Mainstreaming climate change adaptation in Indian cities

DIVYA SHARMA AND SANJAY TOMAR

Dr Divya Sharma is a Fellow in the Centre for Research in Sustainable Urban Development and Transport Systems in the Sustainable Habitat Division at The Energy and Resources Institute (TERI), New Delhi, India. She trained as an architect and urban planner and holds a PhD in the area of climate change and urban development.

Address: Sustainable Habitat Division, The Energy and Resources Institute (TERI), India Habitat Centre (IHC), Lodhi Road, New Delhi 110 003, India; e-mail: divyas@teri.res.in

Dr Sanjay Tomar is a Senior Technical Expert, Climate, at the German Agency for Technical Cooperation (GTZ), New Delhi, India. He works in the area of natural resource management and climate change adaptation and has nine years experience in natural resource management, watershed development, capacity-building and training in agriculture extension management, impacts, vulnerability assessment and climate change adaptation.

Address: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH. B – 5/1 Safdurjung Enclave, New Delhi 110029, India; e-mail: sanjay.tomar@gtz.de

ABSTRACT If climate change is perceived as a global threat, this can mean that too little attention is paid to the ways in which it affects local populations and settlements. This also means too little attention to the importance of locally driven adaptation, both to reduce risks and to be better prepared to cope with consequences. This paper reviews the many initiatives underway in India that respond to climate change, and discusses what else is needed to mainstream effective adaptation, as well as identifying what currently constrains this. It also discusses how adaptation has to be mainstreamed within urban development and urban governance. Most municipal authorities in India are already grappling with large deficits in infrastructure and services and do not see climate change adaptation as a priority or as their responsibility. However, their attention may be engaged if they can see the co-benefits between adaptation and measures to address development and environmental health concerns.

KEYWORDS adaptive planning / climate change impacts / climate change vulnerability / Indian cities / local government

I. INTRODUCTION

The IPCC's fourth assessment report concludes that it is extremely likely that the rise in global atmospheric temperature that has taken place since the mid-nineteenth century has been caused by human activities.(1) Urban centres are not only the generators of greenhouse gas (GHG) emissions, which are the main causes, of climate change, but, in turn, are also affected by the impacts of climate change.

Cities, as concentrations of large populations, are at risk of the impacts of climate change on infrastructure, human lives, human health, personal property, environmental quality and future prosperity. Cities should not be seen only as centres of GHG emissions, as they also play a key role in strategies to reduce these.(2) The need for city governments to reduce emissions is well established, and many city governments in Europe and North America are already acting on this. In India too, the government of Delhi has introduced a Delhi Climate Change Agenda (2009–2012), which lays out the necessary actions as outlined in the Prime Minister's National Action Plan on Climate Change. The agenda primarily aims to reduce Delhi's carbon footprint by identifying a set of 65 action points that each department within the Delhi government would have

Vol 22(2): 451–465. DOI: 10.1177/0956247810377390 www.sagepublications.com

to follow in the next three years.[3] However, the issue of risk reduction and adaptation to climate change has received little attention.[4] For example, the introduction of compressed natural gas (CNG) fuelled buses by the Delhi government and the phasing out of diesel buses was an attempt to improve the air quality in the city, although it did not take into account emissions reduction as a primary objective.[5]

Two broad categories of response mechanism are identified by the UN Framework Convention on Climate Change (UNFCCC) to deal with climate change, namely, mitigation and adaptation. Mitigation refers to an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases, while adaptation refers to the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. Even if GHG emissions were to stop immediately, the average temperature would continue to rise for some time as the life of carbon dioxide in the atmosphere is more than 100 years.[6] Although research on adaptation and mitigation has been rather unconnected to date, it is clear that both responses are equally important and can help reduce the risks of climate change to natural and human systems. For example, mitigation will have global long-term benefits, whereas the benefits of adaptation are on a local to regional scale. However, they will offer immediate benefits compared to mitigation.

Climate change mitigation has captured both international and national attention. However, adaptation to climate change is equally important because most of the vulnerable cities are not big emitters of greenhouse gases.[7] These cities, some of which belong to the developing world, are highly vulnerable to climate change-related extreme events.[8] Climate change not only increases the incidence of extreme events and disasters but also induces gradual changes such as temperature and precipitation changes. This makes resource management and infrastructure planning more challenging and, at the same time, increases the urgency of the need to adapt city level operations to both current climate variability and future climate change.[9] Hence, there is a need for an adaptation agenda in the governance system of cities.

II. ADAPTATION ACTION: POSSIBLE AND FEASIBLE LEVELS OF INTERVENTION

There has been considerable debate within the scientific community about the scale of adaptation to climate change. Adger et al. argue that adaptation operates at different spatial and societal scales and that success and/or sustainability need to be evaluated against different criteria at these different levels.[10]

Adaptation can be targeted at both the national and local scale. For example, Article 3 of the UNFCCC encourages governments to adapt to climate change; and the Delhi ministerial declaration on climate change and sustainable development, issued at the Eighth Conference of the Parties (CoP) of the UNFCCC in 2002, stated that adaptation requires urgent attention and action on the part of all countries. Besides this, municipalities, cities, firms and markets in the West have started to incorporate adaptation actions within the bounds of available technologies, regulatory systems and knowledge of future climate risks.

1. IPCC (2007), "Summary for policy makers", in S Solomon, D Qin, M Manning, Z Chen, M Marquis, K B Averyt, M Tignor and H L Miller (editors), *Climate Change 2007: The Physical Science Basis*, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Cambridge University Press, Cambridge, UK, and New York, USA.

2. Lankao, P R (2007), "Are we missing the point? Particularities of urbanization, sustainability and carbon emissions in Latin American Cities", *Environment and Urbanization* Vol 19, No 1, April, pages 159–175.

3. See http://www.indiaenvironmentportal.org.in/content/climate-change-agenda-delhi-2009–2012.

4. Huq, S, S Kovats, H Reid and D Satterthwaite (2007), "Reducing risks to cities from climate change: an environmental or a development agenda", *Environment and Urbanization* Vol 19, No 1, April, pages 3–15.

5. See http://www.cleanairnet.org/infopool/1411/propertyvalue-19513.html.

6. Reid, Hannah and Saleemul Huq (2007), "How we are set to cope with the impacts. Adaptation to climate change", IIED Briefing, International Institute of Environment and Development, London.

7. See reference 4.

8. Dossou, Krystal M R and Bernadette Glehouenou-Dossou (2007), "The vulnerability of global cities to climate change in Cotonou (Benin): the rise in sea level", *Environment and Urbanization* Vol 19, No 1, April, pages 65–79; also Muller, Mike (2007), "Adapting to climate change: water management for urban resilience", *Environment and Urbanization* Vol 19, No 1, April, pages 99–113; and see reference 2.

9. Mukheibir, P and G Ziervogel (2007), "Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town", *Environment and Urbanization* Vol 19, No 1, April, pages 143–157.

10. Adger, W N, W A Nigel and E L Tompkins (2004), "Successful

adaptation to climate change across scales", *Global Environmental Change* Vol 15, pages 77–86.

11. See reference 9.

Mukheibir and Ziervogel argue the need for a consolidated and coordinated approach to adaptation to projected climate impacts on a municipal scale because it is at this level that people are directly affected by climate-induced impacts and it is at this level that institutional solutions that target wide numbers of people can be introduced.(11) It is, therefore, necessary to develop a framework for adaptation to climate change that enables the most urgent local adaptation activities and identifies the necessary local human and financial resources. There is a need for a clear urban agenda that focuses on building adaptation frameworks within the development plans.

III. EXPOSURE TO CLIMATE-RELATED RISKS AND THE VULNERABILITY OF INDIAN CITIES

The risks to the Indian sub-continent as a result of climate change are high and multi-dimensional. There is a risk of increases in both mean minimum and maximum temperatures of 2–4° C.(12) The predicted regional temperature rise, along with changes in the global climatic system, would alter the monsoon system, leading to an increase of 7–20 per cent in mean annual precipitation. A 10–15 per cent increase in monsoon precipitation, a 5–25 per cent decline in precipitation levels in semi-arid and drought-prone central India and a decline in winter rainfall in northern India is also projected.(13) Another study predicts a decrease in the number of rainy days expected over much of India, along with increased frequency of heavy rainfall in the monsoon season.(14) Extreme precipitation events like the one in Mumbai in 2005 are expected to increase substantially over the west coast and in central India.(15) On 22 August 2009, Delhi witnessed a heavy downpour that brought about 74 millimetres of rainfall in just two hours. This caused the national capital to grind to a virtual halt, as the roads were flooded, the sewers clogged up and the traffic slowed down for hours.(16)

12. Revi, A (2005), "Lessons from the deluge: priorities for multi-hazard risk mitigation in Mumbai", *Economic and Political Weekly* Vol XI, No 36, September, pages 3–9.

13. See reference 12.

14. Kumar, R K, A K Sahai, K Krishna, S K Patwardhan, P K Mishra, J V Revadekar, K Kamala and G B Pant (2006), "High resolution climate change scenarios for India for the 21st century", *Current Science* Vol 90, No 3, 10 February, pages 334–345.

15. See reference 14.

16. See http://www.hindustantimes.com/Hard-two-hour-rain-and-Delhi-has-another-manic-day/H1-Article1–445672.aspx.

Gujarat has faced three floods since 2004 as a result of extreme weather events, resulting in great economic losses in its cities.(17) For example, the devastating Mumbai floods of 2005 caused the bulk of city services and all transportation networks to be shut down for almost five days. More than 1,000 people lost their lives and economic life in the city came to a halt. The catastrophic results of the event were due not only to a natural disaster of extreme intensity but also to a combination of institutional failures, poor preparedness and extremely high vulnerability of the poor.(18) The vulnerability of Indian cities can be defined in terms of the expected and evident exposure to risks. For example, expected increases in the incidence of drought as a result of climate change leads to increased seasonal migration from rural to urban areas. These migrants, in turn, form the most marginalized and highly vulnerable groups in cities, with limited skills, education, capital and limited social and economic mobility.

17. GSDMA/ TARU (2005), *Gujarat Vulnerability and Risk Atlas*, Gandhinagar, Gujarat, India.

18. See reference 12.

Cyclones and storm surges could have a devastating impact on large coastal urban centres, including the mega cities of Mumbai and Chennai, the million-plus cities of Vishakhapatnam, Surat, Bharuch, Bhavnagar and Jamnagar, besides affecting important ports such as Kandla. In 1999, Orissa was hit by a super-cyclone that killed more than 10,000 people and devastated buildings, essential services and infrastructure and economic

assets across 10 coastal and six inland districts, which included a number of towns and cities.[19]

Besides this, a mean sea-level rise (SLR) that could reach 0.8 metres over the century[20] can put a number of regions and cities at risk. A study by McGranahan et al. shows that Asian countries are highly vulnerable to sea-level rise, as they have three-quarters of the world's population and two-thirds of the world's urban population with a concentration greater than five million living in the Low Elevation Coastal Zone (LECZ).[21] The most vulnerable stretches along the western Indian coast are Khambhat and Kuchh in Gujarat, Mumbai and parts of the Konkan coast, and South Kerala. A significant amount of settlement area is expected to be lost in the Ganga, Krishna, Godavari, Cauvery and Mahanadi deltas on the east coast.[22] The increased coastal vulnerability is due to differential population densities along the coast and in coastal deltas, and the greater openness of the Indian economy to trade.

IV. INDIA'S PRESENT URBAN CHALLENGES AND THE NEED FOR CLIMATE CHANGE ADAPTATION

India's present urban challenges make the cities more vulnerable to losses that might result from the impacts of climate change. Climate change risk to Indian urban centres can be seen in the perspective of the expected transition in city growth. By the 2060s, it is expected that there will be approximately 500 million additional people in an estimated 7,000–12,000 urban settlements, with related environmental transitions in water, sanitation and environmental health, air and water pollution and climate change.[23] The cities in India are already grappling with inadequate provision for water, sewerage systems, drainage and solid waste management facilities. Many cities lack proper road infrastructure and efficient public transport facilities. Above all, the housing scenario is grossly inadequate, with almost 50 per cent of the people living in slums in some of the metro cities. The challenge also lies in the sheer number of urban centres and the population they house. India has 4,378 urban agglomerations/cities and towns. Thirty-five of these have populations of more than a million and 393 have populations of more than 100,000.[24] India contributes to 12 per cent of global population growth, and three of India's cities, namely Mumbai, Delhi and Kolkata, are among the world's eight largest cities.

The introduction of the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in 2005 has been a welcome scheme because it targets urban development and urban renewal and covers 65 important cities in India. The scheme focuses on improvements in infrastructure development, urban poverty and urban governance. There is currently no sub-component under the JNNURM scheme for climate adaptation, risk mitigation or vulnerability assessment for urban areas.[25] There is a strong need for integration of climate change risk mitigation and adaptation in the urban planning initiatives, and before that there is a strong need to view, recognize and acknowledge climate change as a major theme to be worked upon and integrated within the whole urban planning agenda and process.

Besides this, there are strong co-benefits to adaptation planning, because not only does it entail good urban planning but it also considers environmental sustainability. For example, reducing the vulnerability of urban populations would require structural, social and economic

19. TARU/ BMTPC (2000), "Rapid assessment of damage to buildings and lifeline infrastructure in districts of Orissa affected by cyclonic storm 05B-99", TARU, New Delhi.

20. Aggarwal, D and M Lal (2001), "Vulnerability of Indian coastline to sea-level rise", Centre for Atmospheric Sciences, Indian Institute of Technology, New Delhi.

21. McGranahan, Gordon, Deborah Balk and Bridget Anderson (2007), "The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones", *Environment and Urbanization* Vol 19, No 1, April, pages 17–37.

22. See reference 20.

23. See reference 21.

24. *Census of India (2001), Provisional Population Total*, Government of India Press, New Delhi.

25. Revi, A (2008), "Climate change risk: an adaptation and mitigation agenda for Indian cities", *Environment and Urbanization* Vol 20, No 1, April, pages 207–229.

interventions. Improving land use planning, housing, infrastructure and services all increase resilience and promote planned and sustainable development. Adaptive actions that target environmental sustainability would help reduce air and water pollution, restore water bodies and promote effective waste management, among many other benefits. For most of the urban centres in India that do not have high GHG emissions and have less scope for mitigation, adaptation co-benefits would prove to be significant landmarks in development planning.

Hence, developing a climate change adaptation framework at city level in India would require opening up a dialogue on urban development and growth and re-directing ongoing investments and programmes towards the cause of climate change adaptation in a way that also takes into consideration development priorities and, before that, the identification of city specific vulnerability and risk.

V. HISTORICAL AND PRESENT PERSPECTIVE – PLANS AND POLICIES IN INDIA

Since 1998, India has undertaken a few national assessments of climate change risks, including an assessment of impact, and adaptation and mitigation options. But local level adaptation actions or policy interventions do not exist. However, the National Action Plan for Climate Change (NAPCC)[26] introduced by the Prime Minister of India, has opened up certain entry points; and a few international agencies such as the World Bank, the International Council for Local Environmental Initiatives (now known as ICLEI–Local Government for Sustainability), the World Wide Fund for Nature (WWF), the Asian Cities Climate Change Research Network (ACCCRN) and the Urban Climate Change Research Network (UCCRN) also have started pilot projects in some Indian cities.

26. See http://pmindia.nic.in/climate_change.htm.

Table 1 gives a brief overview of studies, policies and projects on climate change so far, which are discussed in detail in the coming paragraphs. Not all the interventions mentioned here have been primarily for adaptation. The initial interventions have mostly been assessments of climate change vulnerability and impact assessment studies, or disaster management strategies.

Urban adaptation planning is imperative for Indian cities given the expected addition of almost 500 million people in an estimated 7,000–12,000 urban settlements by the 2060s and simultaneous related environmental transitions in water, sanitation and environmental health, air and water pollution and climate change. Some other initiatives in this area, targeting Indian cities, are discussed below.

The World Bank has initiated a project in Kolkata to assess the vulnerability and adaptation options for the city. The objectives of the study are to:

- improve downscaling of precipitation variation and sea-level rise projections for Kolkata Metropolitan region for the years 2015, 2030 and 2050;
- model stormwater scenarios for the metropolitan region for 2015, 2030, 2050, etc.;
- determine the vulnerability of key urban infrastructure; and
- estimate initial costs for necessary infrastructure adaptation measures under these scenarios.

TABLE 1
A summary of initiatives on climate change

Study/project/ policy intervention	Supported/initiated by:	Significant year
Climate change mitigation and impact assessment		
Asian Least-Cost Greenhouse Abatement Strategy (ALCGAS)[1]	Supported by the Global Environment Facility (GEF), this was a study of national greenhouse gas (GHG) emissions for base year 1990, GHG emissions projections to 2020 and an analysis of the mitigation option in different economic sectors in 12 Asian countries. This was a regional UNDP/GEF project implemented by the ADB. The project objectives were to build capacity and conduct studies to address the then levels of GHG emissions and identify technologies that could be cost-effective in reducing GHGs. The project also proposed to develop implementation strategies for reductions in GHSs.	1998
India's initial communication to the UNFCCC through the National Communication Project (NATCOM)[2]	Supported by UNDP/GEF, this study was prepared through a national effort involving more than 350 scientific personnel constituted into 131 multidisciplinary teams and was coordinated by the Government of India's Ministry of Environment and Forests.	
Climate impact assessment study	Supported by DEFRA (UK government).	
Disaster risk reduction and management strategies		
Gujarat State Disaster Management Authority (GSDMA)[3]	The objectives of GSDMA are to: • undertake rehabilitation, relief and reconstruction, and social and economic activities or restoration of the situation during and after any natural calamity; • minimize the impact of natural calamities through precautionary programmes and schemes; • analyze and study the reasons for natural calamities and suggest remedies to avoid or minimize the effects of such natural calamities; • make best use of the funds, grants and donations received for the revendication of such natural calamities or for handling the after-effects; obtain loans and make proper use of the funds received by the GSDMA.	Kuchh earthquake (2001)
Orissa State Disaster Mitigation Authority (OSDMA)[4]	The objectives of OSDMA are to: • act as the nodal agency for disaster reconstruction works; • coordinate with the line departments involved in reconstruction; • coordinate with bilateral and multilateral aid agencies; • coordinate with UN agencies, international, national and state level NGOs; • promote disaster preparedness at all levels in the state and network with similar and relevant organizations for disaster management.	Orissa super cyclone (1999)
Integrated Coastal Zone Management Plans (ICZMPs) and a review of the principles and norms for managing Coastal Regulation Zones (CRZs)[5]	The objective of ICZMPs is to manage and regulate activities in the coastal and marine areas in order to: • conserve and protect the coastal resources and coastal environment; • ensure the protection of coastal populations and structures from risks of inundation due to natural hazards; • ensure that the livelihoods of coastal population are strengthened.	Indian Ocean tsunami (2005)

TABLE 1 (CONTINUED)

Strategies having adaptation as one or main component		
India's National Action Plan for Climate Change (NAPCC)[6]	Introduced by the Prime Minister's Office of the Government of India, the NAPCCC outlines existing and future policies and programmes that address climate mitigation and adaptation. Eight core "national missions" have been identified, running through 2017, which identify measures that promote development objectives while also yielding co-benefits for addressing climate change effectively.	2008
National Mission on Sustainable Habitat (NMSH) – one of the NAPCC's eight missions[7]	Prepared by the Government of India's Ministry of Urban Development, the plan addresses adaptation and mitigation interventions as a critical area of engagement for Indian cities, and the financial and institutional back-up for the same.	2009
ICLEI and WWF (pilot projects in Kanpur and Meerut)[8]	The objectives of the programme are to: • promote and advocate co-management of water and energy; • promote sustainable use of natural resources and consumption practices in urban areas; • promote and pilot innovative approaches in water resource management, energy use and municipal waste; • develop innovative initiatives such as ecological rating/footprint analysis and disclosure by urban local bodies; • support initiatives for biodiversity and natural resource conservation; • promote management systems such as *eco*-BUDGET in the context of rapid urbanization.	On-going
Asian Cities Climate Change Research Network (ACCCRN) (pilot projects in Surat, Gorakhpur and Indore)[9]	Supported by the Rockefeller Foundation, the network aims to establish, by 2012, a network of cities in Asia with robust plans to prepare, withstand and recover from the predicted impacts of climate change. ACCCRN will help cities to test a range of actions to build their climate change resilience, as well as build a replicable base of lessons learned and successes and failures from the pilots that can address similar efforts elsewhere.	On-going
Urban Climate Change Research Network (UCCRN)[10]	The goals of the programme are to: • develop a shared research agenda on urban climate change issues with stakeholders; • facilitate research collaborations within and across cities/ metropolitan areas; • enhance cutting-edge scientific, economic and planning-related research; • promote knowledge-sharing among researchers, urban decision makers and stakeholders; • exchange lessons learned across cities; • assess and report on on-going mitigation and adaptation research and practice in major cities.	On-going

SOURCE: [1] http://www.adb.org/REACH/algas.asp;
[2] http://www.natcomindia.org/natcomreport.htm;
[3] (http://www.gsdma.org/);
[4] http://v3.osdma.org/;
[5] http://envfor.nic.in/legis/crz/so-1070(e).pdf;
[6] http://pmindia.nic.in/climate_change.htm;
[7] http://pmindia.nic.in/climate_change.htm;
[8] http://www.iclei.org/index.php?id=8801;
[9] http://www.rockfound.org/initiatives/climate/acccrn.shtml;
[10] http://www.uccrn.org/

This study is one of various projects and activities that span several Asian countries, led by the World Bank's East Asia Region. The primary client for the Kolkata project is the West Bengal Department of Environment. The city counterparts are the Kolkata Metropolitan Authority and the Kolkata Municipal Corporation.

Besides, the United Nations International Strategy for Disaster Reduction (UNISDR) is funding activities taken up to test the applicability of the climate resilience self-assessment methodology developed for the World Bank's Climate Resilient Cities Primer[27] in South Asian cities, specifically Mumbai and Pune. The work in Mumbai, led by IIT–Mumbai, has thus far included setting up with the Municipal Corporation of Greater Mumbai (MCGM) a system to collect data on climate vulnerability, assess municipal officials' awareness and readiness to integrate climate considerations into their ongoing programmes, and start the groundwork for a long-term climate change management system within the MCGM.

27. See http://siteresources.worldbank.org/EASTASIAPACIFICEXT/Resources/climatecities_fullreport.pdf.

Another study being led by an interdisciplinary team at IIT–Mumbai, with funding from OECD, aims to establish an understanding of the vulnerability and resilience issues related to floods in the city. The eventual goal is to identify adaptation measures for Mumbai that can reduce the city's vulnerability to future extreme flood events that are expected to become even more frequent and intense due to climate change.

These are a few examples of the different players present in the urban adaptation space in India. The importance of these efforts lies in that they can be treated as pilots in the sectors where they intervene, can provide a basic database and methodological inputs for replication, and can act as case studies and best practices to be adopted for planning adaptation in other cities. They give direction regarding vulnerability analysis, key stakeholders to be involved and possible entry points at city level, and might show initial benefits. However, they run the risk of losing impact once the project is over or when the allocated funds dry up. A definite institutional arrangement is called for to enable adaptation that is a long term effort weaved into the development process.

VI. INSTITUTIONALIZING CLIMATE ADAPTATION IN INDIAN CITIES

A city's legal and institutional framework and the capacity to implement adaptation policies are of great importance while identifying possible avenues and sectors for adaptation, as they are critical to the implementation of the adaptation plans that are prepared.

a. Indian urban governance scene

In India, urban development falls under the purview of the state governments, which, in turn, delegate related responsibilities to urban local bodies as envisaged under the Constitution's 74th Amendment Act. The Ministry of Urban Development and the Ministry of Housing and Urban Poverty Alleviation at the central government level are the nodal agencies for providing policy guidelines to the state governments as well as financial support in priority areas. Most of the time, a scheme or a policy is floated by a ministry and the states may implement it through their municipal bodies. Here, the role of the respective ministries is more

of a facilitator, encouraging states to avail themselves of the benefits of the schemes or to implement policies. But it is completely at the discretion of the states as to whether they take a stand on these matters. Thus, while the ministries are important in pressing forward the urban adaptation agenda because of their financial resources and ability to set policy guidelines, state governments are also key stakeholders in the process.

Local governments at city and town level, namely municipal corporations for larger cities, municipal councils for medium towns and *panchayats* for smaller towns, are also key actors in urban adaptation planning, given that adaptation is fundamentally a local exercise that must consider localized climate impacts and vulnerabilities. However, their limitations in autonomy and capacity must be acknowledged.[28] The 74th Constitutional Amendment Act (1992) envisages that over a period of time the states will delegate a substantial number of functions and powers to local governments. However, in practice, the degree to which decision-making powers have been decentralized varies from state to state. Weak institutional and human capacity poses another challenge to devolving authority to the local governments as envisaged in the 74th Amendment Act. Engaging at the state and national levels in building adaptation policy to ensure adequate support for cities in reframing their development through an adaptation lens is a crucial step.

Coordinating the multiple sectoral institutions relevant to adaptation planning is another important issue to be resolved while institutionalizing adaptation in Indian cities. Patwardhan and Ajit found that the existence of parallel but isolated institutional structures for disaster management and environment at the national level in India has stunted adaptation efforts at the sectoral level, even within institutions that are active in the areas of both disaster management and climate change science.[29] The study found that diverse sectors, including health, planning, resource management and agriculture, coordinated effectively with each other in terms of responding to disasters, supported by a coherent legal framework and resources from above, but then these same actors did not coordinate well when it came to the emerging and more fragmented fields of climate change research and planning.[30] The findings suggest that adaptation planning by Indian cities will require special attention to the forging of partnerships across disaster management and environmental institutions, among others.

28. Farrel, Leanne et al. (2009), "Towards a city adaptation framework for Indian cities – a concept note", unpublished report, TERI, New Delhi.

29. Patwardhan, Anand and Meeta Ajit (2007), "Disaster prevention, preparedness and management and linkages with climate change adaptation", Paper No 10, September, available at http://www.basic-project.net/data/final/Paper10India%20Disaster%20Prevention%20%20Preparedness%20%20Linkages%20w%85.pdf.

30. See reference 29.

b. Possible entry points for mainstreaming adaptation In India

In light of the institutional structure and challenges laid out above, a few specific programmes and institutions are worth highlighting as potentially useful entry points for mainstreaming adaptation policy in India.

i. Ministry of Urban Development's National Mission for Sustainable Habitat

The Ministry of Urban Development's National Mission for Sustainable Habitat is one of eight missions under the National Action Plan for Climate Change and is pending approval by the Government; it provides a broad institutional strategy for integrating adaptation into urban

planning processes at national, regional and city levels. This Ministry is the nodal agency to take this mission forward.

While the central thrust of the mission's objectives is primarily oriented at climate mitigation, there is explicit recognition of adaptation in several of the key objectives, including:

- re-orienting urban planning in light of climate change;
- improving disaster responsiveness;
- bringing together key stakeholders at central, state, district and local levels for a coordinated and comprehensive response to vulnerabilities arising out of climate change; and
- promoting and strengthening efforts aimed at awareness generation related to climate change.

The Mission proposes several specific adaptation interventions, organized sectorally in the following categories:

- water resource management;
- drinking water supply and stormwater;
- urban stormwater management;
- urban planning; and
- coastal zone management.

Likewise, the funding requirements for actions supported by the mission include a line item for mitigation and adaptation measures. The actions fitting into this category are broadly proposed under:

- legal and regulatory changes (national sustainable habitat parameters);
- infrastructure investments (principles of sustainable habitat to be incorporated into city development plans);
- capacity building; and
- mainstreaming new technologies.

Although there are hopes that the mission document (under approval with the Government of India) would bring out some institutional arrangement to implement adaptation within cities in India, our proposal is to mainstream adaptation within the existing urban planning and development arena rather than create a new institutional set-up, which might conflict with the already existing set-up and development agenda and also might not work because of the lack of inter- and intra-institutional coordination. A better approach would be to overlay the adaptation concerns within the existing decentralized institutional set-up, guided by the 74th Amendment Act. However, to ensure implementation of the adaptation interventions, the introduction of a monitoring cell might be feasible. On the other hand, the mission document fails to articulate the means and arrangements for spelling out city specific structural and sectoral responses. Much more work is needed to articulate the institutional linkages between sectoral agencies such as water, transport, sanitation and housing.

ii. The Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) was initiated in 2005, also under the Ministry of Urban Development, and could be a key vehicle for raising the profile of climate change within the urban planning process. The financial resources under JNNURM for

priority urban investments could be an incentive as well as a source of funds for implementing adaptation-oriented reforms at the city level. Its other advantages are its national scope, covering 65 important cities in India, and its urban development focus. Specifically, the scheme focuses on improving urban infrastructure, reducing poverty and strengthening local governance, all of which are spheres of action where climate change issues should be mainstreamed.[31] In its current initial phase, there is no sub-component addressing climate adaptation, risk mitigation or vulnerability assessment for urban areas.[32] But a second phase could include adaptation planning as one of its components.

31. See reference 28.

32. See reference 25.

The point for concern here would be how well the mission plan on sustainable habitat is articulated and implemented. The question also arises as to whether dedicated funds would be provided for activities that fall under the adaptation ambit. The Ministry will have to go further in ensuring funds for implementing adaptation-related responses.

iii. State level disaster management planning

Given the institutional strength of the state level disaster management agencies such as those of the States of Gujarat and Orissa, their relevance to the climate adaptation agenda is obvious and opportunities should be explored for mainstreaming climate adaptation through their activities. As discussed earlier in this paper, the 2005 Indian Ocean Tsunami led to a series of Integrated Coastal Zone Management Plans (ICZMPs), along with a review of the principles and norms to manage Coastal Regulation Zones (CRZs), which identified sea-level rise and other climate risks as critical issues to factor into management plans and policies.

VII. CHALLENGES AND ISSUES INVOLVED IN MAINSTREAMING ADAPTATION AT CITY LEVEL IN INDIA

Having discussed the possible entry points for adaptation interventions in Indian cities, it is clear that a stronger, much clearer institutional set-up is required. This could be initiated through existing vehicles such as the JNNURM and state disaster management institutes, and could be shifted later on towards specific institutions/vehicles created solely for the purpose.

a. Challenges

Urban adaptation planning has just started to build in India. The Ministry has yet to implement the National Mission on Sustainable Habitat, and interventions from other agencies with regard to the number of cities they are focusing on are negligible compared to the need to adapt. Yet, the challenges to mainstream adaptation in cities that lie ahead are many. To spell out a few:

- the biggest impediment is the lack of understanding of the impacts of climate change and the fact that adaptation interventions are best implemented at the local government or city level;
- local governments usually fail to understand that planning for climate change impacts as well as environmental protection are

not something that the Department of Environment and the State Pollution Control Board do for them but, rather, these functions should be taken on in conjunction with the development functions that municipal governments undertake for their communities;
- the climate change debate has seemingly been a global debate, focusing on global impacts, and there has been no translation of these global impacts at the local level;
- local governments in India, in particular, already struggle with other development pressures and hardly find global concerns such as climate change of any interest. They are much more likely to be concerned about the local impacts, for example: "*…what does it mean for my city, town or village*";[33]
- there is a gross lack of capacity within local governments to facilitate the institutionalization of issues such as climate change;
- the ways in which buildings and infrastructure can be adapted to the impacts of climate change have not been an explicit component of the development plans of cities to date. The uncertainty and long-term nature of these impacts pose another challenge in developing specific policies to address climate change adaptation;
- the integration of climate change adaptation considerations at the municipal level would be difficult because of probable competition for funding that would affect budgets and the city's current desired development plans;[34] and
- lack of data and modelling frameworks at the city level. Adaptation needs city specific knowledge of vulnerability and impacts, which is resource intensive and requires an updated and comprehensive database. It also needs a downscaling of climate change impacts for specific urban locations in order to plan location specific adaptation strategies.

33. Roberts, Debra (2008), "Thinking globally, acting locally – institutionalizing climate change at the local government level in Durban, South Africa", *Environment and Urbanization* Vol 20, No 2, October, pages 521–537, page 528.

34. See reference 33.

b. Issues and important points of intervention

Institutional mainstreaming of adaptation is an essential milestone in adaptation planning in Indian cities. But a lot of preparatory research and orientation is required to enable long-term and sustainable institutions aimed at climate response. A few points of intervention that might facilitate and bolster the mainstreaming efforts are outlined below.

Outsourcing research to understand the impacts of climate change – translating global impacts into local effects. This can be achieved either by outsourcing the research to institutes/universities or partnering with the central agency involved in climate change research. The Planning Commission of India has divided India into 15 agro-climatic zones. Climate hazard zones could be prepared along similar lines at a regional level and cities falling within various zones would be identified. This could be mapped on a GIS platform and overlays could be prepared to understand specific geographic risks. This would be followed by an assessment of socio-economic vulnerability and bio-physical vulnerability, which would be represented on the GIS overlays. Integrating these maps with city land use plans would then give a direction for development planning and investment allocation. This could be a national level exercise, with various states being involved in identifying their pilot cities for research, follow up and implementation.

Preparation of a detailed adaptation plan and its incorporation into the development plan for the area. Planning for adaptation intervention, building implementation strategies and time lines, setting up the institutional arrangements needed to facilitate this and assessing the training needs for the municipal officials. The additional budget requirements should be finalized and the funding agency be identified to support the initial adaptation exercise.

There should be a feasibility analysis and consultation with all relevant stakeholders for plan approval; these efforts should be communicated to, and cooperation sought from, the national government so that they are not only recognized and acknowledged at the national level but are also a step towards institutionalizing adaptation efforts at the local level. Cooperation at national level would facilitate funding, research and data inputs, which are more attainable at central government level rather than local level.

Intensive training and capacity-building programme. Capacity-building would involve sensitizing municipal officials to the issues and impacts related to climate change and the importance of adaptation interventions for their local area.

The officials would be given instruction on the technical aspects of the adaptation plan and details of how they could be involved and could contribute. This might involve hands-on technical training in the use of any computer-based software to be used during the process.

Identifying adaptation issues at the local level. Municipal governments need to identify adaptation issues at the local level and need to distinguish between the interventions that fall under the functional domain of the municipal body and those that do not. Those that do fall under the municipal domain would be integrated into the area's development plans; those that do not, but that are, nonetheless, interventions that need to be implemented at the local level, must collaborate with partner agencies that might help implement these measures at the municipal level. For example, building embankments in coastal cities could be delegated to a private construction company or could be put out to tender. A possible constraint to this working might be the lack of influence that development plans generally have on city development, particularly in the case of land use management. But the benefit of doing so lies in the fact that this will provide adaptation that legitimates space in development planning, which is essential for mainstreaming adaptive actions. Supplementing adaptation with policy and institutional level changes would then make adaptation possible at the municipal level. This is all the more important when considering the fact that most municipalities are already grappling with issues of poor service delivery, insufficient revenue collection and poor financial and human resource capacity. Adding more functions, or even reinforcing the functions that municipalities already undertake, with a focus on adaptation would then become a burden.

Once implemented, there should be proper documenting of the efforts and the impediments and opportunities in order to disseminate the information, which will allow other municipalities to follow. Monitoring of the adaptation plans should be undertaken by an independent agency to ensure the long-term sustainability of the exercise.

VIII. THE WAY FORWARD

The climate change adaptation framework for cities requires the initiation of an integrated intervention that involves urban development and growth coupled with environmental safety and sustainability. This will mean re-directing investments towards adaptation planning, therefore calling for a link between different levels of institutional intervention.

This, however, is not going to be an easy task. Municipal governments in India are neither the best equipped nor are they efficient entities. Many lack the necessary finance and capacity to ensure basic services in their area. Thus, assessing the costs of adaptation and mainstreaming some of the adaptive actions into municipal functions is likely to be constrained at the bureaucratic and political level initially. But there is a brighter side to the coin as well:

- there are many co-benefits to adaptation planning. In the first instance, it allows for development and in so-doing, it allows for development that considers environmental aspects and that is sustainable in the long run;
- implementing adaptation would reap environmental benefits such as reduced air pollution, restored water bodies and land use planning that considers ecological balance; and
- investments would be directed towards clean technologies and low carbon development.

There is a strong need to understand what adaptation planning entails and how its components are in line with the development priorities of an urban area. It is also important to appreciate that adaptation planning at city level is not a hindrance; rather, it is an essential component of sustainable development and growth as well as a complementary component of development priorities.

National governments should come forward and motivate city governments into undertaking adaptation planning. State governments could play a pivotal role by introducing adaptive planning to one or more cities and then extending it to other cities in due course. Once applied and tested, the planning framework would catch the attention of other local governments, who would opt to introduce the framework to their cities.

REFERENCES

Adger, W N, W A Nigel and E L Tompkins (2004), "Successful adaptation to climate change across scales", *Global Environmental Change* Vol 15, pages 77–86.

Aggarwal, D and M Lal (2001), "Vulnerability of Indian coastline to sea-level rise", Centre for Atmospheric Sciences, Indian Institute of Technology, New Delhi.

Census of India (2001), Provisional Population Total, Government of India Press, New Delhi.

Dossou, Krystal M R and Bernadette Glehouenou-Dossou (2007), "The vulnerability of global cities to climate change in Cotonou (Benin): the rise in sea level", *Environment and Urbanization* Vol 19, No 1, April, pages 65–79.

Farrel, Leanne et al. (2009), "Towards a city adaptation framework for Indian cities – a concept note", unpublished report, TERI, New Delhi.

GSDMA/ TARU (2005), *Gujarat Vulnerability and Risk Atlas*, Gandhinagar, Gujarat, India.

http://www.cleanairnet.org/infopool/1411/propertyvalue-19513.html.

http://www.hindustantimes.com/Hard-two-hour-rain-and-Delhi-has-another-manic-day/H1-Article1–445672.aspx.

http://www.indiaenvironmentportal.org.in/content/climate-change-agenda-delhi-2009–2012.

http://pmindia.nic.in/climate_change.htm.

http://siteresources.worldbank.org/EASTASIAPACIFICEXT/Resources/climatecities_fullreport.pdf.

Huq, S, S Kovats, H Reid and D Satterthwaite (2007), "Reducing risks to cities from climate change: an environmental or a development agenda", *Environment and Urbanization* Vol 19, No 1, April, pages 3–15.

IPCC (2007), "Summary for policy makers", in S Solomon, D Qin, M Manning, Z Chen, M Marquis, K B Averyt, M Tignor and H L Miller (editors), *Climate Change 2007: The Physical Science Basis*, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Cambridge University Press, Cambridge, UK, and New York, USA.

Kumar, R K, A K Sahai, K Krishna, S K Patwardhan, P K Mishra, J V Revadekar, K Kamala and G B Pant (2006), "High resolution climate change scenarios for India for the 21st century", *Current Science* Vol 90, No 3, 10 February, pages 334–345.

Lankao, P R (2007), "Are we missing the point? Particularities of urbanization, sustainability and carbon emissions in Latin American Cities", *Environment and Urbanization* Vol 19, No 1, April, pages 159–175.

McGranahan, Gordon, Deborah Balk and Bridget Anderson (2007), "The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones", *Environment and Urbanization* Vol 19, No 1, April, pages 17–37.

Mukheibir, P and G Ziervogel (2007), "Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town", *Environment and Urbanization* Vol 19, No 1, April, pages 143–157.

Muller, Mike (2007), "Adapting to climate change: water management for urban resilience", *Environment and Urbanization* Vol 19, No 1, April, pages 99–113.

Patwardhan, Anand and Meeta Ajit (2007), "Disaster prevention, preparedness and management and linkages with climate change adaptation", Paper No 10, September, available at http://www.basic-project.net/data/final/Paper10India%20Disaster%20Prevention%20%20Preparedness%20%20Linkages%20w%85.pdf.

Reid, Hannah and Saleemul Huq (2007), "How we are set to cope with the impacts. Adaptation to climate change", IIED Briefing, International Institute of Environment and Development, London.

Revi, A (2005), "Lessons from the deluge: priorities for multi-hazard risk mitigation in Mumbai", *Economic and Political Weekly* Vol XI, No 36, September, pages 3–9.

Revi, A (2008), "Climate change risk: an adaptation and mitigation agenda for Indian cities", *Environment and Urbanization* Vol 20, No 1, April, pages 207–229.

Roberts, Debra (2008), "Thinking globally, acting locally – institutionalizing climate change at the local government level in Durban, South Africa", *Environment and Urbanization* Vol 20, No 2, October, pages 521–537.

TARU/ BMTPC (2000), "Rapid assessment of damage to buildings and lifeline infrastructure in districts of Orissa affected by cyclonic storm 05B-99", TARU, New Delhi.