2001 to 377 million in 2011.
- Nearly 30% of the population in India is now living in the urban areas.
- It is estimated that by 2030, more than 40% of the population would be living in the urban areas.

Contents

Vulnerabilities of Cities

- Cities house
  - More than half of the world's population,
  - Trade, businesses, economic activities
  - Built assets
- Cities are the centres of economic growth generating more than 80% of the global GDP
- Urbanization and economic growth go hand in hand.
- Cities also responsible for a significant share of the GHG emissions and consequent climate change.
- Due to high concentration of people, economic activities, business, property and livelihood.

Cities will be hit hard by Climate Change

Imperative to understand the impacts of Climate Change on cities.

Direct Physical Impacts

INCREASE IN HEAVY PRECIPITATION EVENTS

Landslides

Flooding

Disruption of Traffic

Massive destruction of lives and property

INCREASE IN EXTREME HEAT EVENTS

- Increased use of mechanical means for thermal comfort and climate control.
- Increase in heat island effect.
- Effect on demand and supply of energy.
- Increased incidences of diseases.
- Lowers overall human productivity and efficiency.

SEA LEVEL RISE

- Impact on large population and crucial economic assets.
- Impact on coastal and port cities.
- Flooding of wetlands and tidal flats.
- Erosion of beaches, sedimentation of river floors in estuarine zones.
- Decreasing coastal aquifers affect fresh water supply and peri-urban agriculture.

INCREASE IN EXTREME DROUGHT AFFECTED AREAS

- Water shortages due to changes in precipitation.
- Water stress due to increased water demand
- Decline of water quality.
- Reduced food supplies.
- Raised food prices &food insecurity.
- Frequent power outages(when hydropower source of electricity)

INCREASE IN FREQUENCY AND INTENSITY OF CYCLONES

- Large scale destruction of lives, property and assets and ecosystems.
- Inundation and Power shutdowns
- Disruption of normal lives, business, and economic activities for several days.
- Heavy financial burden to bring the city back to normalcy.
- Vulnerable to the outbreak of water borne diseases.

Odisha's climate vulnerability

- Orissa is placed at the head of the Bay of Bengal where weather is formed. So even a slight change in the sea's behaviour can have an immediate impact on the coast.
- The bay becomes the centre of low pressure, bringing heavy rain and cyclones to the sub-continent, especially in Orissa.
- The state's mean daily maximum and minimum temperature is gradually rising

According to data from the weather department, in the last 50 years the state's average temperature has gone up by 1 degree. The Titilagarh and Koraput belt comprising south and west Orissa has witnessed an exceptional increase in daily maximum and minimum temperatures. Even the coastal areas have recorded high temperatures. Earlier, western Orissa was a known calamity hotspot. But now the coastal areas are also experiencing heatwaves

Past record

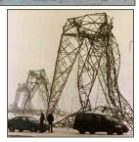
- **Floods**: Between 1834 and 1926, floods occurred at an average interval of 3.84 years. Between 1961 and 2000, floods became an annual affair.
- **Drought**: During the 1950s only three districts were drought-prone. By the 1980s, the whole of western Orissa, consisting of five districts, became drought-prone. During the 1990s, 25 of the 30 districts became drought-prone.
- **Cyclones**: During the 1970s and 1980s only two severe cyclones hit the state. During the 1990s, two severe cyclones hit the state and the number of cyclonic conditions rose. With 13 severe cyclones in the last 100 years, Orissa is the worst-affected state in India.

Source: http://infochangeindia.org/environment/features/disaster-dossier-the-impact-of-climate-change-on-orissa.html

Associated Impacts on Urban Systems

- Complex systems with extensive interlink ages.
- Impacts on a broad spectrum of city functions, infrastructure and services:
  - Impacts on economic activities
  - Impacts on physical infrastructure
  - Damage of lives and property
  - Impacts on urban poor
  - Health
  - Air Pollution
  - Nutritional issues
- Aggravates the existing stresses in the city
- Disruption of physical infrastructure impairs the functioning of the city.
- Eventually impacts living conditions, economic activities and livelihood of the city.
- Damage particularly severe in low lying coastal cities where most of the worlds' largest cities are located



Cities need to…

- Identify risks and vulnerabilities
- Tackle the impacts of climate change and direct the focus on developing climate resilient urban systems.
- Consider both current and future climate risks as well as other likely changes in the urban environment for climate resilient urban planning

THANK YOU

CHALLENGES AND OPPORTUNITIES FOR BUILDING RESILIENCE IN CITIES- ROLE OF POLITICAL LEADERSHIP

TERI-APN TRAINING PROGRAM ON
BUILDING URBAN CLIMATE CHANGE RESILIENCE
20-22 APRIL 2015
BHUBANESWAR, ODISHA

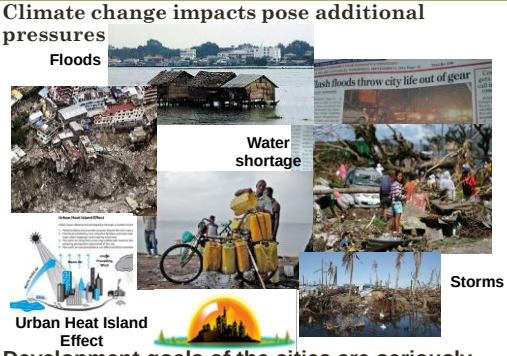
Faculty
Dr Divya Sharma
Fellow and Area Convener
Center for Research on Sustainable Urban Development and Transport Systems
Sustainable Habitat Division
TERI

- Recent calamities in India have drawn attention not only towards the great damage climate events can instill on settlements but also towards the uncertain climate conditions that might await us in near future

- Urban development has assumed important position in national agenda given the growth rate and increasing GDP contribution of the urban centers to nation's economy.

- However, the nature of urban development so far is not only putting pressure on the resources but is also oblivious of climatic factors, thus impacting the environment negatively

Climate change impacts pose additional pressures



Development goals of the cities are seriously undermined by climate change impacts

- There is a strong need therefore, to incorporate climate resilience considerations into
  - City systems (Infrastructure, services, sectors)
  - City planning (Development norms, land-use planning)

Resilient cities in the light of climate change should be able to develop plans for future development and growth bearing in mind the climate impacts that the urban systems are likely to face*.

Climate resilience is not about development in new way.

It is about adding climate variability and change considerations in the planning and development framework to ensure long term sustainability and preparedness to climate change

Cities across the world are engaging in planning for climate resilience……..

…….transforming their systems to address climate variability and change without compromising on present development challenges

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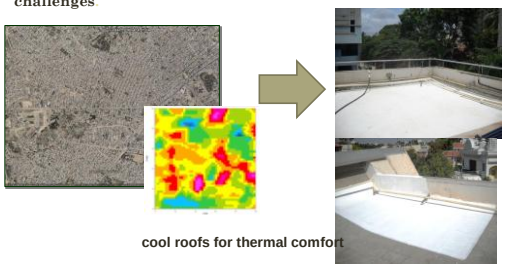


Cities across the world are engaging in planning for climate resilience.....

.....transforming their systems to address climate variability and change without compromising on present development challenges.

How are climate resilient cities different or better?

- Climate resilient cities have the capability to reduce and manage the negative impacts of climate change because they have planned and factored these changes in their development goals and planning by:
  - Utilizing climate information (past and future) to identify climate stressors typical to their cities/region
  - Preparing and implementing strategies to reduce vulnerability of population and city systems.
  - Adapting to change, preparing and responding to disasters, mitigating GHG emissions

Responding to Climate Change : From Reactive to Proactive Action

Reactive (driven by actual perceived climate variability) → Proactive (driven by climate forecasting / future scenarios)

Disaster mitigation/ response (post extreme event)	Disaster preparedness measures (based on current variability)	"Climate proofing" at project level	Mainstreaming climate forecasts into sectoral policies and processes	Strategic multi-stakeholder adaptation and mitigation planning
Key actors:				
Households, CBOs, aid/relief organizations	Private developers, insurers, development NGOs	Sectoral agencies (environment, water, housing, etc.)		Centralized unit ("climate czar") with strategic planning authority

- Key steps:
  - Urban profiling
  - Identification of current and future climate stressors
  - Understanding risks and vulnerabilities
  - Identification of strategies to reduce vulnerability and manage risks- develop resilience
  - Steering governance processes, regulations and institutions for long term benefits
  - Locating finance
  - Involving community throughout

How to plan for climate resilient cities? Are there general rules to follow?

Indian cities planning for resilience

- **Surat, Indore , Gorakhpur , Guwahati, Shimla, Mysore, Bhubaneswar under ACCCRN**
- **Kanpur and Meerut under WWF initiative**
- **Delhi and Mumbai under Clinton Foundation Initiative**
- **Climate roadmaps for 41 Indian cities supported by ICLEI-SA**

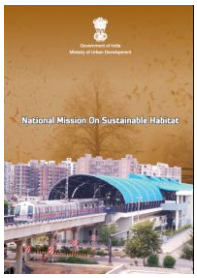
International Programs supporting Resilience

- Asian Cities Climate Change Resilience Network
- Cities Development Initiative of Asia
- UNHABITAT's cities and climate change initiative
- Rockefeller Foundation's recent 100 resilient cities program
- USAID's Climate Change Resilient Development(CCRD) program have been working towards addressing knowledge gaps with improved mechanisms to support cities to be climate resilient.
- Global Resilience partnership
- ADB's Urban Climate Change Resilience Partnership(UCCRP)

.....to name a few

National Programs –existing and Future opportunity

- National and state level:
  - National Mission on Sustainable Habitat
  - State action plan on climate change
  - National schemes like UIDSSMT,RAY, BSUPS
  - Smart cities program
- Local level
  - Master planning process
  - District disaster management plans
  - Zoning regulations/ building bye laws
  - CDPs/ DPRs



Challenges

- Lack of understanding of the impacts of climate change and the fact that adaptation interventions are best employed and covered at local level.
- Creating awareness amongst the local government that adaptation is synonym to their functions and their development goals
- Already pressing development pressures might overlook adaptation issues
- Integrating adaptation at municipal level would be difficult because of the perception of contest for budget.
- Lack of capacity within the local government .
- Development plans of cities do not factor climate change related factors in a targeted way.
- Translation of global impacts of climate change to local level (downscaling) has been missing
- Lack of data and modeling framework at the city level

Need for a robust 'Institutional Policy Arena' To be made available to support city resilience building

Key Enablers

- **Policy and mandate** at national and state level
- **Integration of climate agenda** with city development agenda
- **Institutionalization** of urban climate resilience planning.
- **Strong Political leadership** at local and state level
- Use and involvement of **local expertise** to generate context specific locally driven solutions
- **Capacity building** and awareness generation to generate momentum and facilitate action at all levels
- **Access to knowledge** on climate variability and change
- **Data management** and updating to facilitate decision making

Thank You for Joining

Contact : divyas@teri.res.in

Climate Change Modelling:

BASICS AND CASE STUDIES

TERI-APN's Training program on building Urban Climate Change Resilience

20th – 22nd April, 2015

Bhubaneswar

Saurabh Bhardwaj
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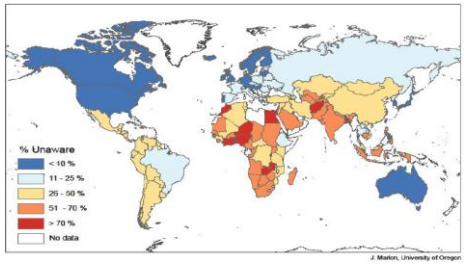
Earth Science & Climate Change Division
TERI
saurabh.bhardwaj@teri.res.in

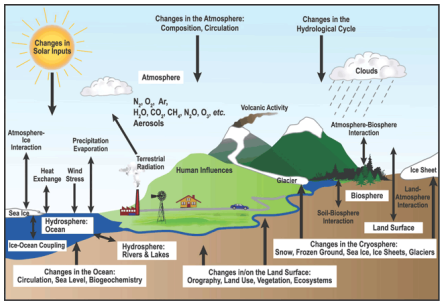
"Unaware" of Climate Change

"How much do you know about global warming or climate change?"
(*I've never heard of it; don't know; refused*)
n = 269,913 in 132 countries (2007-2009)



Leiserowitz (2011)

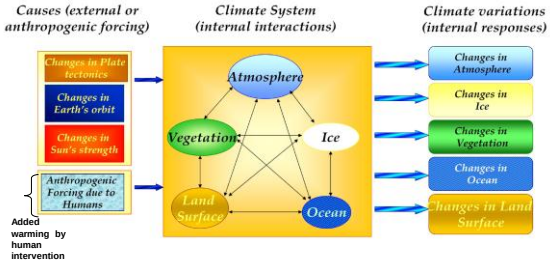
Interactions



The non-linear interaction among the components leads to climate variability at a range of spatial and temporal scales

Pic . NOAA

Review of Basics: Climate System



The non-linear interaction among the components leads to climate variability at a range of spatial and temporal scales

How do we quantify the response of the climate?

- The response of the climate system to this forcing agents is complicated by:
  - feedbacks
  - the non-linearity of many processes
  - different response times of the different components to a given perturbation
- The only means available to calculate the response is by using numerical models of the climate system.

What is a Model ?

"a simplified description, esp. a mathematical one, of a system or process, to assist calculations and predictions"

- dictionary

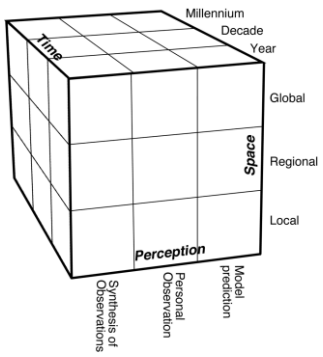
How do we define a Climate Model ?

"A climate model is a mathematical representation of the physical processes that determine climate"

Why do we need Climate Models ?

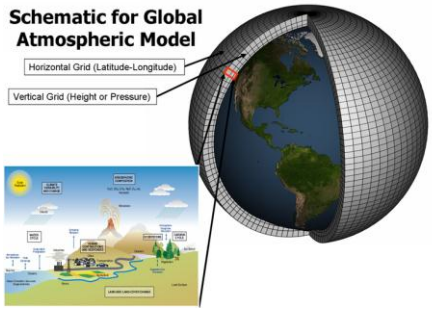
- **To create an understanding of the climate processes.**
- **To create plausible-scenarios, reflecting the current state of scientific understanding.**
- **To plan for the future.**

The Climate Cube



McGuffie, K. and Henderson-Sellers, A. (2005) A Climate Modelling Primer. 3rd ed., Wiley.

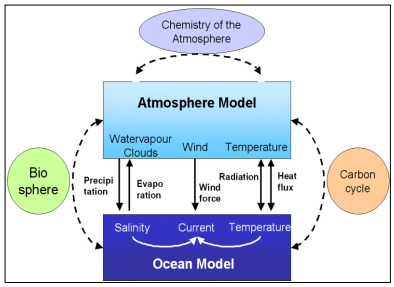
Numerical Solution: Time steps and Grid boxes



All the physical processes occurring in the climate system are resolved at individual grid and the coupling occurs at these grids.

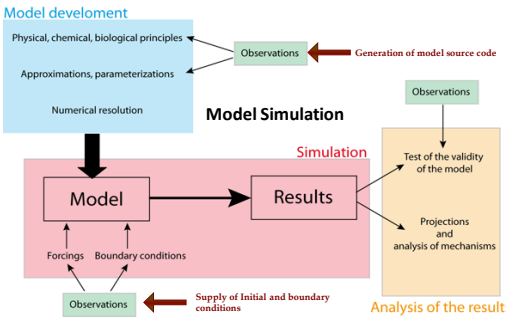
Source: NASA

Framework for a Model



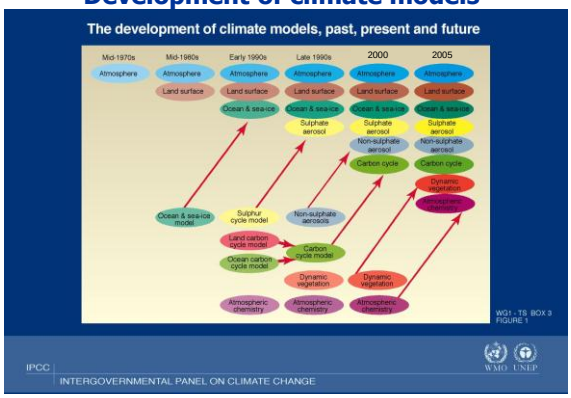
Source: MPI, Germany

Process of Model Simulation



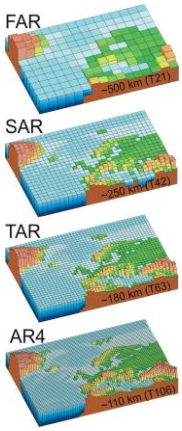
Source: Goosse et al 2010

Development of climate models

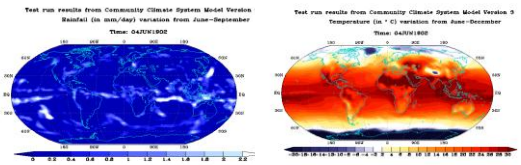


Improvements in Grid resolution

- The evaluation of the Climate models has become an essential pre-requisite to understand the Earth's climate system
- A Model Inter-comparison Project is an approach to model verification and they are part of community analysis and verification/activity.
- Intergovernmental Panel for Climate Change has started its MIP programs with Atmospheric Models in 1995 till today with CMIP (Coupled Ocean Atmospheric Models).



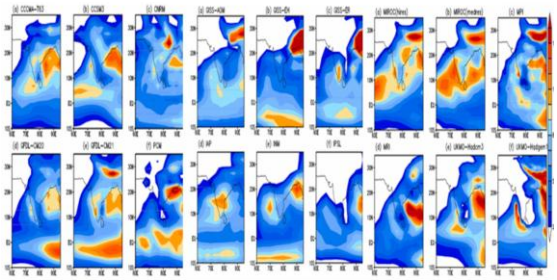
Simulations using a Global Coupled Model:



The simulations of a model should be comparable to the observations, this step is called as Validation of the model outputs

Source: TERI (2011)

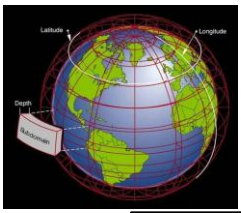
Need for Regional Climate Modeling Tool



Most of AR4 coupled models even with high spatial resolution of 110km x 110km were unable to represent the mean monsoon pattern similar to observations.

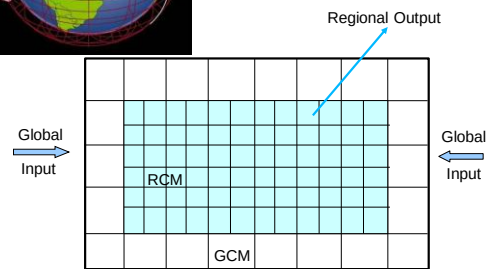
Downscaling from GCMs

- **Downscaling is a way to obtain higher spatial resolution output based on GCMs.**
- **Options include:**
  - **Combine low-resolution monthly GCM output with high-resolution observations**
  - **Use statistical downscaling**
    - **Easier to apply**
    - **Assumes fixed relationships across spatial scales**
  - **Use regional climate models (RCMs)**
    - **High resolution**
    - **Capture more complexity**
    - **Limited applications**
    - **Computationally very demanding**



Downscaling

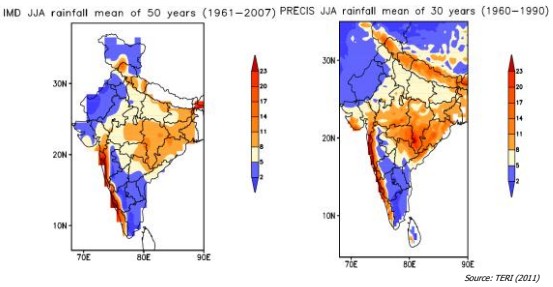
Dynamical Downscaling



Regional Climate Models (RCMs)

- **These are high resolution models that are "nested" within GCMs**
- **A common grid resolution is 50 km or lesser.**
- **RCMs are run with boundary conditions from GCMs**
- **They give much higher resolution output than GCMs**
- **Hence, much greater sensitivity to smaller scale factors such as mountains, lakes**

Regional Modelling Product

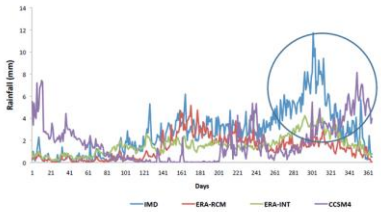


Source: TERI (2011)

RCM is able to capture the major features but overestimates the rainfall in few regions.

Lack of observations: poor model result

Observed rainfall climatology compared with IPRC_RegCM over peninsular India

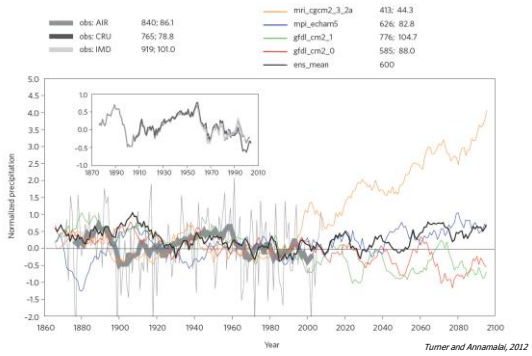


Reanalysis – temporal variability of atmospheric states and internal variability preserved – yet, results are not encouraging

Monsoon region – lack of 3-D moisture observations – severe constraint

Annamalai, 2012

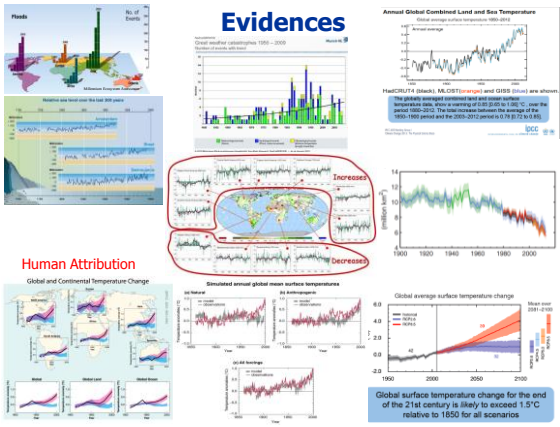
Uncertainties in Observation and Models



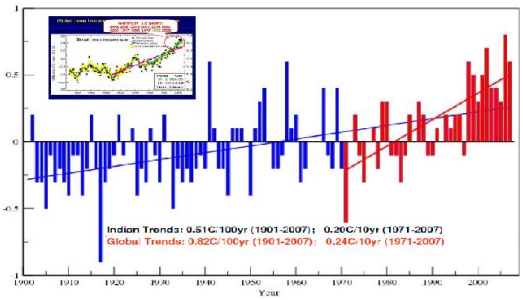
Turner and Annamalai, 2012

Climate Modelling: Global to Regional

Evidences

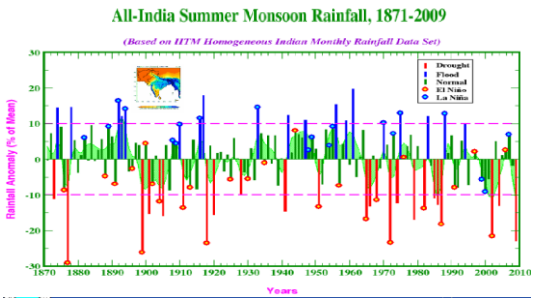


All India Mean Annual Temperature Anomalies (1901-2007) (Base: 1961-1990)

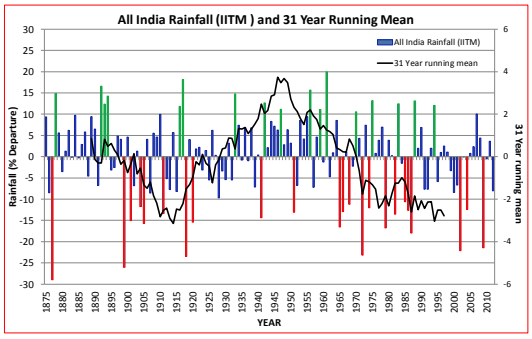


Krishna Kumar, 2009

Observed variability in India's Monsoonal Climate



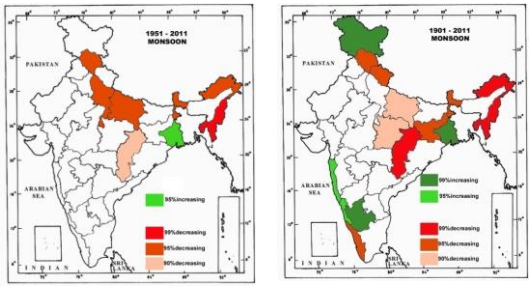
Krishna Kumar, 2009



All-India monsoon season rainfall time series shows NO long term trends. It is marked by large year to year variations. There is a tendency of occurrence of more droughts in some epochs (for example, 1901-1930, 1961-1990).

Rajeevan, 2013

Regional Rainfall Trends



Guhathakurta et al. 2014, Int J. Climatology

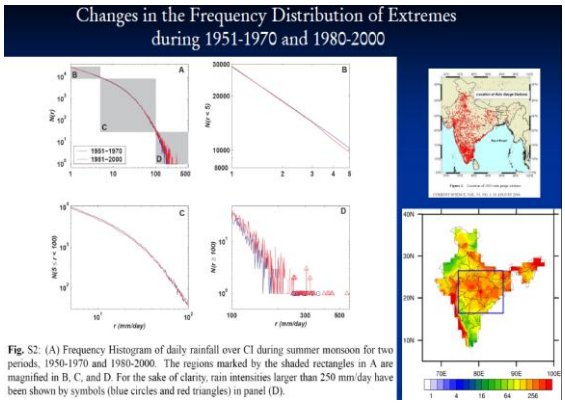
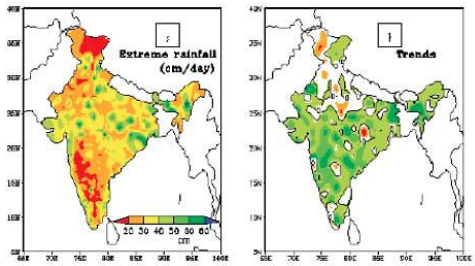


Fig. S2: (A) Frequency Histogram of daily rainfall over CI during summer monsoon for two periods, 1950-1970 and 1980-2000. The regions marked by the shaded rectangles in A are magnified in B, C, and D. For the sake of clarity, rain intensities larger than 250 mm/day have been shown by symbols (blue circles and red triangles) in panel (D).

Goswami et al., 2006

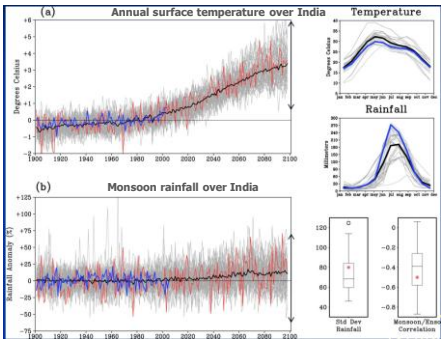
Rainfall Extremes and Trends for 1951-2004



MoEF, 2010

PROJECTIONS

Simulations over India for the 1901–2098 period



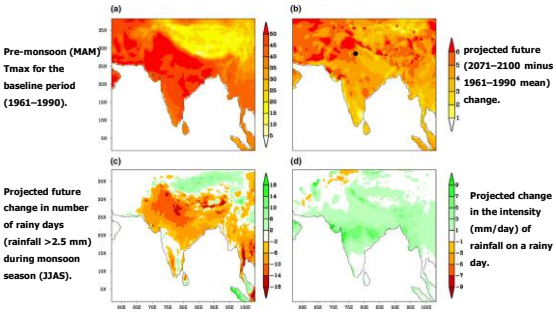
Annual cycle of temperature and rainfall over India

Standard deviation (mm) and monsoon-ENSO correlation, for the observational (1901–2000) period

The grey lines indicate the ensemble, the black line is the ensemble mean and the blue line is the observed. The red line is the ensemble member corresponding to the Hadley Center coupled model.

Krishna Kumar et al., 2009

Projected changes in daily maximum temperature and daily rainfall



Pre-monsoon (MAM) Tmax for the baseline period (1961–1990).

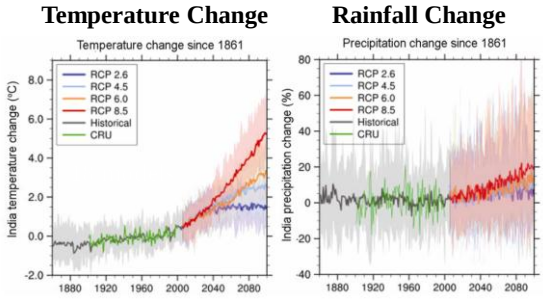
projected future (2071–2100 minus 1961–1990 mean) change.

Projected future change in number of rainy days (rainfall >2.5 mm) during monsoon season (JJAS).

Projected change in the intensity (mm/day) of rainfall on a rainy day.

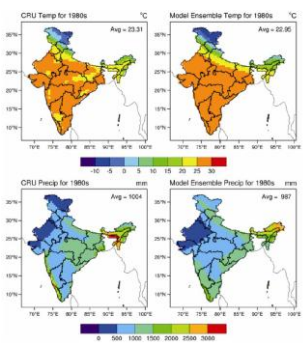
Krishna Kumar et al., 2009

CMIP5 projections for India



Chaturvedi etal. 2012, Current Science

But how good are the models?



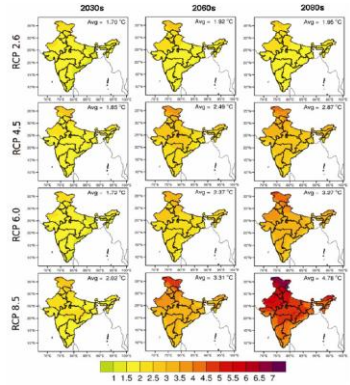
Observations Versus Ensemble mean for 1971-1990

Temperature

Rainfall

Chaturvedi etal. 2012, Current Science

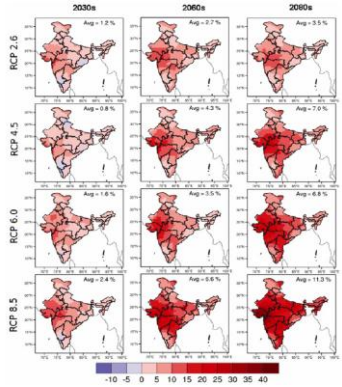
Clear indication of Warming



Ensemble mean from 18 models

Chaturvedi etal. 2012, Current Science

% change in rainfall

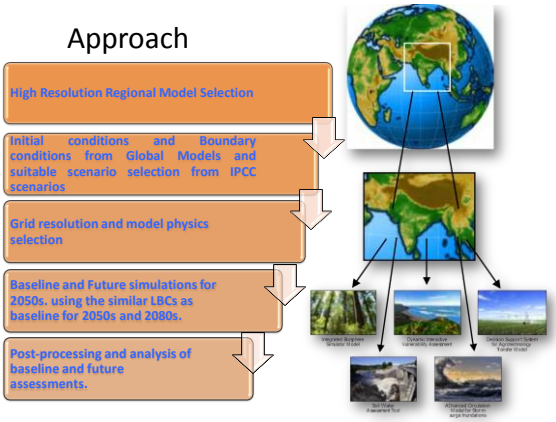


Ensemble mean from 18 models

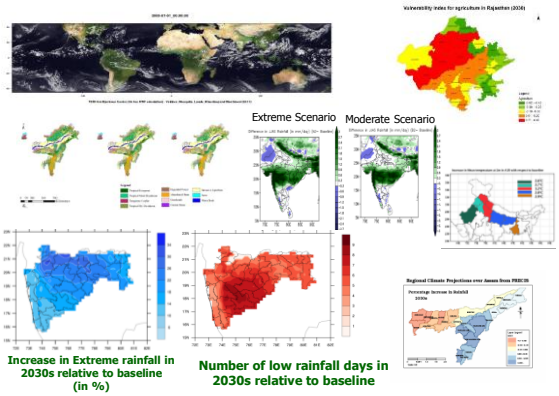
Chaturvedi etal. 2012, Current Science

Modelling Products and Case studies

Approach



Modelling Products/Services

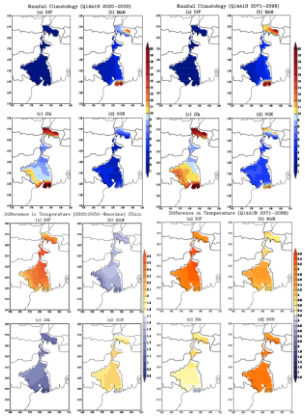


Increase in Extreme rainfall in 2030s relative to baseline (in %)

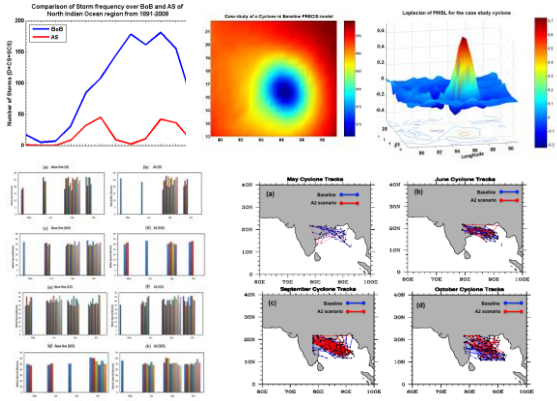
Number of low rainfall days in 2030s relative to baseline

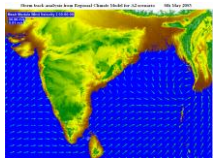
Coastal vulnerability assessment and strategies for better preparedness towards impacts of climate change and sea level rise:

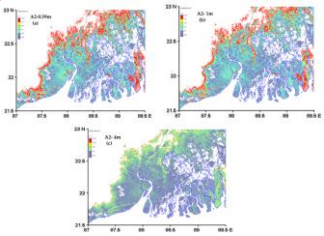
State of West Bengal



Rainfall and Temperature (Future) A1B scenario

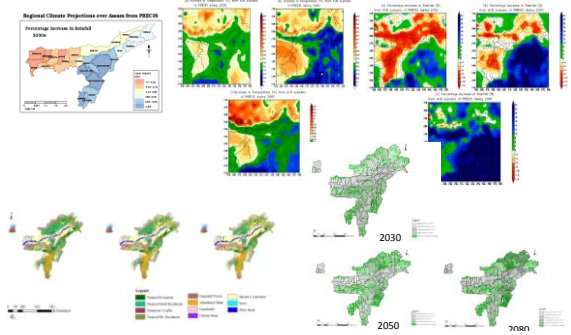




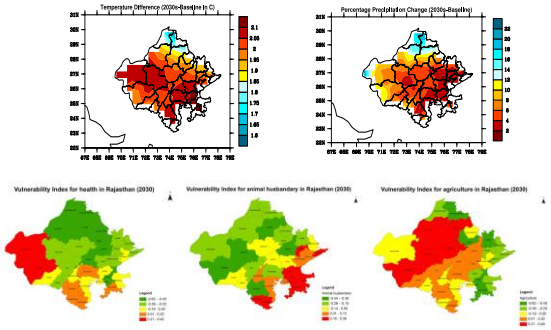


Storm Surge Modelling

An integrated impacts and vulnerabilities assessment of communities dependent on forest resources for livelihoods (NER-India)



Rajasthan Vulnerability Assessment



UNEP Global Environmental Alert Service (GEAS)

Taking the pulse of the planet; connecting science with policy

UNEP

Website: www.unep.org/geas E-mail: geas@unep.org

November 2013 | Home | Subscribe | Archive

Thematic focus: Environmental governance, Disasters and conflicts

Cyclone Phailin in India: Early warning and timely actions saved lives

Forecast on Cyclone Phailin was "more or less" accurate: IMD

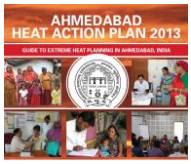
PTI Oct 13, 2013, 02.10PM IST

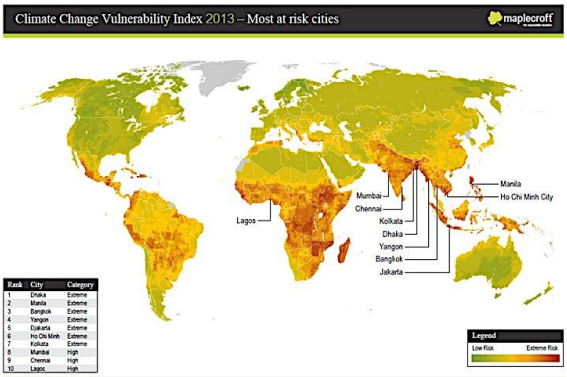
PM's address at 101st Indian Science Congress in Jammu

"Our advances in meteorology were evident during the recent cyclone in Odisha, when we received accurate forecasts of the landfall point that were more accurate than the forecasts of well known international bodies. Our decision to set up a new Ministry of Earth Sciences following the Indian Ocean Tsunami in 2004 and to invest in world-class tsunami forewarning systems in 2007 has been amply rewarded. We now have the ability to issue alerts within 13 minutes of a tsunami-genic event. This has established India's scientific leadership in the Indian Ocean region.

I would also like to see continuous improvement in our monsoon prediction capability through the recently launched Monsoon Mission so that we avert the kind of calamities that we saw in Uttarakhand last year. "

Source-IMD

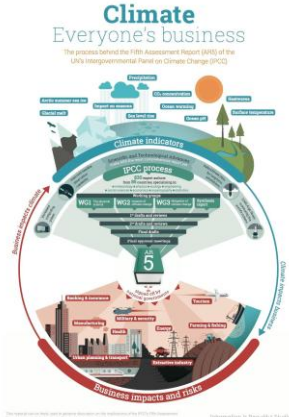




Rank	City	Category
1	Dhaka	Extreme
2	Manila	Extreme
3	Bangkok	Extreme
4	Yangon	Extreme
5	Djakarta	Extreme
6	Ho Chi Minh	Extreme
7	Kolkata	Extreme
8	Mumbai	High
9	Chennai	High
10	Lagos	High

Thank you

saurabh.bhardwaj@teri.res.in



Urban resilience planning and mainstreaming approach:

Gorakhpur and Guwahati cities

Bhubaneswar
21st April, 2015

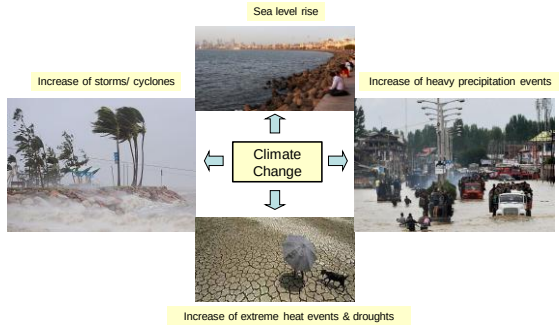
Raina Singh
Associate Fellow,
Sustainable Habitat Division, TERI

Urban resilience planning - Why and How?

Structure of the session

1. Urban resilience planning – Why and How?
2. Examples of Planning tools for building climate resilience
3. Case studies – Guwahati and Gorakhpur cities

Climate change and Cities



Urbanization and climate risk – Why does it matter?

Urban areas are concentration of large population, economies, infrastructure: central to growth of the nation or the region

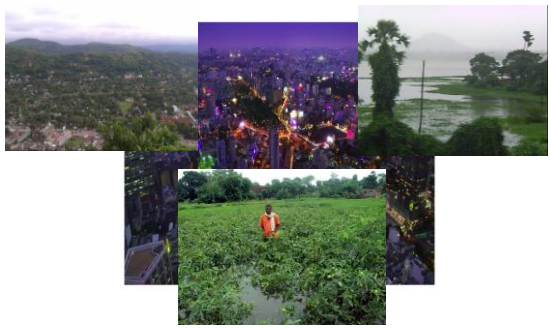
Urban areas are growing at an unprecedented rate - often unplanned and unregulated on vulnerable land, prone to hazards

Over 50% of India's GDP is derived from cities - Climate change impacts can wipe out development gains and significantly reduce quality of life

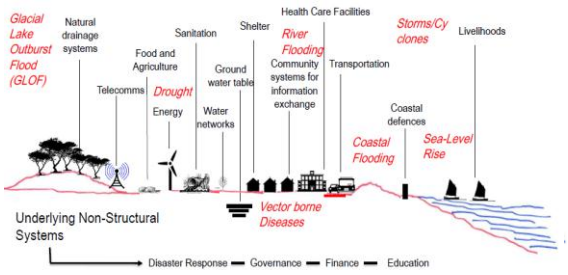
Climate related Disasters cost an estimated $370 billon USD globally in 2011 (80 per cent of this was in Asia alone)

Associated social costs - Vulnerable groups are the most affected

But what is 'Urban'?



The Urban System



Climate Change and Natural Hazards

How to climate proof cities

- Strengthening the adaptive capacity
- Reducing the vulnerability of the urban system against climate change
- Developing strategies and policy instruments for building resilience of our cities
  - **Sensitized planning and management practices – climate resilience on agenda**
  - **Long term resilience building – integrated approach to sector wise climate change adaptation**
  - **Ensuring flow of planned investments for climate resilience**

Development challenges for cities

In-migration, unplanned growth and urban sprawl

Inadequate infrastructure and limited access to:

- Housing
- Basic services
- Employment opportunities

Marginalization of vulnerable groups

Environmental Degradation

Poor quality of life

Limited resources and capacities of city governments

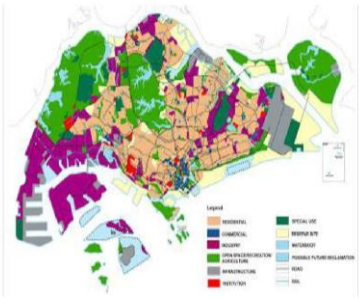
Source:Francesco Terzini Flickr Creative Commons

Urban Resilience Planning for Climate Risk Management: Approach

Video: Its time to take actions now!

Examples of Planning tools for building climate resilience

Regulatory Tools – Land use plans



Source: Government of Singapore, online database

- Legal spatial policy which designates use of land, typically by:
  - Residential
  - Commercial
  - Industrial
  - Governmental
  - Infrastructure
  - Green/Open Space
  - Mixed Use
- The function of land can be limited due to characteristics related to risk or other geographic features
- Can be limited in dynamic settings

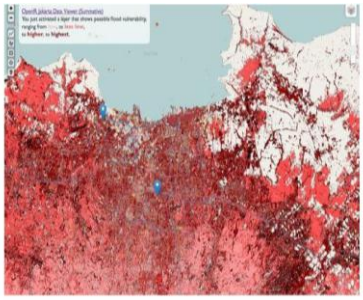
Regulatory Tools – Building codes

Source ADPC database

- Ensure that new development does not occur unless structures are designed and built to withstand the impact of hazards.
- Can be implemented at various levels.
  - Ward
  - City-wide
  - Provincial/State
  - National
- Many are hazard specific but some regulations can provide support from various hazard

Restriction Tools – Transfer of Development Rights

- The transfer of a property's development potential under current zoning provisions from one site or property to another.
- The development potential can be relocated to another area of land or parcel not at risk.
- Usually requires a cost-benefit analysis from the local government and developer



Source Jakarta city, Online database

Natural Protection Tools - Mangroves and Wetland Creation/Restoration

- The natural functions of wetlands and mangroves create a buffer to reduce wave energy, which can greatly reduce the impact of cyclones, storm surge, and flooding
- Planting trees or other vegetation that can withstand high-speed wind from cyclones and other storms.
- Less of a negative impact on environment when compared to "hard" engineering solutions
- Also fosters biodiversity and can contribute to livelihood development

Source: IFRC, Vietnam

Natural Protection Tools – Dune building and rehabilitation

- Enriching natural sand dunes provide an effective defense against coastal erosion and flooding by dissipating floodwaters from coastal or riverrine sources.
- Less of a negative impact on environment when compared to "hard" engineering solutions
- Can be difficult to implement in areas that thrive on beach front development, notably for tourism

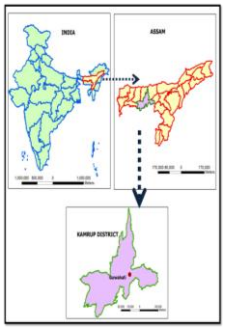
Source: Landscape Urbanism

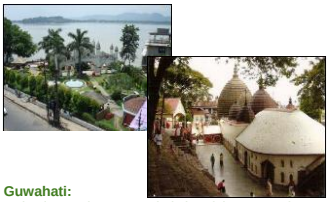
Case Studies

Case study

- Project on "Risk Assessment and Review of Prevailing Laws, Standards, Policies and Programs to Climate Proof Cities"
- Part of the Rockefeller Foundation's Asian Cities Climate Change Resilience Network
- Goals:
  - **Assess risk** of the city to climate change impacts
  - Review the **regulatory environment** and
  - Suggest **resilience measures** and ways to **integrate them into city planning – City Resilience Strategy**
- Study cities- Gorakhpur (UP) and Guwahati(Assam)

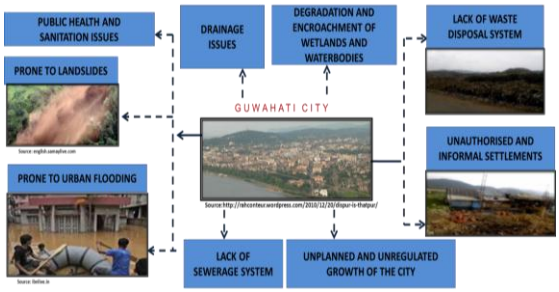
Guwahati





Guwahati:
Twin city to Dispur - Capital city of the State of Assam
Population – 11.9 lacs (UA area, 2011)
Location- 26^{0}10′ N and 92^0 49′ E, on the banks of the Brahmaputra River
Undulating topography
District HQ for Kamrup Metropolitan Distt
JnNURM city

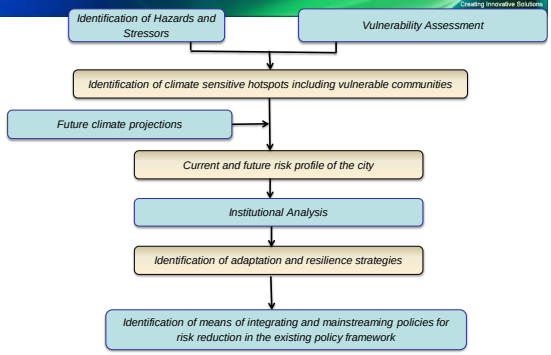
Guwahati – Risks and Challenges



TERI's Approach to Resilience Strategy

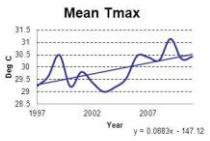
- What are the critical assets in the city which might be at risk due to flooding or any other disasters?
- What are the sectors impacted by the 'future and current risks'?
- Which are the vulnerable class subjected critically to risks?
- What are the governance parameters that can help build resilience?

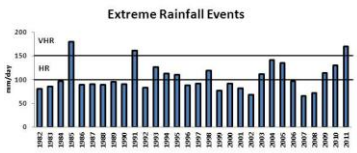
Framework for Risk Assessment

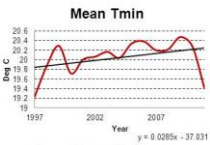


Climatic stressors – Past trends

- Increasing trend for both maximum and minimum temperature for Guwahati city
- Decreasing trend seen in seasonal mean rainfall for monsoon months over Guwahati
- Increase in extreme rainfall events especially in the last decade



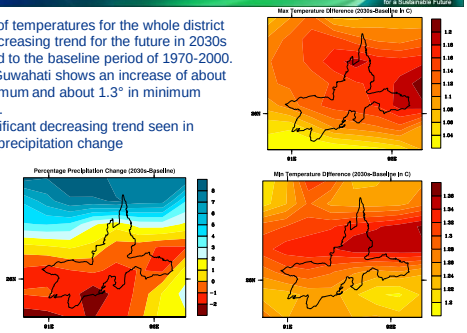




Source: Regional Meteorological Centre, Guwahati

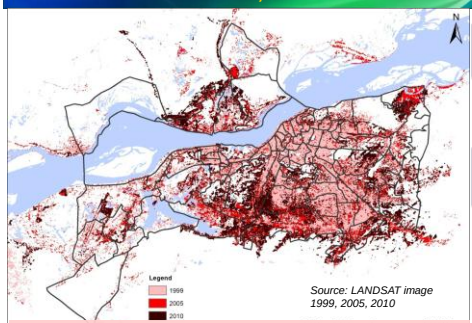
Climatic stressors - Future Projections A1B scenario for 2030s

- Projections of temperatures for the whole district shows an increasing trend for the future in 2030s as compared to the baseline period of 1970-2000.
- The city of Guwahati shows an increase of about 1.2° in maximum and about 1.3° in minimum temperature.
- Slight insignificant decreasing trend seen in percentage precipitation change



Regional model simulations at 25kmX25km resolution carried over the Kamrup district using PRECIS

Non-climatic stressors - Urbanization trend, 1999-2010



Source: LANDSAT image 1999, 2005, 2010

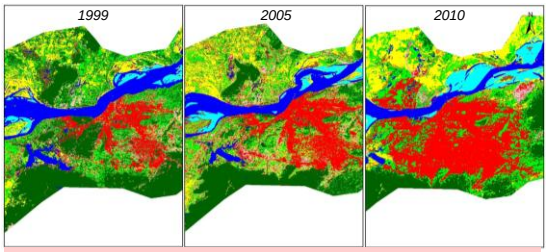
1991 Population: 646,169

2001 Population: 890,773

2011 Population: 1,193,429

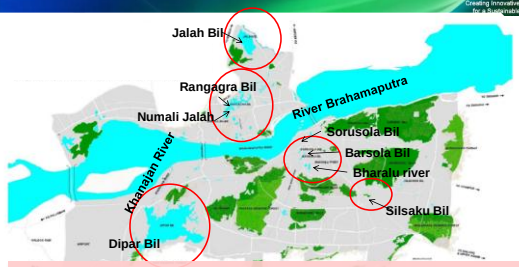
Rapid increase in population and spatial extent (built-up) of the city

Non-climatic stressors – Land Use Land Cover Changes, 1999-2010



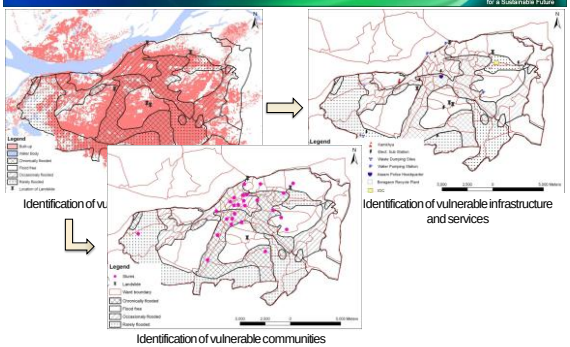
- *Conversion of sparse built-up into dense built-up*
- *Emergence of pockets of sparse built-up*
- *Northern part of the river has emerged as a new built-up in year 2010.*
- *Decrease in extent of dense forest and conversion of dense to sparse forest*

Implications on the urban ecosystem



- *Encroachment of significant natural features like natural wetlands (Bils), watershed areas and hills.*
- *Hill cutting in fragile hilly areas which are not fit for development.*
- *Unplanned and unregulated expansion of the city, especially on hills has added to the vulnerability of the city. 90% of the landslides occur in these areas*

Guwahati: Vulnerability to floods & landslides



Identification of vu

Identification of vulnerable infrastructure and services

Identification of vulnerable communities

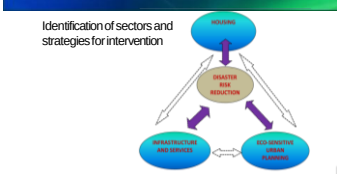
Non-climatic stressors – Inadequate and inefficient urban services

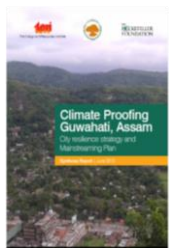
- **Inadequate capacity of existing drainage and sewerage systems**
- **Siltation, solid waste**
- **Marginalization of informal settlements and slums while urban planning and service provision**
- **Inadequate pubic health management – lack of resources and infrastructure**
- **Low emergency response capacity**

Implication - Increased incidence of Urban Floods, Epidemics & Landslides

Guwahati City Resilience Strategy

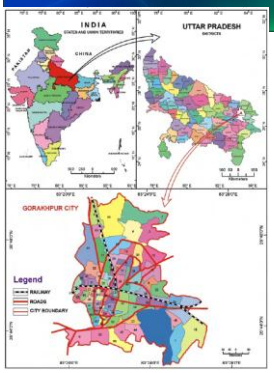
Identification of sectors and strategies for intervention





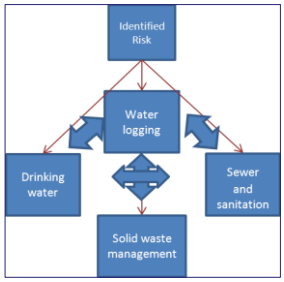
Identification of entry-points for implementation through Institutional and Policy Analysis

Gorakhpur



Gorakhpur:
Medium sized city in the State of Uttar Pradesh
Population -692,519 (UA area, 2011)
Location- 26° 45' N and 83° 24' E
Height- 80m above sea level
Set in the foothills of the Himalayas, at the convergence of two rivers 'Rapti' and 'Rohin'.

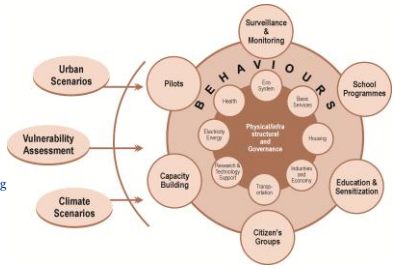
Gorakhpur - Identified Risk



- Water logging is the prime risk for the city and would accentuated in the climate change scenario.
- The other 3 risks either have causal relationship with the occurrence of water logging or are impacted severely by the water logging problem.
- They become an essential components while addressing the overall problem of water logging in the city with climate change scenario or without climate change scenario.

Gorakhpur City Resilience Strategy (CRS)

- City Resilience Strategy prepared by Gorakhpur Environment Action Group with support from The Rockefeller Foundation under ACCCRN
- Targeted physical and institutional actions to improve drainage, housing, health and communications systems
- Calls for information, data and knowledge focused activities to establish the evidence base required for long term planning
- An evolutionary resilience strategy
- Focuses on capacity building



Challenges in CRS implementation

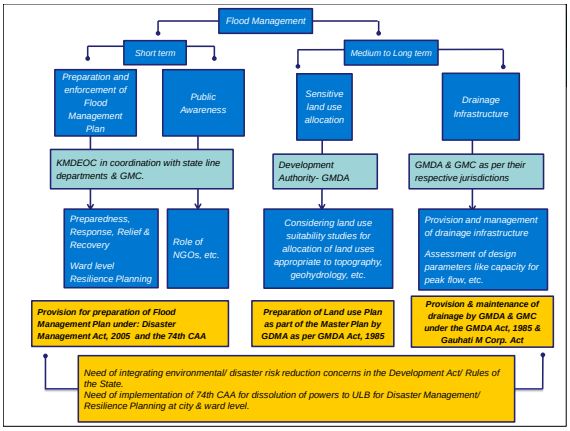
- The CRS identified climate resilience projects. Selected projects funded by the Rockefeller foundation
- Most part of the strategy remained shelved in the absence of any regulatory or policy backing and as a result could not be integrated in the formal urban planning and development framework nor could all the projects/strategies be channelized to any funding
- Current vulnerability too pronounced – difficult for city managers to take precautionary approach to future vulnerabilities
- Lack of awareness and capacity at city level to address its vulnerabilities
- Lack of funds at city and state level to address basic infrastructure related issues

TERI's Action Plan for CRS implementation

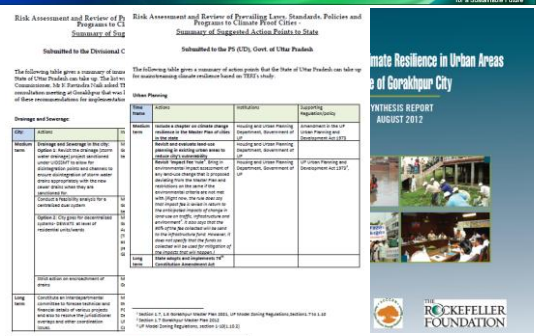
1. **Analytical Review of Secondary literature**
   - Resilience strategy
   - Vulnerability Report
   - Geohydrology study
   - Includes:
     - Climate analysis
     - Risk
     - Vulnerability
     - Resilience options
2. **Review of institutions and regulatory environment**
   - Review of state and city level regulations
   - Institutional assessment
   - Stakeholder consultation at Gorakhpur
   - Consultation with GEAG team
3. **TERI's Action plan to help implement resilience strategy**
   - Scoping exercise
   - Identifying sectors for implementation
   - Assessing current sectoral status
   - Sectoral Recommendations
     - **Structural/ physical**
     - **Regulatory and institutional**
   - Overall recommendations

Scoping

Institutional and regulatory analysis



Phased action points for CRS



Video: Tales of Gorakhpur

Thank you!

Raina.singh@teri.res.in

MAINSTREAMING CLIMATE RESILIENCE

TERI-APN TRAINING PROGRAM ON
BUILDING URBAN CLIMATE CHANGE RESILIENCE
19 MAY 2015
PUNE, MAHARASHTRA

Faculty
Dr Divya Sharma
Fellow and Area Convener
Center for Research on Sustainable Urban Development and Transport Systems
Sustainable Habitat Division
TERI

Climate resilient cities: a change in perspective

- The level of resilience of our cities and towns is dependent on the quality and performance of the overall urban system.
- Adaptation to climate change and focus on disaster risk reduction is becoming increasingly relevant as the negative impacts of climate change increase.
- "There needs to be a shift, in both adaptation to climate change and disaster risk reduction, from a singular and specific focus on affected infrastructures and locations towards a more integrated focus on overall risks, development conditions, and local area performance"*.

*Source: "ICLEI, 2011, Financing the Resilient City: A demand driven approach to development, disaster risk reduction and climate adaptation - An ICLEI White Paper, ICLEI Global Report"

Climate resilient cities: a change in perspective

- **This calls for :**
  - Mainstreaming climate and disaster risk reduction to become factors in conventional planning processes, project design and development decision making.
  - Developing specialized financial instruments for the risk-oriented components of these projects that cannot be addressed via mainstreaming measures.
  - Building local institutional capacity to prepare, structure and manage large scale redevelopment

Source: "ICLEI, 2011, Financing the Resilient City: A demand driven approach to development, disaster risk reduction and climate adaptation - An ICLEI White Paper, ICLEI Global Report"

What is mainstreaming

Mainstreaming climate resilience is the iterative process of integrating considerations of climate change into policy making, budgeting, implementation and monitoring process at national, sector and subnational levels.

It is multi year, multi stakeholder effort grounded in the contribution of climate change to human well being, pro-poor economic growth and achievement of the MGDs.

It entails working with a range of government and non government actors, and other actors in the development field.

Definition adopted from the definition of mainstreaming climate change adaptation in mainstreaming climate change adaptation into development planning-a guide for practitioners(www.unpei.org)

Why do we need to mainstream climate resilience

- Recent calamities in Uttarakhand, Kashmir, and Visakhapatnam have brought out the need for building climate resilience into development systems and planning
- Climate change in urban areas interferes with a wide range of existing and emerging policy challenges, among them poverty eradication, water supply and sanitation, scarcity of food and water, and population growth.
- Climate change, therefore, should no longer be considered a solely environmental challenge, addressed in isolation from other social and economic issues.

Why do we need to mainstream climate resilience

Cities need to consider impacts of slow onset climate change as well as vulnerability to extreme events in their planning decisions, infrastructure planning and land use planning

A strong policy mandate and regulatory backing is needed to start this integration.

When climate change is embraced as an integral part of these challenges, solutions can be designed to more adequately reflect and address myriad impacts upon cities

Integration points for mainstreaming

Action to address climate change in urban areas should be multi-level, involving national-, state-, and city-level governments, as well as multi-sectoral including sectors such as infrastructure and services, urban planning, transport, disaster risk reduction, and housing and construction

1. **Policy**
2. **Regulations**(Building bye laws, Acts etc)
3. **Institutions**
4. **Schemes** like (JNNURM, RAY, Smart cities)
5. **Project level interventions** (DPR, Master plans, CDP

Integration points for mainstreaming

POLICY

An effective policy will :

- Be that which provides for capacity building, mainstreaming, facilitating data, tools, and techniques to enable risk assessment and climate projections.
- Draw out a structure of the institutions and regulations needed to implement the same, and identify windows for financing the actions.
- Facilitate preparatory actions like risk and vulnerability assessmentsto potential climate impacts in the near future.
- Informs the requirements of such assessments like data base, multi-sectoral and multi institutional coordination.
- Guide the overall mechanisms to support resilience mainstreaming into urban development discourse, it should also identify various entry points within existing institutional mechanisms and regulatory framework.

Integration points for mainstreaming

Key points that the policy should address

- **Making a case for climate-related actions and investment:** The need for risk and vulnerability assessments and data base management systems for facilitating the same
- **Capacity building** :The policy must ensure capacity building, competence, and adaptability at various levels of urban governance that would eventually be dealing with mitigation and/or adaptive practices on ground
- **Multilevel engagement:** policy should establish a mechanism to institutionalize the process of this multi-stakeholder engagement; e.g., the national government could incorporate climate resilience in the reforms agenda and resource planning under national schemes, and bring in incentive mechanisms for states and cities. They could also facilitate partnerships with international and non-government actors for technical and implementation support.

Integration points for mainstreaming

Key points that the policy should address

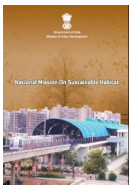
- **Integrating climate resilience into urban development laws and regulations :**

1. Integrating Climate-related issues through the state-level acts and regulations.
2. Resilience interventions could be included into the development regulations of the cities.
3. Integrating measures to bring in climate resilience into national and sub-national schemes and plans

- **Financing urban resilience:** Financial allocation for resilience building and adaptation projects would also be an integral part of the proposed policy. Policy should support and facilitate establishing national- and state-level climate funds and resource planning under various national schemes

Integration points for mainstreaming

Regulations



Integration of elements that support climate resilience into:

- National level Acts like the Disaster Management Act, National Mission on Sustainable Habitat
- State Level Acts those govern land-use and town planning, defines development regulations and environmental zoning, sector specific regulations like solid waste management, ground water, water supply, waster water and sanitation .
- Example

1. Town and Country Planning Acts
2. Coastal Regulation Zone Notification, 2011
3. Regulation on Land Development and Building Construction
4. Ground Water Regulation Act
5. Building Byelaws and codes

Integration points for mainstreaming

Institutions

- Once mandates are created at national , state and local level; Institutionalization of the same needs to be carried out by creating necessary institutions to implement resilience options and to drive resilient city planning practices in a city.

http://uhcrc.org/home

Surat:

- Surat city is a part of Asian Cities Climate Change Resilience Initiative(ACCCRN).
- The city engaged with The Rockefeller Foundation and the technical partners to come up with a city resilience strategy that identified critical challenges for the city in the wake of climate change
- This led to the formal adoption of the strategy by the municipal corporation and creation of the :

1. **Urban Health and Climate Resilience Centre (UHCRC) and**
2. **The Surat Climate Change Trust (SCCT).**

SCCT

- SCCT is a city level multi-stakeholder public trust, having its office at the City Engineer's Office
- Formulated with the objective of addressing problems arising out of urbanization and climate change and to facilitate capacity building of Surat to address these challenges

S C C T
Surat Climate Change Trust

UHCRC

- Establishing the UHCRC in order to provide support to the state and central-level urban health support systems to incorporate climate change resilience issues
- Established within SMC's Health Department, this first-of-a-kind institution in the country aims to address public health and climate change adaptation issues
- In February 2013, the SMC announced that it would allocate INR 10 million to UHCRC for its functioning

Integration points for mainstreaming

Schemes

Either floating new schemes or integrating elements of resilience /climate response into the existing schemes of Government of India.

In case of large scale urban transport projects (e.g. metro rail, bus rapid transit), industrial zones, Special Economic zones (SEZ), etc. economic policies or manifesto of the national/ state governments

Integration points for mainstreaming

Project level interventions

- **Master plans-** The land-use plans should be prepared giving due cognizance to the climate risks and vulnerability.
- The development regulations spelt out in the master plans must spell out the vulnerable locations and restrictions/ guidelines thereof for development should be drawn up
- **CDPs**- The city development plans provide details for various projects that need to be implemented and for which central and state level grants have to be sought. The CDPs therefore can integrate climate adaptation projects

Thank You !

Financing Urban Infrastructure
For Implementing Urban Resilience

Alok Shiromany
Expert In Urban Finance

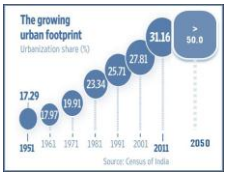
Contents

Introduction

- **Rapid urbanisation** - tremendous pressure on urban infrastructure and its delivery system.
- Fast economic growth and growing population have led to huge demand-supply infrastructure deficit
- Lack of adequate and quality infrastructure is proving to be a binding constraint in sustaining, deepening and expanding India's economic growth and global competitiveness

Urbanization & Economic Growth

- 31% of Indian's Population lives in urban areas.
- **Cities with population of 1 million are increasing** - *35 in 2001 to 50 in 2011 and is expected to increase further to 87 by 2031.*
- Cities and towns of India are deficient in the quality of services.
- Investment for urban infrastructure over the 20 year period – *INR 39.2 lakh crore at 2009 – 10 prices (HPEC)*
- McKinsey Report (2010) has estimated an investment requirement of INR. 53.1 lakh crore.



*Urban population likely to increase from present **377 million** to **600 million** by 2030 & **900 million by** 2050*

53 Million Plus cities

Status of Urban Services in India

- Drinking Water availability within the premises is **71.2%;**
- **32.7%** of the urban population has access to piped sewer system;
- Average duration of water supply ranges from **1 - 6 hours;**
- **21%** of waste water is treated **;**
- Waste collection efficiency ranges between **70%** and **90%** in major Metro cities;
- Segregation of solid waste is around **30%;**
- Organized public transport system operational in more than **65** class-I cities; and
- BRTS and Metro projects are operational in various **Mega and Metropolitan cities.**

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Service Level Gaps

Service Indicators	National Benchmark	India Status
Water Supply		
Per Capita supply of water	135 lpcd	69 lpcd
Extent of metering of water connections	100%	13%
Extent of non revenue water (NRW)	20%	32%
Cost recovery in water supply services	100%	39%
Sewerage		
Coverage of toilets	100%	70%
Collection efficiency of the sewage network	100%	10%
SWM		
Household level coverage	100%	35%
Extent of scientific disposal of municipal solid waste	100%	10%
Storm Water Drainage		
Coverage of storm water drainage network	100%	46%

Source: Service Levels in Urban Water and Sanitation Sector-Status Report(2010-2011) Ministry of Urban Development

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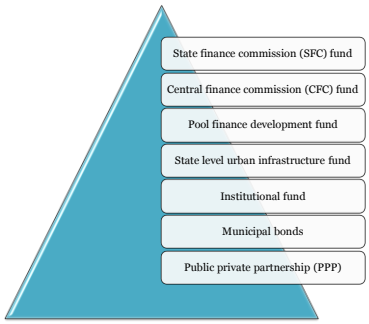
Ground Issues & Key Challenges

Cities are not self reliant	• Depend on grants from Central/State Governments, which are reducing • ULBs need to be provided 3Fs (Funds, Functions & Functionaries) • Devolution of funds is not predictable and timely
ULBs caught in a low equilibrium cycle	• Generating less revenues and spending even less on services and infrastructure. • Lack of Regulator & Std. Concession agreement
Lack financial viability	• Cities lack financial viability and internal accruals are insufficient. • ULBs should be strengthened in financial management to enable own-source revenue generation.
Inadequate infrastructure in cities	• Inadequate infrastructure in cities; Cities unable to meet rising demand for services and unable to raise resources.
Weak credit worthiness	• ULBs' revenue sources inadequately capture the economic buoyancy in the local area - *leading to overall weak credit worthiness.*
Planning	• Absence of financial investment plans • Lack of stakeholder consultation • Weak Asset Management • Absence of data availability and mapping
Lack of Private Investors	• Lack of Regulator • Lack of Standard Concessionaire Agreement

Other Constrains

- Inadequate availability of long term finance (10 year plus tenor) both equity and debt
- Availability of Information - While plain service contracts may require limited information on an existing system and minimal monitoring capacity; whereas, options such as BOOT and concession require high political support, a good information base about the existing system and a strong regulatory framework;
- Concerns on low user charges recovery remain high;
- Inadequate shelf of bankable infrastructure projects that can be bid out to the private sector;
- Inadequate advocacy to create greater acceptance of PPPs by the public; and
- Lack of clarity during project planning and execution by the ULBs.

What are the other sources of funding for ULBs?



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Institutional Finance- Avenues & Suitability

Parameter	Suitability of funding from various avenues of Institutional Finance				
	Banks	Financial Institution	Bi-lateral & Multi-Lateral bodies	Municipal Bonds	National/ State level infrastruc-ture funds
Availability of funding for capital projects	L	H	H	H	H
Getting interest rates lower than commercial borrowings	M	H	H	H	H
Loan term commensurate with gestation period	M	H	H	H	H
Ease of procedures in accessing finance	M	M	L	L	M
Need for escrow account	H	H	L	H	H
Need for credit rating	H	H	M	H	H
Funding for project preparatory expense	L	M	H	L	M
Availability of grant component for capacity building	L	L	H	L	M
Requirement of Techno Economic Feasibility Report	H	H	H	H	H
Close monitoring fund utilization & project implementation	H	H	H	M	H

Source: Toolkit for Accessing Institutional Finance, Jan 2011 L=Low, M=Medium, H=High

Process for Institutional Finance

Internal Decision of ULB

- Purpose of loan
- Amount of loan
- Preferred model of execution- PPP, Govt.: http://jnnurm.nic.in/wp-content/uploads/2011/01/10.ToolkitPP.pdf
- Loan preparation expenses
- Tentative time for repayment
- Person authorized to represent the ULB, negotiate & sign
- Time limit for closing deal
- Necessary approvals from State Govt. other authorities

Accessing Institutional Finance

- Credit rating
- Approaching financing institution
- Preparing Techno Economic Feasibility Report: http://jnnurm.nic.in/wp-content/uploads/2011/01/JNNURM_Toolkit_DPRs.pdf
- Appraisal of project
- Negotiation
- Signing agreement
- Funding
- Implementation of loan covenants- escrow account, SPV etc.

Infrastructure Financing

Sources of Infrastructure Financing:

- Local government capital budget allocation
- Bank and Institutional loans
- Grants from State and Central Government
- Long-term municipal funds/Bonds
- Leveraging municipal assets and private equity
- Pooled bonds issued by urban infrastructure funds

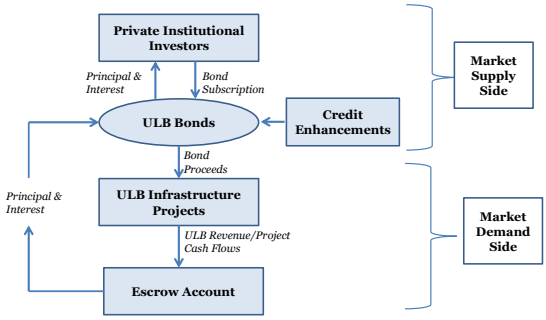
Infrastructure Financing Options

Infrastructure Finance

- Municipal Bonds
- Public Private Partnership
- Public Financing Institution/Bank Finance
- Multilateral Financial Institutions

Municipal Bonds

Process



Municipal Bonds

- Municipal Bonds issued by the ULBs, are **redeemable after a specific period** and have a definite rate of interest.
- **Municipal bonds are appropriate instruments** - raising resources, channeling funds from the capital market into infrastructure development.
- **Long term in nature**, unlike bank loans that are of shorter tenure.
- Provides opportunities for long gestation infrastructure development projects.

Municipal Bond Issues in India		
Type of Bonds	No. of Bonds	Amount (in Rs. Crore)
Taxable bonds	11	437.84
Tax-free bonds	12	905.30
Pooled finance (one tax-free)	2	206.00
Total	25	1,549.14

- About **11 ULBs** out of 65 **continued their reliance on institutional and bank borrowings** to finance urban infrastructure projects from commercial banks.
- Agra , Allahabad, Lucknow , Varanasi, Kanpur, Meerut are using JnNURM revolving fund to fund the capex for their projects.

Public Private Partnership (PPP)

Experience

Public Sector
- Facilitator
- Enabler
- Concessioning
- Monitoring and Supervision

Private Partner
- Management and Technical Skills/Innovative Technologies
- Operational Efficiency
- Financing
- Builder/Operator

Collaboration
- Public funding with private service delivery and private management.
- Public as well as private funding with private service delivery and private management.
- Public as well as private funding with public/private service delivery and public/private/joint management.

The Public-Private Partnership (PPP) Project means a project based on contract or concession agreement between a Government or statutory entity on the one side and a private sector company on the other side, for delivering an infrastructure service on payment of user charges.

Infrastructure Financing Options

Public Private Partnership

Experience

- Nearly **48 projects** have reportedly been supported through PPP with almost **19%** of the project-cost been leveraged through private sector participation under JnNURM ;
- SWM, Water Supply and Transportation sectors have been found to be most amenable sectors related to PPP.

Constraints

Regulatory Framework	• No tariff regulatory mechanism for determining the principles of tariff fixation, regulate service delivery standards and implementation of reforms under PPP. • No framework for evaluating the revenue and return of the project.
Funding Requirements	• Need for long-term funding at concessional rates/or provide credit enhancements for the urban PPP projects.
Capacity Constraints	• Lack of capacity at the State and city levels to engage with Department of Economic Affairs (DEA), shortlist transaction advisors and manage them.
Financial Constraints	• Need for rules and standardized procedures to regulate and guide PPP projects and an enabling provision for PPP in the General Financial Rules.

Public Financing Institution/Bank Financing

- These Institutions provide short term, medium term and long term credit.
- Banks are permitted to finance SPVs, registered under the Companies Act, set up for financing infrastructure projects .

Multilateral Financing Institution (MFIs)

- MFIs refers to World Bank and regional development bank such as ADB.

Institute	Type of Financing	Type of Borrower
World Bank Group		
International Bank for Reconstruction and Development (IBRD)	Non-concessional loans and loan guarantees	Primarily middle-income governments, also some creditworthy low-income countries
International Development Association (IDA)	Concessional loans and grants	Low-income governments
International Finance Corporation (IFC)	Non concessional loans, equity investments, and loan guarantees	Private sectors firms in developing countries
Asian Development Bank	Concessional and Non-concessional loans, equity investment, grants and loan guarantees	Middle-income governments, some creditworthy low income governments, and private sector firms in the Region.

JnNURM – *A Catalyst*

Jawaharlal Nehru National Urban Renewal Mission (JnNURM) was launched by the Government of India on 3rd **December 2005**

*To encourage **reforms** and fast track **planned development** of identified cities as prioritized by States*

*Focus is to create **economically productive, efficient, equitable** and **responsive cities***

The program was planned to operate on a mission mode by facilitating large scale investments in the urban sector, policy change and institutional reforms for strengthening

- Policy Framework
- Institutional Framework
- Financial Framework
- Project Development
- Monitoring & Evaluation

Municipal Finance agenda & JnNURM

- Essential to expand the investment envelope by mobilizing long-term debt financing from the financial markets;
- Improved credit-worthiness shall help create interface between capital market/FIs and municipal finance;
- Need to develop bankable projects and leverage from market;
- Need for better expenditure management;
- Urgent need for improving revenue mobilization/ innovative use of assets; and
- There is an urgent need for supplementing institutional capacity by capacity building measures.

Several JnNURM reforms, such as accounting reforms, property tax system, user charges on basic services and reengineering and computerization (e-Governance) of key municipal functions are important initiatives that will help enable the local bodies to access the capital market.

JnNURM Financial Reforms
Municipal Accounting Reform

- *Preparation of State Municipal Accounting Manual*
- *Manual Approval & Adoption by the Local Body*
- *Listing the Assets and Liabilities at ULB level*
- *Valuation of Assets*
- *Preparation of Opening Balance Sheet*
- *Migration to DEAS*
- *Appointment of Audit Officers/CA/Cadre*

JnNURM Financial Reforms
Property Tax Reform

- *Notification/Amendment of Act on Collection of Property Tax*
- *Extending of property tax to all properties*
- *Posting of tax details in the public domain & migration to standardized self-assessment system of property taxation on the basis of periodic revisions and review of rates*
- *Setting up non-discretionary method for determination of property tax (unit area method or capital value method)*
- *Coverage (85%)*
- *Collection Efficiency (90%)*

JnNURM Financial Reforms
O&M Cost Recovery

- 100% O&M cost recovery is one of the **ULB level** reforms;
- **40 UIG cities** are collecting more than **50% O&M** cost recovery in water supply;
- **23 UIG cities** are collecting more than **50% O&M** cost recovery in SWM;
- **758** water supply projects have been sanctioned under the Mission of which **344** have been completed;
- **108** Solid waste management projects have been sanctioned of which **30** have been completed;
- Some of the completed projects: **Kanpur, Nashik, Madurai, Navi Mumbai, Asansol, Durgapur, Surat, Pune ,etc;**
- Impact of service levels yet to be seen as projects are yet to be completed;
- More cities are **introducing water meters**;

Need for Credit Rating

- Independent and credible evaluation of **credit quality;**
- **Independent financial analysis of city finances;**
- Benchmarking/Comparative analysis with other municipal entities - **highlights strengths and weaknesses; and**
- External credit assessment encourages **financial discipline amongst rated cities.**

Access to wider set of investors:

1. *Increased accessibility to capital markets-helps investors in pricing the debt offer;*
2. *Increased marketability of debt issues by municipal entities;*
3. *Improved visibility-attracts international capital; and*
4. *Eases risk identification and diversification for investors.*

JnNURM Financial Reforms
Credit Rating of ULBs

- MoUD commissioned **4 agencies** to rate the JnNURM cities (general obligation debt and not any specific bond/issue);
- **Initial credit rating exercise completed for 65** cities (8 UIG cities not rated);
- Surveillance rating undertaken for **63 ULBs***
- Initial Ratings were assigned during January 2008-February 2011, and Surveillance Ratings were assigned during January 2010-February 2012;
- Ratings are generally live for 12-15 months from the date on which rating is assigned;
- **35 ULBs have received investment grade rating** (BBB- and above)

**Jamshedpur & Panaji*

Overall Financial Performance

Less financially burdened and positive progress	Stability shown by	Slow progress and financially burdened ULBs
10 Cities	7 Cities	12 Cities

- ULBs with octroi income have achieved investment grade rating
- Only 55% of ULBs without octroi income made it to investment grade category.
- Revenue expenditure was dominated by establishment expenditure (salary, pension, etc.) followed by spending on operations and maintenance
- For BB and B category rated municipalities, establishment and O&M expenditure together accounted for more than 95% of the total revenue expenditure.
- **Income from own sources contributes approximately 59% on average across all ULBs.**
- **ULBs in metro cities generate over 70% of their revenue income from own sources**
- ULBs with population lesser or closer to a million only generate slightly more than half of their revenue income from own sources

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JnNURM and Leveraging Municipal Borrowings

- About **11 ULBs** out of 65 **continued their reliance on institutional and bank borrowings** to finance urban infrastructure projects from commercial banks
- Agra , Allahabad, Lucknow , Varanasi , Kanpur, Meerut are using JnNURM revolving fund to fund the capex for their projects

Key Highlights – Municipal Borrowings

- World Bank Survey conducted for 19 cities for report on 'Developing a Regulatory Framework for Municipal Borrowing in India', reveals:
  - » ***Rajkot, Nanded, Bhopal, and Madurai have already exhausted their borrowing limits*** assessed on the basis of past financial performance;
  - » Since **Nanded, Bhopal and Madurai have low investment grade ratings** they **might struggle to service the existing debt** in a timely manner;
  - » Cities such as **Chennai, Coimbatore, Jabalpur, Kalyan-Dombivili, Nanded and Nagpur may be burdened** to meet their commitments on projects already approved under JNNURM through borrowings; and
  - » Data for ULBs such as **MCGM, Navi Mumbai, Pune, Nashik, Vadodara and Surat** reveals that they have the **ability to fund the ULB share.**

Ahmedabad
Vadodara
Surat
Rajkot
Nagpur
Nanded
Nashik
Kalyan Dombivilli
Thane
Pune
Navi-Mumbai
M.C. of Greater Mumbai
Bhopal
Indore
Jabalpur
Chennai
Coimbatore
Madurai

Overall Financial Performance (1/2)

Progressing ULB and not burdened with Outstanding Debt ⇧ | ULB is stable in terms of revenues, expenditure and repaying the debt ⇔ | ULB not progressing well and burdened with debt ⇩

Cities	Trend
Coimbatore	⇧
Amritsar	⇧
Bangalore	⇩
Chennai	⇧
Faridabad	⇩
Mysore	⇩
Shimla	⇩
Srinagar	⇔
Delhi	⇧
Navi Mumbai	⇔

Cities	Trend
Cochin	⇩
Chandigarh	⇧
Ajmer	⇔
Bhopal	⇩
Gr. Mumbai	⇧
Guwahati	⇔
Indore	⇧
Jabalpur	⇩
Jaipur	⇔
Asansol	⇩

Overall Financial Performance (2/2)

Progressing ULB and not burdened with Outstanding Debt ⇧ | ULB is stable in terms of revenues, expenditure and repaying the debt ⇔ | ULB not progressing well and burdened with debt ⇩

Cities	Trend
Pune	⇔
Ahmedabad	⇧
Vadodra	⇔
Nagpur	⇩
Nanded	⇩

Cities	Trend
Rajkot	⇩
Surat	⇧
Kolkata	⇔
Lucknow	⇩
Vijaywada	⇧

- **Less financially burdened and positive progress** : Coimbatore, Amritsar, Chandigarh, Chennai, Greater Mumbai, Indore, Delhi, Ahmedabad, Surat and Vijayawada.
- **Stability shown by:** Ajmer, Guwahati, Jaipur, Srinagar, Navi Mumbai, Pune, Vadodara and Kolkata.
- **Slow progress and financially burdened ULBs:** Bangalore, Faridabad, Mysore, Shimla, Cochin, Bhopal, Jabalpur, Asansol, Rajkot, Nagpur, Nanded and Lucknow

Issues

- Volatility in assigned credit rating
- 22 cities had proposed market borrowing in their CDPs submitted to JnNURM. However, availability of grants has reduced incentive for borrowing
- Credit worthy ULBs are usually cash rich; hence, reluctant to borrow
- Theoretically inv. grade entities may not find investors till they attain good rating on specific issue; requires commercially viable projects

Way Forward:

- Need to assess willingness to borrow by ULBs and lend to ULBs
- Cash rich entities should be encouraged to develop good projects & meet funding requirements from accessing institutional finance
- Setting up of specialized state level urban financing intermediaries such as TNUDF, KUIDFC- provides comfort to lenders that municipal borrowing will not exceed prudent limits

Action Taken by Ministry

- New insights in Municipal debt market and the Pooled Finance Development Fund (PFDF) Scheme
  - Removal of 8% cap on tax free instruments;
  - Separate regulatory and disclosure requirements for ULBs may be made by SEBI;
  - Allow credit enhancement of Municipalities by Multilateral agencies;
  - JnNURM and other Central schemes to be linked with raising resources from the market;
  - Simplify Pooled Finance Development Fund (PFDF) requirements to enable utility and implementation of the scheme.

Action Taken by Ministry

- Model Concession Agreement for SWM;
- A set of guidelines regarding solid waste management project development with several case studies;
- PPP in Solid Waste Management - Procurement Guideline; and
- Capacity Building programme through Regional Capacity Building Hubs (RCBH's).

Way Forward (1/3)

- Resources are available in the capital market and FIs.
  - Essential to expand the investment envelope by mobilizing long-term debt financing from the financial markets. Need to increase the overall funding for infrastructure by leveraging varied sources against one another.
  - Improved credit-worthiness shall help create interface between capital market/FIs and municipal finance
  - **Mainstream Climate Resilience , DPR to incorporate elements**
  - **Insurance Component**
  - **Need for Capital Investment Planning and better Financial Management Need to develop bankable projects** and leverage from market.
  - Develop a commercially viable project with detailed engineering, costing, procurement plan, etc.
  - Attempt reducing capital cost through appropriate credit enhancement measures to facilitate leveraging

Way Forward (2/3)

- Need for better expenditure management like –
  - Appropriate costing of services and better targeting of subsidies,
  - Revenue rationalization and
  - Asset management helping mobilize resources - translating to better services
- Urgent need for improving revenue mobilization/innovative use of assets:
  - Considerable scope for increasing revenue especially from property tax
  - Levy Development Charges
  - Non-tax sources such as use of land monetization may be used
  - Commercial utilization of land/property through PPP

Way Forward (3/3)

- **There is an urgent need for supplementing institutional capacity by capacity building measures**
- **Timely progress in the implementation of reforms** under JNNURM such as the
  - Introduction of an accrual based accounting system,
  - Self-assessment of property tax,
  - 100% cost recovery of key urban services,
  - Public private participation and
  - Implementation of e-Governance

Will help improve credit worthiness of ULBs

To reveal the fresh progress made by ULBs in their financial and overall performance in the past couple of years and in future years, the Ministry is in process of commissioning the second annual Surveillance Rating exercise for all JnNURM UIG cities

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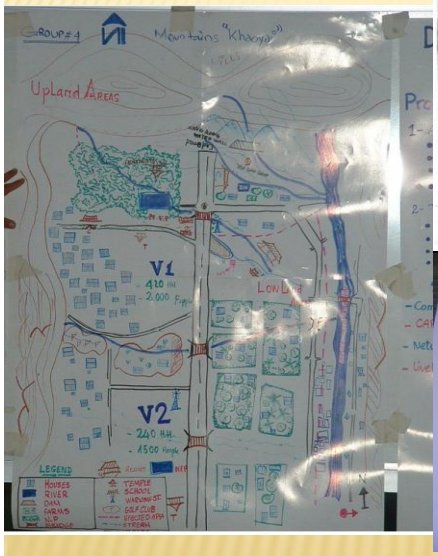
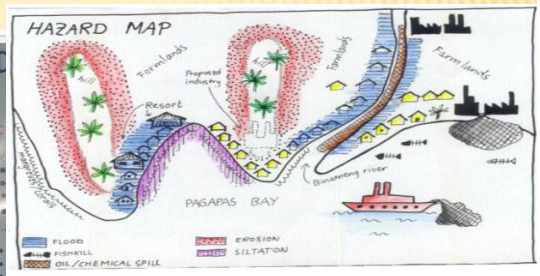
Thank you!

Appendix F: Group Exercises

Hazard Mapping





GROUP EXERCISE-1

- Participants will be divided into groups and will have to chose to work on a municipality/municipal corporation
- In their selected location, the group will discuss:
  - Exposure/risks due to climate impacts(increased occurrence of cyclones, coastal erosion, floods, heat waves)
  - Vulnerability to key sectors like:
    - Housing
    - Water
    - Sewerage and sanitation

- Discussions would be around :
  - Perceived impacts of climate change/climate variability
  - Vulnerable sectors and areas in the municipality
  - Degree to which these vulnerability impact the identified sectors
  - Categorize vulnerability in terms of high, medium, low

GROUP EXERCISE-2

- Participants will be divided into groups and will have to discuss on the following questions:
  1. Do you think climate change and environmental issues should be included in the planning processes?
  2. What capacity needs that you think needs to be addressed to enable urban local bodies to address climate change and to design and adopt climate strategies?
  3. Are training programmes a regular feature in ULBs in your state? What kind of training programs are generally conducted for municipal officials and at what level?
  4. What kind of training programs and skill building are required by you if you have to plan for climate resilience or address issues related to climate variability and change?
  5. What should be the format of such training?
  6. How much time can you devote –probable duration of training program?
  7. Who should be facilitating these training programs/
  8. Should incentives be designed for attending the training programmes? How to ensure participation and practical application?

APPENDIX G- Participant Details

TERI-APN's Training program on Building Urban Climate Change Resilience
22-23 January, 2015
Venue: Hotel Taj Vivanta, Panaji, Goa
Registration for orientation program for elected representatives - 22 January

S. No	Salutation	First Name	Last Name	Designation	Organisation	e-mail Address	Contact number
1	Mr	J R Gracias	Flor	Dy. Director(Trade)	Department of Tourism, Goa	dir-tour.goa@nic.in	+91 0832-2494208/2438750/2494214/51/52/ 09527599633/
2	Mr	Dasharath N	Gawas	Chief Officer	Valpoi Municipal Council	gawasd@gmail.com	9422579061
3	Mr	Sudin A	Natu	Chief Officer	Canacona Municipal Council, Goa, Div. of Municipal Adminstration	sdm-canacona.goa@nic.in	9422395833
4	Ms	Mario Simon	Rebello	Chairperson of Canacona municipal council (CMC)	Div. of Municipal Adminstration	simonrebello1@hotmail.com	9822183313
5	Mr	Gaurav	Mhapne	Municipal Engineer (III), Mapusa Municipal Council	Mapusa Municipal Council	mhapneg@yahoo.co.in	9860484794
6	Mr	Saurabh	Bhardwaj	Associate Fellow	TERI	saurabh.bhardwaj@teri.res.in	9911055559
7	Mr	G K	Bhat	Director	TARU	gkbhat@taru.org	9421248111

8	Mr	Nizamddin	Shaikh	Executive Engineer	Electricity Department, Goa	nizsha4@gmail.com	7588444457
9	Dr	Jose De	Sa	Dy. Director of Health Services, Goa	Directorate of Health Services, Goa	specialcelldhs@gmail.com	9011025036
10	Dr	Divya	Sharma	Fellow	TERI	divyas@teri.res.in	9971662126
11	Ms	Ashwini Pai	Panandiker	Associate Fellow	TERI	ashwini.panandiker@teri.res.in	9403214749
12	Ms	Riya	Rahiman	Research Associate	TERI	riya.rahiman@teri.res.in	9643664126
13	Mr	Gajanan	Khoyoreka	Assistant Engineer	Goa Housing Board	gkhojunka@yahoo.com	
14	Ms	Bhavna	Bhogle	Chairperson			9823707217
15	Ms	Deepti	Chodankar	LDC	USUDA	gsuda.gsuda@yahoo.com	9552917158
16	Dr	Vasudev	Deshprabhu	Chairperson	Pernem Municipal Council	vvdeshprabhu@gmail.com	9822486095
17	Mr	Anil S	Ringane	Dy CPO	GUSDA	dy.cpo@gsuda.org	8975082436
18	Ms	Vijeta A	Naik	Acting Chairperson	Mapusa Municipal Council		7875234787, -832-2262203
19	Mr	Landry T	Mascarenhas	Chairperson	Cuncolim Municipal Council	admin@cmccuncolim.com	9923301076

20	Dr	Mohan R	Givap	Scientist	Goa PCB	mgivap@gmail.com, mgivap@yahoo.com	8390908208
21	Mr	Anant G	Bhagwat	Surveyor of Works	WRD	anbhagwath@gmail.com	9423883391
22	Mr	Pandharinath N	Naik	CO/Cuncolim	Cuncolim Municipal Council Goa		9823141951, 09422451650
23	Mr	Shrikant V	Lawande	JE/CCP	CCP Panaji		9403687475
24	Mr	John	Aboru	MEI CCP	CCP Panaji		9403687465
25	Mr	M	Colaco	SEIPWD	PWD		9370278030, 9011010083
26	Ms	Maria Marcia Da	Costa	Assistant Project Engineer	GSUDA		9922412965
27	Ms	Smita	Pawaskar	Junior Project Engineer	GSUDA		9922958424
28	Ms	Kavita	Patil	Research Associate	TERI	kavitah@teri.res.in	9011056624
29	Mr	Atmaram	Kalanekar	Account officer	GSUDA		9922412966
30	Mr	Ramdas	Shirodkar	Chairperson Valpoi Municipal Council	GSUDA		9423308708
31	Mr	Pramod V	Desai	Chief Officer Quepem / Sanguem Municipal	Quepem Municipal Council		9423058981

				Corporation			
32	Mr	Surendra F	Naik	Dy. Collector, South Goa	Collectorate South Goa		9822142132
33	Mr	Devin	Sohres	Councillor	Ponda Municipal Council		9764073092
34	Mr	Diniz C T De	Melo	Margao Municipal Council	MMC		9767721951
35	Mr	Yatin S	Phatarpekar	JE Civil	Sankhali municipal council (SMC), North Goa	ycongsa@rediffmail.com	9823521639
36	Mr	Dhomesh	Soaloni	Chairperson	SMC	sagloni1975@gmail.com	9822183775
37	Ms	Karuna	Goverkar	Chairperosn	Bicholim municipal council (BMC)		9158849896
38	Mr	Ajit R	Buji	Councillor	BMC		9422451863
39	Mr	Vishnu	Nare	MEI CCP	Mormugao Municipal Council MMC, Vasco		9822689084
40	Mr	Jayesh	Kalangutkar	Municipal Engineer III	Valpoi Municipal Corporation	jaykalangutkar@gmail.com	9823900767
41	Mr	R K	Pandita	Member Secretary	North Goa Planning & Development Authority NGPDA	panditrjudkumar@gmail.com	9890753044
42	Mr	Sasi	Kumar T	OSD	Housing Board	designersasikmr@gmail.com	8589070815, 9923652760

43	Ms	Sharmila	Naik	Junior Project Engineer	GSUDA	snnaiksharmila@gmail.com	9922958423
44	Mr	Santosh S	Kundaiwar	Chief Officer PWDA	Ponda Municipal Council		9822180533
45	Mr	Subhash G	Mhalsekar	Municipal Engineer, GR III	Sankhali Municipal Councial, Goa		7774907507
46	Mr	Agostinho	Mesquita	Municipal Engineer III	Ponda Municpal Council		8308800435

TERI-APN's Training program on Building Urban Climate Change Resilience
22-23 January, 2015
Venue: Hotel Taj Vivanta, Panaji, Goa
Registration Sheet - 23 Jan 2015

S. No	Salutation	First Name	Last Name	Designation	Organisation	E-mail Address	Contact number
1	Dr	Antonio	Mascarenhas	Scientist	National Institute of Oceanography (NIO)	amascarenhas10@gmail.com, mascarenhas@nio.org	9422416181
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Registration Sheet Building climate resilient cities : Exploring theories, practices and prospects

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TERI –APN- Government of Uttarakhand
Orientation program on Urban Climate Change Resilience for elected representatives
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TERI –APN Training program on Building Urban Climate Change Resilience

Date: 20-22 April, 2015

Venue: Gopabandhu Academy of Administration, Bhubaneswar

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TERI –APN- Government of Maharashtra
Training program on Building Urban Climate Change Resilience
Venue: YASHADA, Pune, Date: 18-19 May, 2015

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APPENDIX H- BRIEFING PAPER

BRIEFING PAPER

JUNE 2015

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APN ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH

20 YEARS Bridging Science & Policy for a Sustainable Asia-Pacific

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Capacity Building for Building a Sustainable and Smart Urban India

Introduction

Urban India is at the threshold of major transformation. While we are gearing up for building smart Indian cities, we are also recognizing the need for sustainability in our development patterns. Therefore, there is a need for us to relook the ways in which we design our infrastructure, run our cities, and manage current pressures emanating from urbanization. All these requirements are also coupled with serious development related challenges confronting the cities of the 21st century. Cities need to continuously gear up for addressing issues of increasing pressures on resources, environmental degradation, air pollution, climate change, and increasing frequency of climate induced events and disasters.

There is a strong need for addressing each of these challenges and equipping the cities to take these challenges head on.

Continuous skill development of people who are responsible for addressing the urban challenges is an absolute necessity for bringing about requisite changes in existing urban governance and management systems.

It is also about learning from the past and bringing in new and improved systems that facilitate efficiency in municipal functions as well as bring in planning and management tools that equip cities to deal with the present and future challenges more efficiently.

This briefing paper draws from the key learning derived from TERI's programme on capacity building which was supported by the Asia-Pacific Network for Global Change Research (APN). The programme covered urban local bodies (ULBs) of four Indian states on the theme of 'Urban Climate Resilience'. The key messages from this experience have gone beyond the theme for the training programme itself and posed challenges of larger issues with training and capacity needs at the ULBs' level. These are the challenges that call for a relook on the training needs and design of targeted and focused

training programmes that are able to derive tangible benefits and those that can be monitored. It also calls for facilitating a culture of learning and continuous education that equips urban managers, engineers, planners, and decision makers to deal with new changes in the technology and new demands of the future cities in India. This paper attempts to bring out some of these requirements and synthesize experience from the TERI-APN programme in the larger context of existing capacity building initiatives in urban India.

Matching Capacities with the Requirements of the National Agenda on Urban Development and Urban Growth

On April 29, 2015, the Union Cabinet approved the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart Cities Mission to drive economic growth and foster inclusive urban development. The basic aim of these schemes is to recast the urban landscape of the country to make urban areas livable, sustainable, smart and inclusive besides driving the economic growth of the country. With an outlay of INR 45,000 crore for 500 cities under AMRUT and INR 50,000 crore for 100 cities under the 'Smart Cities Initiative', both these schemes define the National government's agenda to meet the challenges of growing urbanization in the country in a sustainable manner as well as ensuring the benefits of urban development to the poor through increased access to urban spaces and enhanced employment opportunities.

While the 'Smart Cities Initiative' will entail project-level planning as well as implementation of retrofitting, redevelopment, pan city initiatives, and development of new cities; the AMRUT scheme, on the other hand, will be a project-based approach to ensure basic services and infrastructure which will be linked to urban reforms. These reforms as envisioned at present will include e-governance, constitution of municipal cadre, devolving functions and funds to urban local bodies, review of building bye-laws, improvement in assessment and collection of municipal taxes, credit rating, energy and water audit, and citizen centric urban plans. It is believed that the implementation of AMRUT scheme will enable cities and towns to eventually graduate to 'Smart Cities'. The candidate cities for Smart Cities will be required to prepare their smart city plans and city challenge applications and will be required to work closely with national and international consultants in implementing smart initiatives.

While these schemes have ambitious and relevant agendas of the National government, in practice, the success of these schemes will depend on the cities' capacities, financial prowess ,and preparedness to implement it. Urban development policies and schemes are expected to become more and more cross-sectoral and dynamic in nature.

To start with, extensive awareness generation is needed to disseminate the very basis and intent of this agenda to all levels of urban functionary. While this is done, a parallel programme on skill building, technical assistance, and administrative reforms to match the requirement of the new age needs to be facilitated. As we can see, the training has to go beyond a classroom format and get into a demonstrative doing, learning, and reiterative learning mode.

Experience thus Far

Several assessments and reports like: The High Powered Expert Committee (HPEC) Report on the Urban Infrastructure and Services (2011); Report on the Mid-term Appraisal of the Eleventh Five Year Plan (2010); Training Needs Assessment (TNA), and Strategic Training Plan (2014) have expressed serious concerns over the need for extensive capacity building in ULBs. The training needs assessment report, prepared as part of Ministry of Urban Development (MoUD) and The World Bank's Capacity Building for Urban Development (CBUD) project, notes that the requirements for capacity building is high not only on account of the number of people to be trained but also in terms of the competencies of the trainers required. It is also to be noted that given the purview of the 74th Constitution Amendment Act, very few cities are looking at urban planning as a function which is reflected in the quality of development plans and Master plans. The concerns like environmental degradation, air pollution, and extreme climate events are not addressed and need a specific entry point in the capacity building plans of the government.

Capacity building has so far been accorded very low priority and is largely limited to administrative training. In the current context of rapid urbanization, the challenges in urban management require not only specialized knowledge but also cross-sectoral learning to tackle several new and emerging challenges in managing a city. The training needs assessment carried out under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) scheme points out the strong need for systematic training which would enable the urban local bodies to discharge their duties and responsibilities effectively.[1] Notwithstanding the fact that systematic training programmes have to be designed, it is to be ensured that tangible benefits are derived and monitored at all levels through these training programmes. Besides this, the content of the training programmes should also be critically formulated to address these issues holistically. Partnerships from global progressive cities, National and Global governments

[1] http://jnnurm.nic.in/wp-content/uploads/2014/06/TNA-Strategic-Training-Plan_Vol-I-6-June14Eng.pdf (last accessed on May 22, 2015).

and expertise would go a long way in addressing this challenge pragmatically. The capacity building scenario in urban India has been sporadic and detached from the real and continuous need for knowledge upgradation and skill building. For the urban sector, the capacity building initiatives could be phased out into two—pre JNNURM and post JNNURM. The following table enlists various programmes targeting capacity building for city officials.

Pre JNNURM

Before JNNURM, the public health engineering training programmes were conducted with an objective of providing training to in-service engineers and para-engineers. Besides this, the Regional Centre for Urban and Environmental Studies (RCUES) and the National Institute of Urban Affairs (NIUA) played an important role in disseminating information about government rules, policies, and programmes, besides acting as a knowledge hub and training institute. Apart from these, individual organizations like Central Public Health and Environmental Engineering Organization (CPHEEO) and the Town and Country Planning Organization (TCPO) prepared policy and guidelines to assist cities to prepare various plans and policies. These efforts, however, were sporadic and were not part of a larger scheme of events that might have led to a systematic change in the level of capacity and skills in the ULBs in India.

ORGANIZATION	PROGRAMMES
	Pre JNNURM
MoUD[2]	Public Health Engineering Training Programme
	Financial Assistance
	Establishment of Regional Centres for Urban and Environmental Studies
	National Institute of Urban Affairs
	Research and Capacity Building in Urban and Regional Planning
	Central Public Health and Environmental Engineering Organisation
	The Town and Country Planning Organization
	Under JNNURM
JNNURM[3]	Toolkits and Guidelines for Preparation of City Development Plans (CDP) and Detailed Project Report (DPR)
	Independent Review and Monitoring Agencies
	Reform Appraisal and Monitoring Agencies
	The Programme Monitoring and Evaluation System
	Programme Management Unit and Project implementation Unit
	Rapid Training Programme
	Peer Experience and Reflective Learning
	National Mission Mode Project
	Regional Capacity Building Hubs
MoHUPA[4]	A Toolkit for Financial Support
	A National Network for Resource Centres
Capacity Building Under CBUD[5]	Component 1: Capacity Building for Strengthened Urban Management
	Component 2: Capacity Building for Effective Urban Poverty Monitoring and Alleviation
Capacity Building Under CBULB[6]	Component 1: Capacity Development of ULBs for Strengthened Urban Management
	Component 2: Creation of Supporting Structures and Mechanisms at State and Central Level to Facilitate Capacity Building of ULBs
NERUDP[7]	Five Capital NE Cities—Technical Assistance for Project Design, Monitoring and Implementation, Financial Reforms and Institutional Development and Project Management Capacity
LBS NAA[8]	National PPP Capacity Building Programme (NPCBP)
	Capacity Building Project on Disaster Management

[2] Report of the Working Group on Capacity Building for the Twelfth Plan – Planning Commission, 2012–17.
[3] Report of the Working Group on Capacity Building for the Twelfth Plan – Planning Commission, 2012–17.
[4] Report of the Working Group on Capacity Building for the Twelfth Plan – Planning Commission, 2012–17.
[5] http://jnnurm.nic.in/capacity-building-activities-under-cbud-program.html (last accessed on May 22, 2015).
[6] http://jnnurm.nic.in/toolkit-for-comprehensive-capacity-building-programme.html (last assessed on May 22, 2015).
[7] NERUDP-North Eastern Region Urban Development Programme Report of the Working Group on Capacity Building for the Twelfth Plan – Planning Commission, 2012–2017.
[8] Report on Pilot Project - Capacity Building Project on Disaster Management, Centre for Disaster Management, 2012–13.

Post JNNURM

JNNURM marked the beginning of the realization of systematic capacity and skill building of the ULBs to implement reforms, to match the National and State level agendas for urban growth and development. The scheme required the cities to prepare their city development plans and detailed project reports, the guidelines for which were made available by the JNNURM cell and the cost of preparation of CDPs and DPRs were dispersed to the 65 cities covered under the scheme. Besides, these rapid training programmes to upgrade the skills of municipal and parastatal staff involved in service delivery were implemented to support reform implementation, DPR preparation and project management and implementation. Regional capacity building hubs were established across India to strengthen and facilitate the capacity needs. Even the peer experience and reflective learning (PEARL) programme was launched to support and facilitate knowledge and experience sharing with peer networks and to disseminate best practices taken up in different cities.

Other Parallel yet Important Initiatives

In addition to this, the Ministry of Housing and Urban Poverty Alleviation (MoHUPA) prepared a toolkit for financial support for comprehensive capacity building meant for improving urban governance and poverty alleviation. The Ministry also created a national network of resource centres to contribute towards knowledge management, capacity building on various issues related to housing, and urban development in the cities.

The capacity building under CBUD programme funded by The World Bank and housed within the Ministry of Urban Development and the Ministry of Housing and Urban Poverty Alleviation targeted capacity needs through its two major components:

- Capacity building for strengthened urban management—A component that was designed to provide support to urban local bodies (ULBs) on financial management reforms, urban planning, service delivery, and governance.
- Capacity building for effective urban poverty monitoring and alleviation—The component included support in upscaling and replication of good practices, support to create networks of practitioners and network on community development and formation of apex resource institutes.

Similar to this programme, the capacity building for urban local bodies (CBULB) programme undertaken under JNNURM in the year 2013 also had two components:

- Capacity development of ULBs for strengthened urban management for 375 cites—This included the establishment of city level reforms and performance management cell (RPMC) in all these cities and also provided capacity building support for preparation of Integrated City Plans for the city and the peri-urban areas of these cities. The scheme also included support to these cities in preparation of business cum financial plans and also to conduct residential and non-residential training programmes for staff and elected representatives of all the ULBs on the basis of their training need assessments.
- Creation of supporting structures and mechanisms at State and Central level to facilitate capacity building of the ULBs—This included establishment of State level RPMCs in 31 States/UTs, strengthening of state administrative training institutes (ATIs) by establishing urban management centres to help support training of municipal officials, preparation of state capacity building strategy and capacity building plan, preparation of training modules and implementation of training programme workshops along with exposure visits for the staff and elected representatives.

Under the CBULB programme, 13 Centres of Excellence were established in the Ministry of Urban Development out of which nine were for urban development and four for urban transport. Besides this, the North Eastern Region Urban Development Programme (NERUDP) needs a mention here as this was specifically formulated to provide technical assistance for project design and monitoring, implementation of institutional and financial reforms, and for creating project management capacity at the State level.

National and State Level Training Institutes

The National and State level training institutes—Lal Bahadur Shastri National Academy of Administration (LBSNAA), and other State ATIs were established for implementing national- and State-level capacity building programmes and train probationary and serving officials of State governments, urban local bodies, and Central government departments. LBSNAA, established in 1959 at Mussoorie (Uttarakhand), is a research and training institute on public policy and public administration undertaken by the Government of India to train civil service officers.

Besides this, some State governments have initiated their own capacity building programmes. The foremost amongst these are the states of Tamil Nadu, Karnataka, Andhra Pradesh, and Maharashtra. While Tamil Nadu has created an exclusive institute for the urban sector, Karnataka has established a State Institute of Urban Development at Mysore. The State governments of Andhra Pradesh and Maharashtra have been utilizing their own state ATIs and local training organizations to conduct capacity building programmes in their states.

Gaps in the Current Plans and Schemes for Capacity Building

The working group on capacity building under the 12th Plan document highlights some of the gaps and shortcomings of the capacity building initiatives. The report emphasizes the fact that there is a lack of demand for systematic skill enhancement and planned capacity building in the urban local bodies (ULBs) in India. Absence of formal structures to support capacity building, lack of municipal cadre and staffing norms, clear job descriptions and reluctance to adapt to new technologies are some of the shortcomings with the current system. Again, issues such as low budgetary support, lack of autonomy to plan and govern cities, lack of the culture that supports skill development for technical and managerial capacities and little attention to competencies of the elected representatives create further problems. The report also highlights the limited capacity of the ULBs to absorb various capacity building programmes and subjects that were directed to them under the JNNURM. Also, the scale and pace of the states and the cities to implement these capacity building programmes could not match the pace of the large scale government programmes. This is particularly because of the absence of a strategy for planned capacity building and skill enhancement that led to implementation of stand-alone training programmes rather than having process- and outcome-based regular training programmes that could be measured for their effectiveness. The following table consolidates some of the recommendations made by the working group on capacity building under the 12th Plan period:

The **Working Group Committee recommended** starting a campaign of capacity building for the ULBs and State governments. The following were its recommendations:

- Set up **five Indian Institutes of Urban Management** through partnership between the Government of India, State governments and the private sector
- **Lateral hiring of professionals** into the municipal cadre with flexibility with respect to special skills into the cadre
- **Infuse funds and new talent** into existing Schools of Urban Planning
- Promote **think tank initiatives** in urban policy through Centres of Excellence/ Innovation in existing institutions
- Create a **Reform and Performance Management Cell** (RPMC) in the Government of India (at State level and in large cities) with a multidisciplinary team undertaking activities
- Train civil service officers and others central services annually as **urban specialists**
- Build/**Reform Municipal cadres**

The working group also notes the recommendations made by the **Second Administrative Reform Commission** in its report "Local Governance—An Inspiring journey into the future". The following recommendations on Capacity Building were made:

- State governments should encourage **local bodies to outsource specific functions to public or private agencies,** through enabling guidelines and support, backed by the development of in-house capacity for monitoring and oversight of outsourced activities
- **'Networking' of institutions concerned with various subjects** such as financial management, rural development, disaster management, and general management
- A **pool of experts and specialists** (engineers, planners, etc.) could be maintained by a federation/consortium of local bodies, to be utilized whenever required for specific tasks

Based on **JNNURM experiences,** the Working Group arrived at certain conclusions:

- It might be preferable that **capacity building interventions precede the implementation of programmes** for infrastructure development and governance reform, rather than implemented either simultaneously or separately
- **Capacity building has been limited** due to the supply driven approach, provision of support on a 'first come, first serve' basis, limited and unpredictable modalities of funding
- The interventions have had **limited success in engaging political leaders** and elected representatives
- **Absence of capacity building strategy** at the administration level stand-alone programmes with no measurable process and outcome indicators, save utilization of funding
- **Inadequate engagement of supply side agencies** which are essential partners in any comprehensive capacity building programme for the urban sector

Source: Report of the Working Group on Capacity Building for the 12th Five-Year Plan – Planning Commission, 2012–17

Learning from TERI-APN Programme: Feedback and Experience

The 'Capacity building programme on urban climate change resilience in India' is sponsored by the Asia-Pacific Network for Global Change Research (APN). Under their CAPaBLE programme, The Energy and Resources Institute (TERI) designed and delivered capacity building programmes on urban climate resilience in four states of India—Goa, Uttarakhand, Odisha, and Maharashtra. For Goa, TERI associated with the Directorate of Municipal Administration, Government of Goa; for Uttarakhand, The Department of Urban Development, Government of Uttarakhand; and for Odisha and Maharashtra, TERI associated with the respective state ATIs to conduct these training programmes. It included a day-long orientation programme for elected representatives of the ULBs of the selected states and a two-day long training programme for city officials and practitioners. A seminar for students and researchers was also conducted in association with the TERI University.

The project endeavours to inculcate the goal of building urban climate change resilience at all levels of governance and is

implemented to its true intent. The content of the programme included lectures on application of tools and techniques, such as climate modelling and GIS for climate proofing the cities; risk and vulnerability assessment approaches; financing mechanisms for implementing resilience; policy and regulatory measures for mainstreaming urban climate change resilience; role and functions of various institutions and public agencies in building urban climate resilience and disaster risk reduction in urban areas. These were substantiated by screening films on the subject and group exercises for the participants.

The feedback received from these training programmes has been consolidated under the following heads for clarity:

Language

Language is an important consideration while designing a training programme in Indian cities. Unlike the common belief, English may not work in every situation and the local/regional language is the preferred mode. Hindi works better than English in some states, but a pre-assessment of language requirement goes a long way in increasing the effectiveness of the programme. Since it might not be possible for experts to know all languages, it is also advisable to prepare short and crisp reading materials in the regional language. Inviting local resource people and keeping a good mix of external and local experts help in covering a range of topics.

Duration

Duration of the training programme is an important factor. If the training is organized for various ULBs and for a particular set of audience, for example, engineers, the training could be more technical in nature and could be planned for a longer duration. While a training programme for a mix group will have to compromise on the technicalities, but it could focus on broader issues related to the subject and have to be shorter than the one that is designed for a focused group. The duration of the training programme would also depend on the location. For example, in Uttarakhand, not all municipalities could attend the training programme because they found Dehradun too far to go for a two-day training programme. Some of the participants, particularly elected representatives travelled for an average of six hours to attend a day-long training programme. It was suggested that the duration and location have to be a major consideration while planning a programme.

Audience/Participants

Keeping two separate programmes for elected representatives and municipal officials turned out to be a good decision because of the clear distinction of roles and responsibilities of the two groups and also the level of understanding of the topic of training. However, it was suggested that for matters related to ULBs, a day should be dedicated only for interaction and collective learning between the elected representatives and city officials—something that is not possible under the regular protocols of municipal administration and hence, there is great communication gap between the two levels of functionaries.

Content

While the subject matter was found interesting and new, and the overall reaction to the training programmes was positive, yet it was suggested that the training modules should give direct examples from the day-to-day functioning. Subjects like climate change and climate resilience, even, disaster management are not directly related to the functions of the officials. While the officials were very interested in knowing about the theme, they wanted sector specific solutions to be presented along with the problems, risks, and vulnerability. It was suggested that there should be avenues for more involvement/interaction of the participants, with their roles in the respective projects being discussed. It was also discussed how their role in the projects could be streamlined towards building climate resilience.

Besides these, demonstrations and site visits to projects were suggested to be more effective than classroom teaching. The participants also suggested that if these training programmes have to become practical and something that they could use in their regular working, then these should also

provide information on how projects to build climate change resilience can be brought into the cities and where officials should apply to bring such projects to their municipality. It was also advised that information should be provided on what each department specifically should do to build climate change resilience in the cities.

The sessions should focus on more practical and ground-level implementable solutions such as sewage treatment plants (STPs), biogas, rainwater harvesting and use of renewable energy. This programme should also be open to different planning department heads of local bodies, such as executive engineers, assistant engineers, medical officer for health, staff like junior engineers and staff looking at municipal solid waste (MSW), block level officers, Nagar Parishads, Jal Nigam, electricity department, development authority, PWD and the environment department.

It was suggested that the content of the training programme should be designed to be context specific, for example, adaptation solutions specific to hill states in Uttarakhand. It was also suggested by the participants that they would prefer training programmes that equip them best to deal with their day-to-day activities and learn new things in the area of their work. They will be more interested in learning new things if it adds value to their current responsibilities and the training programme is designed, such that they can relate functionally to the subject. So, the modules should be streamlined and aligned to such needs.

Sustainability and Regularity of the Capacity Building Programmes

TERI–APN programme was organized in association with the State government and the State ATIs of participating states. This helped plan the date, duration, and venue for the programmes besides ensuring participation. Participants suggested that similar training programmes should be organized at regular intervals. A State level training calendar where municipal officials are trained on various topics of relevance on a regular basis will help in skill building a well as in inculcating a culture of education and learning.

Dedicated Programmes for Targeted Group of Officials

This was a general suggestion across the four states, that training programmes for specific group of officials, for example, senior engineers, junior engineers, etc., should be designed and conducted as these officials work on ground and deal with day-to-day challenges and has the least opportunity for skill building.

Learning from the Seminar for Students

A two-day long seminar for post graduate students of architecture and planning and early researchers was organized in association with the TERI University. The objective of the programme was to acquaint future practitioners with the technicalities of the subject and to create interest in the emerging challenges that cities are facing and for which cities should equip themselves. The students suggested that the duration of the programme could be extended to accommodate more technical subjects and demonstration projects. It was suggested that subjects like climate resilience and associated technical modules should be mainstreamed into their course curriculum. The students wanted to be trained on the usage of different tools available in the knowledge domain and also wanted to have hands-on training for some of these tools in training programmes such as these.

Conclusion

The challenges related to capacity of urban local bodies are multiple and have to be addressed at various levels. At the larger level, mandates and mechanisms have to be created that foster an environment of learning and skill building. There should be a planned mechanism to ensure regular training. Besides this, different requirements of different cadre of officials should be assessed and accordingly training programmes should be designed. Issues related to subject matter, new developments, information on the government's new agendas and expectations thereof, have to be addressed through these capacity building programmes.

It is also recommended that capacity building should be the first activity when a new scheme/programme is implemented by the government. Several other new subjects such as energy efficiency, climate change impacts, and disaster management that may not fall directly in the purview of ULBs' functioning have to be covered through standalone programmes, to keep the official abreast of new developments and also to build a cadre of well-informed and skilled ULB officials.

Language barriers, challenges related to scheduling the training programmes and time of the officials could be planned in consultation with the State government. State ATIs will have to play a key role in this, while the State and National government have to tap external and institutional expertise, considering the huge volume of capacity building that is required in Indian cities at this juncture. Strategic planned efforts towards a common goal of smart and sustainable ULBs will go a long way in building smart and sustainable cities in India.

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