

# Climate Resilient and Sustainable Urban Development



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# Foreword

The Government of India, State governments and urban local bodies are working hard to transform India's cities for the better. India's cities continue to grow. Unless this massive growth is planned and made sustainable, the costs will be enormous, particularly for the urban poor. Urban poverty, as a proportion of total poverty in India, has doubled from 15% in the early 1960s to nearly 30% in 2004/05. The urban poor are the most vulnerable to current climate variability, such as regular floods and water shortages. Investments in new city infrastructure offer a tremendous opportunity to build sustainable and resilient cities using less energy and water. India, unlike other emerging economies, still has tremendous choices about how it can grow along a sustainable development path. Choices in housing, energy and public transport could reap massive local and global benefits over decades: the right choices will save water, energy and carbon, and improve health and quality of life.

DFID has been supporting partnerships in urban development in India for twenty years, including in Andhra Pradesh and West Bengal. Our more recent partnerships in Madhya Pradesh and Bihar will help partners accelerate delivery of the Jawarhalal Nehru National Urban Renewal Mission (JNNURM) and the Rajiv Awas Yojana (RAY) improving the living conditions of at least three million citizens. As the JNNURM and RAY move forward, it will be vital to strengthen approaches to environmental sustainability so that poor people share the social and economic gains of urban development. We hope this report offers useful information on global and national experiences and contributes to the debate on environmental sustainability and urban development in India.

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Sincerely  
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# List of abbreviations

AIIMS	All India Institute of Medical Sciences	GRIHA	Green Rating for International Habitat Assessment
BEE	Bureau of Energy Efficiency	HFA	Hyogo Framework for Action
BREEAM	Building Research Establishment Environmental Assessment Method	HIP	Home Improvement Packet
BRTS	Bus Rapid Transit System	HK-BEAM	Hong Kong Building Environmental Assessment Method
CAPA	City Adaptation Plan of Action	HVAC	Heating, Ventilation and Air Conditioning
CASBEE	Comprehensive Assessment System for Building Environmental Efficiency	IDS	Institute for Development Studies
CDM	Clean Development Mechanism	IMEP	Integrated Metropolitan Environmental Policy
CERs	Certified Emission Reductions	IPCC	Intergovernmental Panel on Climate Change
CFA	Central Financial Assistance	IRFC	Indian Federation of Red Cross
CNG	Compressed Natural Gas	ISDR	International Strategy for Disaster Reduction
CoEs	Centers of Excellence	IT	Information Technology
CPWD	Central Public Works Department	JNNURM	Jawaharlal Nehru National Urban Renewal Mission
CRED	Centre for Research on the Epidemiology of Disasters	KUSP	Kolkata Urban Services for the Poor
CRM	Climate Risk Management	LEED	Leadership in Energy and Environmental Design
CRS	Climate Risk Screening	LIDAR	Light Detection and Ranging
CRZ	Coastal Regulation Zone	MNRE	Ministry of New and Renewable Energy
CTTPI	Comprehensive Traffic and Transportation Plan for Indore	MoEF	Ministry of Environment and Forests
DFID	The UK Department for International Department	MoUD	Ministry of Urban Development
DRR	Disaster Risk Reduction	MPUSP	Madhya Pradesh Urban Services for the Poor
ECBC	Energy Conservation Building Code	MW	Mega-Watt
EPC	Environment Performance Certificate	NAPCC	National Action Plan on Climate Change
ESCO	Energy Service Company	NDMA	National Disaster Management Authority
ESIS	Employee's State Insurance Schemes	NDMF	National Disaster Mitigation Fund
EU	European Union		
FEMP	Federal Energy Management Program		
FYP	Five Year Plan		
GHG	Greenhouse Gas		
GIS	Geographic Information System		
GoI	Government of India		

## List of abbreviation

NDRF	National Disaster Response Force	TERI	The Energy and Resources Institute
NMSH	National Mission on Sustainable Habitats	TRP	Top Runner Program
NMT	Non-motorized transport	ULBs	Urban Local Bodies
NSSO	National Sample Survey Organization	UHFWC	Urban Health and Family Welfare Centre
NTPC	National Thermal Power Corporation	UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
NUSP	National Urban Sanitation Policy	UN	United Nations
NUTP	National Urban Transport Policy	UNECE	United Nations Economic Commission for Europe
OECD	Organization for Economic Co-operation and Development	UNEP	United Nations Environment Programme
ORCHID	Opportunities and Risks from Climate Change and Disasters	UNFCCC	United Nations Framework Convention on Climate Change
PEPS	Promoting an Energy-efficient Public Sector	UNISDR	United Nations International Strategy for Disaster Reduction
PHC	Primary Health Centre	USAID	United States Agency for International Development
PMSY	Pradhan Mantri Swasthya Yojna	UTMA	Unified Metropolitan Transport Authority
PPP	Public Private Partnership	WELS	Water Efficient Labeling and Standards
RAY	Rajiv Awas Yojna		
SIDA	Swedish International Development Cooperation Agency		
SSLB	Standardized Service Level Benchmark		
SWM	Solid Waste Management		

# Executive Summary

Cities can be viewed as hubs of intensive resource demand, environmental degradation and greenhouse gas emissions. Cities form a major part of the solution in promoting low carbon development, through use of renewable energy, energy efficiency, green buildings and mitigating emissions from urban transport. Cities are also going to be the loci of increasing losses due to the impacts of climate change because of concentrated populations and large-scale economic investments. The objective of this publication is to highlight the global and regional trends in urban development, identify key issues, projected risks, impacts and opportunities in the light of climate change through case study examples from cities in India and the world. Key messages emanating from the six chapters have been summarized below:

## Chapter 1: Introduction

- By 2030 nearly 60 percent of the global population is projected to be urban with the developing world housing nearly 80% of this population.
- Not only do risks and vulnerabilities need to be identified and reduced, but potential opportunities also need to be tapped for low-carbon urban development under a changing climate
- Sustainability and resilience can be promoted through a combination of strategies such as integrated urban planning, identifying synergies between disaster risk reduction and adaptation, building efficiency of urban service quality and delivery and promoting green buildings and sustainable transport.
- India is projected to witness a 'RUrban' transformation, or a rapid demographic transition, as its urban population rises from 300 million to

over 700 million by 2050. By 2025, an estimated 70 Indian cities are expected to have a population size of over one million.

- Mainstreaming climate resilience into urban development is essential because climate risks may only be one of the several factors defining poverty levels, well-being, economic growth and development in an urban environment.
- In an urban environment, there may be very few strategies that exclusively address adaptation and/ or mitigation. Hence entry points within existing development programmes need to be tapped.
- Climate resilient urban planning needs to consider both current and future climate risks as well as other likely changes in the urban environment. Climate risk-screening is one of the methodologies used by developmental organizations to screen their developmental portfolio in climate-sensitive sectors.

## Chapter 2: Integrated Urban Planning Processes for Resilience and Low Carbon Development

- Urban planning decisions taken now can shape the well-being of city inhabitants and direct urban growth. Strategic urban planning directly supports urban resilience as a tool for sustainable development that: 1) directs land use and transportation systems; 2) reduces population vulnerability to climate change by facilitating improved access to resources, services and amenities; and 3) generates sensitivity towards the environment whilst incorporating social and economic goals.

- City governments and urban local bodies (ULBs) must actively coordinate and mainstream mitigation, adaptation and resilience into urban planning processes to prepare their cities to deal with climate risks and impacts.
- Low-carbon development strategies can simultaneously promote mitigation, adaptation and resilience and are best implemented through an environmentally oriented and integrated city planning process.
- Low-carbon development as an urban planning intervention has the potential to reduce energy utilization by enabling physical proximities between buildings as well as land-uses.
- For Indian cities, it is crucial to bridge the efforts by the National Sustainable Habitat Mission (NSHM) and Jawaharlal Nehru National Urban Renewal Mission (JNNURM), as well as to involve multiple stakeholders to facilitate integrated, city-level planning.
- Technology should be leveraged to support of municipal data gathering and management systems; spatial mapping software and remote sensing offers a means to explore and understand the environmental risks associated with cities.
- Convergence of DRR and adaptation in cities is essential not only for managing current risks but also potentially higher risks in the future.
- India's XI Five Year Plan's (FYP) focus on disaster mitigation, rather than simply disaster response, provides an opportunity to integrate disaster mitigation into the development process. Win-win strategies need to be promoted for planned disaster risk reduction.

### Chapter 3: Disaster Risk Reduction (DRR) and Adaptation

- Many definitions, interpretations and approaches exist for quantification of disaster risk and assigning critical thresholds beyond which an event/ hazard can be termed a disaster..
- Assessment of changing profile of hazards due to climate change can provide key inputs for the disaster risk reduction and risk management efforts in cities.
- While DRR and adaptation efforts aim towards safeguarding development and poverty reduction in many direct and indirect ways, there are many differences in the basic nature of the issues they address. Owing to differences in the concept of DRR and adaptation, their convergence largely remains in a conceptual form.
- Financial resources are often concentrated in current risks, developmental priorities and relief and rehabilitation efforts after a disaster occurs rather than planning for future risks.

### Chapter 4: Urban services and resilience

- The impacts of climate change on urban services are expected to vary depending on the geographical setting and associated climate of the urban agglomeration; the nature, size and density of settlement; and the existing coping capacity of the society and its economy.
- Unabated growth of urban population and high incidence of marginal employment and urban poverty have aggravated the accumulated backlog of shortages of basic urban services such as water, power and sanitation and has also resulted in the proliferation of slums and squatter settlements.
- Informal settlements are usually inadequately connected to basic urban services, and often located in low-lying areas. This makes them particularly vulnerable to direct and indirect environmental risks.
- Government investments for the development of infrastructure and provision of basic services have not been spatially balanced during the past few decades leading to high levels of inequity across States and cities in India.
- Unplanned development in most of the fast growing urban centres of India has contributed to a widening gap between demand and supply of infrastructure services, especially for the urban poor, whose access to drinking water, sanitation, education, and basic health services is shrinking.
- There are potential entry points for enhancing service delivery in urban centres through programmes such as JNNURM, Rajiv Awas Yojana, NMSH and India's XI Five Year Plan.

### Chapter 5: Green buildings: the policy perspective

- The construction sector is resource consuming in its entire life cycle-right from extraction of materials

to manufacturing, transportation, construction and operation of the infrastructure/building.

- Climate change will further increase site energy demand as people shall seek to maintain comfort levels in more extreme conditions.
- The IPCC Fourth Assessment Report highlighted relatively simple options to reduce energy consumption in buildings.
- Green buildings entail promotion of energy efficiency, land sustainability, water efficiency, resources efficiency and better building environment.
- Green buildings have minimal adverse impacts on the built and natural environment and are designed to minimize the total environmental impact of the materials, construction, operation and deconstruction. They also seek to maximize opportunities for indoor environmental quality and performance; saving money, reducing waste, increasing worker productivity and creating healthier environment for people to live and work.
- An integrated approach to promoting green buildings policies to create both supply push and demand pull will be central in getting accelerated action.

## **Chapter 6: Mitigating the emissions from the urban transport sector**

- Metropolitan cities in developing countries are fast becoming one of the key drivers of economic growth, which has resulted in increasing per capita income in these cities. Increasing per

capita incomes have had direct impact in terms of growing motorization rates in these cities, which has been the precursor to most of the urban transport related challenges that these cities face.

- It is expected that by 2020, the number of motor vehicles in the world will double from the present level and will increase to about 1.3 billion, the fastest growth being in the growing cities of Latin America and Asia.
- Developing countries' cities are experiencing an undesired trend of declining share of public transport and non motorized transport.
- The current urban transportation situation in Indian cities is adopting a high energy and carbon intensive pathway as the share of personal modes is increasing rapidly and public transport and non-motorized transport shares are declining.
- Cities need to arrest their current pattern of transportation growth in order to bring down their CO<sub>2</sub> emissions, which calls for a shift of urban traffic movements to mass transport having least tail-pipe emissions and to non motorized systems. Cities should adopt an 'Avoid, Shift and Improve' approach in their transportation planning. The main goals should be to:
  - Reduce utilization of personal modes of transport,
  - Increase usage of public transport and non motorized transport, and
  - Promote use of clean fuels and technologies in addition to properly maintaining the in-use vehicular fleet.







TOP PARKING





# CHAPTER 1

## Introduction

Sreeja Nair

### Key messages

- By 2030 nearly 60 percent of the global population is projected to be urban with the developing world housing nearly 80% of this population.
- India is projected to witness a rapid demographic transition, as its urban population rises from 300 million to over 700 million by 2050.
- Not only do risks and vulnerabilities need to be identified and reduced, but potential opportunities also need to be tapped for low-carbon urban development in cities under a changing climate
- Sustainability and low-carbon resilience in cities can be promoted through a combination of strategies such as integrated urban planning, identifying synergies between disaster risk reduction and adaptation, building efficiency of urban service quality and delivery and promoting green buildings and sustainable transport.
- In an urban environment, there may be very few strategies that exclusively address adaptation and/ or mitigation. Hence entry points within existing development programmes need to be tapped to mainstream climate resilience into urban development.
- Climate resilient urban planning needs to consider both current and future climate risks as well as other likely changes in the urban environment. Climate risk-screening is one of the methodologies used by developmental organizations to screen their developmental portfolio in climate-sensitive sectors.

### 1.1 Cities and sustainability

The last five decades have not only witnessed a rapid increase in the world's urban population but has also brought a large share of urban dwellers to reside in slums, squatters and informal settlements. These settlements are often located in low-lying areas prone to direct and indirect risks due to environmental degradation including changes in the climate and lack access to basic urban services (Satterthwaite et al, 2007). By 2030 nearly 60 percent of the global population is projected to be urban with the developing world containing nearly 80% of this population. By 2015, 12 out of the largest 15 cities in the world will be in developing countries and 4 of those will be in Asia (Prasad et al, 2009).

The number of cities and towns in India increased from 4,651 in 1991 to 5,161 in 2001, with a significant increase in the number of cities with population above 1 million (12 in 1981 to 35 in 2001) (NIPFP, 2007). In

#### WHAT IS A SUSTAINABLE CITY?

The United Nations (UN) Habitat and the UN Human Settlements Programme defines a sustainable city as “a city where achievements in social, economic, and physical development are made to last. It has a lasting supply of the natural resources on which its development depends (using them only at a level of sustainable yield)”.

The Charter of European Cities and Towns Towards Sustainability states: “sustainable development helps cities and towns to base living patterns on the carrying capacity of nature, while seeking to achieve social justice, sustainable economies and environmental sustainability” (Nijkamp and Finco, 2000).

what is referred to as India’s ‘RUrban transformation, the country is projected to witness a rapid demographic transition as its urban population rises from 300 million to over 700 million by 2050. By 2025, an estimated 70 Indian cities are expected to have a population size of over one million. In addition, three mega urban regions: Mumbai-Pune, the National Capital Region of Delhi and Kolkata will be among the largest urban concentrations in the world (Revi, 2008). India is also one of the most multi-hazard risk prone countries in the world (IFRC 2005). India’s 7500 km long coastline accommodates more than a 100 million people. The 2001 Census of India lists 65 coastal districts within nine coastal states (West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat and Union Territories; Puducherry, Daman and Diu, Andaman and Nicobar and Lakshadweep) with an average population density of 455 persons per sq. km- almost 1.5 times the average population density of the country. Of the 35 cities in India having population over a million- 18 are in the coastal states. These include Rajkot, Ahmedabad, Vadodara, Surat, Greater Mumbai, Pune, Nagpur, Nashik, Bangalore, Kochi, Hyderabad, Vishakhapatnam, Vijayawada, Chennai, Coimbatore, Madurai, Asansol, and Kolkata (GoI, 2004).

A major challenge for cities in the face of rapid population growth is to maintain sustainability within the social, economic and environmental dimensions. Figure 1.1 illustrates various components that influence sustainability in a city.

- At the core of a sustainable city framework lies the health, comfort, safety and quality of life of its residents;
- *environmental factors* and phenomenon such as climate change, risks and hazards, quality of air, land and water etc. that affect and are affected by the social systems;
- *subsystems* such as urban functions, transport, building, energy etc. that provide opportunities for improvements in the urban environment through institutional factors that include urban planning, governance, land management, legislation and financing.

## 1.2 Urban systems as risk hotspots

Urban systems are at risk to different kinds of hazards. Several factors contribute to the urban risk profile. For example:



Figure 1.1 Factors that influence sustainability in a city (SIDA, 2007)

A **hazard** is defined as a “potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation”

**Risk** to a hazard is defined as the “probability of harmful consequences, or expected losses resulting from interactions between natural or human-induced hazards”.

- The spatial arrangement of population and assets in an urban environment creates a different hazard profile for urban areas as compared to rural, in terms of the population at risk, the nature of hazards and the chances for interaction between different hazards (example floods and epidemic outbreaks).
- Cities also often expand in ways that may degrade natural buffer systems, for example mangroves (provide protection from the sea) and creeks (for drainage) and construct impermeable land surfaces that prevents percolation of water into the soil (Satterthwaite et al, 2007).
- Constraints on the availability of land as a resource in urban areas often results in proliferation of slums and informal settlements on public and private land (Shaw, 2009).

It is projected that Asia is likely to witness maximal increase in built-up areas by 2030. These increases might result due to a combination of factors- such as faulty land use and planning, rapid urban population

growth, migration from rural areas, lack of integrated land use and transport planning that enables mass transit and efficient clustering of settlements and industries (Figure 1.2). A study by McGrahan et al (2007) conducted a detailed analysis of the urban population residing along the low-elevation coastal zone (the continuous stretch of land along the coast that is <10 metres above sea level). Nearly 2 per cent of the world's land area falls in this zone but it houses nearly 13 per cent of its urban population.

### 1.3 Impacts of climate change on cities

Short term and long-term changes in climatic variables such as temperature and precipitation may pose hazards to urban systems. Changes in the climatic

variables are likely to impact future patterns of spatial growth and development in cities and act as a stressor in addition to existing pressures. The populations most vulnerable to climate change are those living in slums and informal settlements that often lack access to basic services and infrastructure (IDS, 2007). Apart from the risk to coastal populations from sea level rise, cyclones, storm surges and other associated impacts, a high proportion of urban settlements in the low- and middle-income countries are on sites that are at risk from flooding or landslides. The key primary and secondary order impacts on cities due to short-term and long-term changes in climatic variables have been summarized in Table 1.1.

Table 1.1 Impacts on urban systems due to changes in climatic variables (compiled from IPCC, 2007 and Prasad et al, 2009)	
Changes in climatic variables	Primary and secondary impacts
<b>Temperature extremes</b> Rise in average temperatures of a region may lead to warm spells and heat waves	<ul style="list-style-type: none"> <li>Heat-related mortality - at high risk being the aged, those with pre-existing ailments such as cardiovascular and respiratory diseases and those with poor housing structures.</li> <li>Increase in demand for water and impacts on air and water quality, and increased demand for cooling etc.</li> </ul>
<b>Heavy precipitation events</b> (which may or may not be associated with cyclones and storm surges)	<ul style="list-style-type: none"> <li>Deterioration of the quality of surface and groundwater</li> <li>Mortality, injury, water-borne and food-borne diseases</li> <li>Flooding and water-logging</li> <li>Disruption of mobility</li> <li>Displacement of settlements</li> <li>Damages to industry and infrastructure (including drainage, sewerage etc.)</li> </ul>
<b>Sea Level Rise<sup>1</sup></b>	<ul style="list-style-type: none"> <li>Land inundation</li> <li>Salt-water intrusion into groundwater aquifers</li> <li>Impacts on coastal agriculture and livelihoods etc.</li> <li>Displacement of coastal settlements</li> <li>Damage to industry and infrastructure</li> </ul>
Climate change may increase the frequency and intensity of <b>extreme events</b> such as floods and cyclones	<ul style="list-style-type: none"> <li>Mortality and morbidity</li> <li>Damage to infrastructure, including communication channels, power supply etc.</li> <li>Spread of water- and food borne diseases etc.</li> </ul>

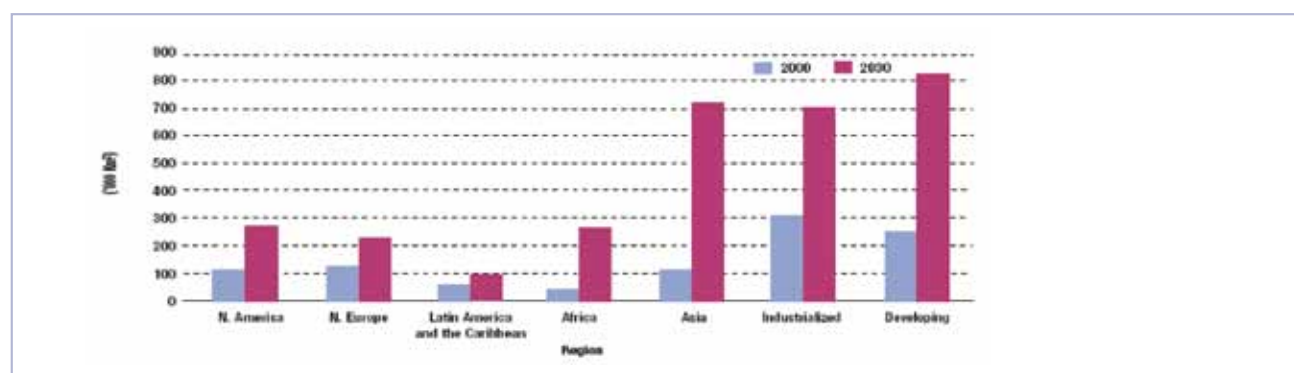


Figure 1.2 Region-wise projections for built-up area by 2030 (Prasad et al, 2009)

<sup>1</sup> A rise in global mean sea level between 0.18- 0.59 meters by 2100 has been projected by various IPCC models (there will be regional variations in the level of rise)

Climate is described in terms of the mean and variability of temperature, precipitation and wind over a period of time, ranging from months to millions of years

Climate variability refers to variations in the mean state and other statistics (standard deviations, occurrence of extremes, etc.) of climate on all spatial and temporal scales beyond that of individual weather events.

Climate change refers to a “change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

## 1.4 Need for building resilient cities

An urban environment is complex primarily because of rapidly changing variables such as socio-economic and demographic indicators, land-use patterns, resource demand and utilization patterns, lifestyle changes etc. In the light of climate change, a new layer of uncertainty is added in terms of changes in precipitation, temperature and occurrence of extreme events. Furthermore, there are scale mismatches; in terms of the timescales over which policymakers and urban planners operate, and scales over which projected impacts of environmental decisions, degradation, climate variability and change will manifest (Figure 1.3). Also policies and developmental initiatives in cities should enable urban systems to adjust to changes as and when they happen and accordingly respond in a way that maintains their original structure and function. This leads the discussion to the concept of resilience. Resilience can be defined as the “ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions”<sup>2</sup>. Urban resilience can be defined as “the ability of cities to tolerate alteration before reorganising around a new set of structures and processes” (Alberti et al 2003). 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 (Prasad et al, 2009) (refer Chapter 2).

There is a two-pronged approach to respond to man-made climate change:

- **Adaptation** that refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.
- **Mitigation** that refers to human interventions to reduce the sources or enhance the sinks of greenhouse gases (IPCC, 2007).

The Committee on Housing and Land Management as part of the UNECE (United Nations Economic Commission for Europe) focuses on developing ‘carbon neutral cities’, in cognizance of the fact that to address climate concerns in urban areas, an integrated approach needs to be taken. Through targeted low-carbon strategies in key sectors such as buildings, urban planning, sustainable urban transport and infrastructure, there is a potential to decrease nearly 29% of the projected emissions by 2020 (UNECE, 2009).

### 1.4.1. Integrating/ ‘mainstreaming’ low-carbon, climate resilience thinking to urban development

Mainstreaming can be defined as the “integration of climate change related policies and measures into developmental planning process and decision-making”

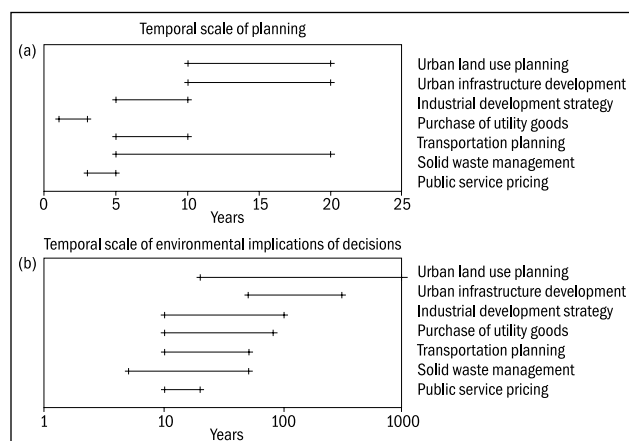


Figure 1.3 Temporal scale of urban decision making (a) temporal scale of planning (b) temporal scale of potential environmental impacts of decision (Bai et al, 2009)

<sup>2</sup> Retrieved from [http://www.unisdr.org/preventionweb/files/7817\\_UNISDRTerminologyEnglish.pdf](http://www.unisdr.org/preventionweb/files/7817_UNISDRTerminologyEnglish.pdf)

(Eriksen et al, 2005). A key opportunity for mainstreaming resilience in India is by integrating Disaster Risk Reduction with developmental efforts (Smith et al, 2003) (refer Chapter 3). Mainstreaming low- carbon, climate resilience into urban developmental agenda is essential because in an urban environment, there may be very few strategies that exclusively address adaptation and/ or mitigation. Hence entry points within existing programmes that may not be directly aimed to reduce risks and vulnerability, however that may contribute towards poverty reduction and enhancing overall well-being, need to be tapped.

Key policies, programmes and initiatives of the Government of India that offer several entry points for mainstreaming resilience, adaptation and mitigation within the urban sustainable development agenda have been discussed in this publication. In 2008, India announced the National Action Plan on Climate Change (NAPCC) listing eight priority areas for adaptation and mitigation action. Of these Missions, it is the National Mission on Sustainable Habitats (NMSH) that directly focuses on urban areas (Box 1.1).

Another important Mission by the Government of India is the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) that was launched in 2005 and is operational till 2012. JNNURM offers numerous entry points for sustainability and climate resilience and its primary aim is to create economically productive, efficient, equitable and responsive cities. JNNURM focuses on 65 cities and has two components:

- *'Urban Infrastructure and Governance'* aiming at reforms and planned development of cities through efficient urban infrastructure and service delivery mechanisms, community participation, and accountability of ULBs/ Parastatal agencies, preparation of City Development Plans, and leveraging financial resources for specific activities.
- *'Basic services to Urban Poor'* aiming at integrated development of slums through initiatives for providing shelter, basic services and other basic amenities for the urban poor<sup>3</sup>.

## 1.5 Conceptual framework for the publication

Given this background, this publication builds on a conceptual framework as illustrated in Figure 1.4. The

basic premise for the discussions in this publication is that:

- An urban system is dynamic, facing conditions of balance or normalcy and conditions of stress (owing to climatic, socio-economic, demographic factors etc.).
- While sustainability is related to the "ability of a system to maintain its optimum structure and function over time", Resilience is more than maintaining the optimal conditions- it is also the "ability to accommodate new changes and conditions of stress, and shifting to new states while maintaining the set of critical functions being provided earlier". In these ways resilience overlaps with sustainability (Milman and Short, 2008).

This publication highlights key strategies that can enable cities to address the dual goal of sustainability and climate resilience. Specific chapters include:

### BOX 1.1 NATIONAL MISSION ON SUSTAINABLE HABITATS

- NMSH targets promoting sustainability in urban habitats by enhancing the energy efficiency of buildings, solid waste management and shift towards public transport through:
  - Extension of Energy Conservation Building Code
  - Urban waste management and recycling, including production of energy from waste
  - Regulatory and financial measures for enforcement of automotive fuel standards and to encourage purchase of efficient vehicles
  - Incentivising the use of public transportation.
- The mission proposes that climate change objectives should be integrated in the planning process in a way that optimizes developmental goals.
- Emphasizes preparation of city Master Plans considering sustainable development norms, addressing environmental standards and GHG mitigation under building bye laws.
- Formulation of city development plans including preparation of comprehensive mobility plans for long term energy efficient and cost effective transport planning in cities.
- In terms of institutional framework: NMSH proposes a Mission Implementation and Monitoring group and a Mission Directorate at Central level, Apex coordination committee at State level; and a district /city level committee on climate change.

<sup>3</sup> <http://jnnurm.nic.in/>, last accessed on 18 August 2010

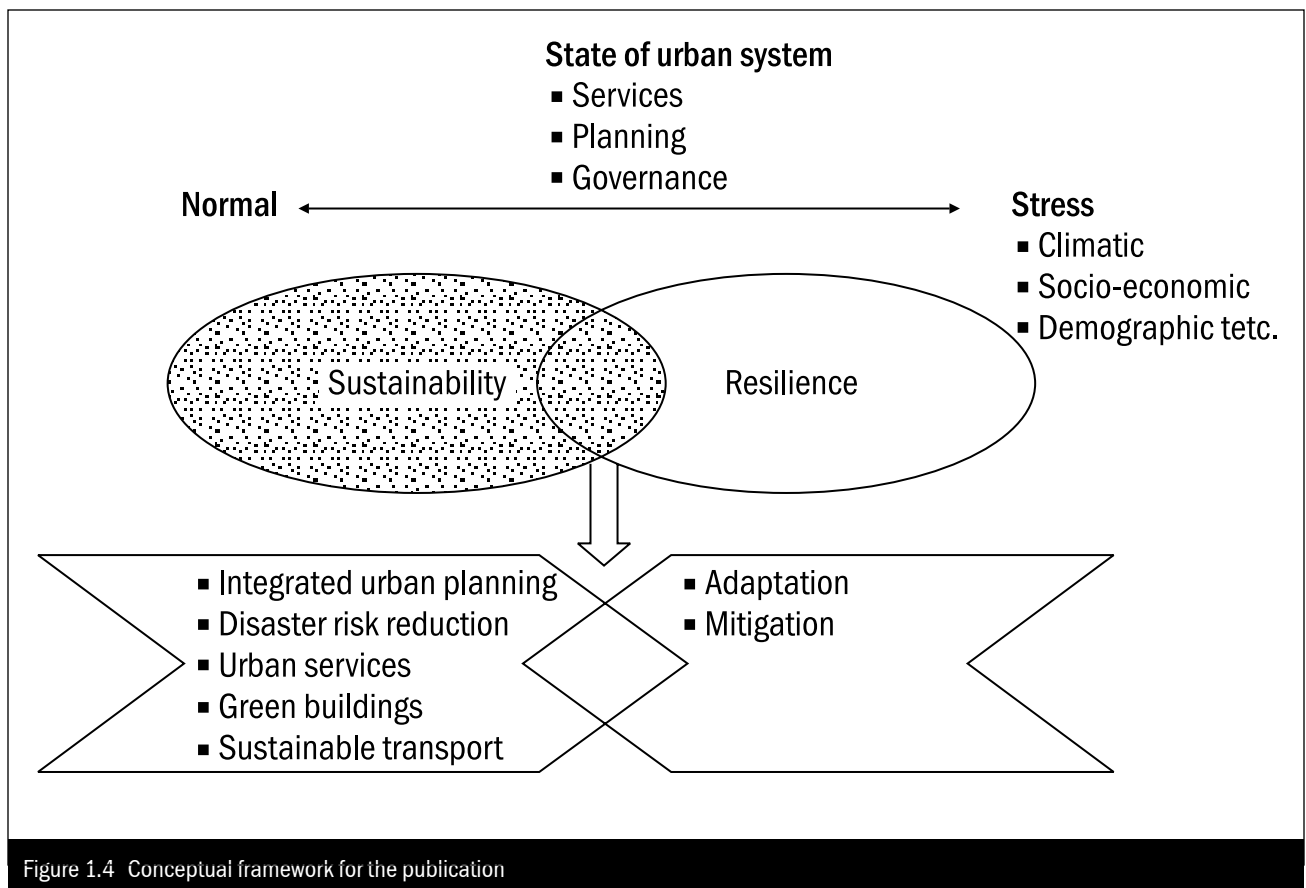


Figure 1.4 Conceptual framework for the publication

- Integrated Urban Planning Processes for Resilience and Low Carbon Development (Ch 2);
- Understanding the linkages between DRR and Adaptation (Ch 3);
- Strengthening urban services quality and delivery for climate resilience (Ch 4);
- Reduction in GHGs through promotion of the Green buildings concept (Ch 5) and,
- Mitigation efforts in the transport sector (Ch 6).

These chapters are supplemented with examples of best practices from cities in India and across the world towards meeting the climate challenge by promoting the dual path of sustainability and resilience and understanding the co-benefits.

### KEY QUESTIONS ADDRESSED IN THE PUBLICATION

- Apart from risks and impacts, what are the opportunities that cities can tap in the light of a changing climate?
- What are the synergies between urban sustainability and resilience?
- What are some best practices from cities across the world and in India in terms of early steps towards sustainability and low-carbon resilience?
- What are the current efforts by governments to promote sustainability and build resilience?
- Given the financial, technical and institutional constraints under which city governments and municipalities function, what are some additional policy entry points that can be leveraged for sustainability and low-carbon resilience?









# CHAPTER 2

## Integrated Urban Planning Processes for Resilience and Low Carbon Development

Shriya Malhotra and Divya Sharma

### Key messages

- Urban planning decisions taken now can shape the well-being of city inhabitants and direct urban growth. Strategic urban planning directly supports urban resilience as a tool for sustainable development that: 1) directs land use and transportation systems; 2) reduces population vulnerability to climate change by facilitating improved access to resources, services and amenities; and 3) generates sensitivity towards the environment whilst incorporating social and economic goals.
- City governments and urban local bodies (ULBs) must actively coordinate and mainstream mitigation, adaptation and resilience into urban planning processes to prepare their cities to deal with climate risks and impacts.
- Low-carbon development strategies can simultaneously promote mitigation, adaptation and resilience and are best implemented through an environmentally oriented and integrated city planning process.
- Low-carbon development as an urban planning intervention has the potential to reduce energy utilization by enabling physical proximities between buildings as well as land-uses.
- For Indian cities, it is crucial to bridge the efforts by the National Sustainable Habitat Mission and Jawaharlal Nehru National Urban Renewal Mission as well as to involve multiple stakeholders to facilitate integrated, city-level planning.
- Technology should be leveraged to support of municipal data gathering and management systems; spatial mapping software and remote sensing offers a means to explore and understand the environmental risks associated with cities.

### 2.1 Introduction

Urban planning decisions taken now can shape the well being of city inhabitants and direct urban growth. Planning has a decisive role to play in climate change resilience because it spatially influences activities that lead to GHG emissions and guides patterns of land-use as well as energy use. The built environment in cities also shapes and directs the location and concentration of socioeconomic activities (Jia, 2009). Strategic urban planning directly supports urban resilience and encourages urban sustainability in several ways. It can be used as a tool for sustainable development, because it specifically directs land use and transportation systems. Planning can reduce population vulnerability to climate change by facilitating improved access to resources, services and amenities. It also creates sensitivity towards the environment whilst incorporating social and economic goals.

Many environmental problems in cities can be attributed to lax land-use policies that encourage sprawl and hence more dependence on mechanical means of heating and cooling, increased use of private vehicles for commuting, and concentrations of single land-use at specific sites in the cities. Consequently, urban sprawl tends to agglomerate several small cities around a parent city. These smaller cities in turn engulf agricultural land, forest area and wetlands as they expand. Over the course of time, they require supporting infrastructure as they become more energy intensive. This is becoming increasingly visible in developing world cities, which seem to be repeating past mistakes made by the developed world. Meanwhile, developed world cities are reorienting themselves to anticipate climate change and promote resilience as well as 'smart growth.' It is crucial for the developing world to catch up, learn and

share strategies in sustainability that simultaneously promote resilience and low carbon development.

Municipal bodies in developing cities are struggling to provide transport, water and sanitation services to the ever-increasing urban population. Meanwhile, the peri-urban areas are mainly dominated by real estate developers, offer residential areas, often altering the travel distances and patterns of urban migrants/residents. Low-carbon development as an urban planning intervention has the potential to reduce energy utilization by enabling physical proximities between buildings as well as land-uses. Despite the importance placed by international organizations and national governments on the value of urban planning for climate resilience, urban preparedness in the face of climate change relies on the timely policy and planning strategies that are implemented at the city level.

In spite of a realization that urban planning has direct as well as indirect benefits for sustainability and resilience, the situation for India's ever-growing cities seems bleak and is aggravated by climate change threats. It is therefore crucial to share lessons between developed and developing world cities, particularly because younger cities seem to be following and repeating past mistakes. The priority should be to use urban planning for mitigation, adaptation, resilience, and sustainability by directing strategies to climate proof cities.

City governments and urban local bodies (ULBs) need to actively coordinate and mainstream mitigation, adaptation and resilience into urban planning processes to prepare their cities to deal with climate risks and impacts. Low-carbon development strategies are one way of promoting mitigation, adaptation and resilience at the same time. They are best implemented through an environmentally oriented and integrated city planning process. Communities in the developed world have already started to think and act towards revamping the way their cities function and develop through regional plans and policies that drive urban planning towards sustainability; but this is not the case in developing countries. This chapter discusses the role of city planning as a tool to achieve urban resilience and low-carbon development in an integrated manner.

## 2.2 Global experiences in City-level integrated planning<sup>1</sup>

There are many examples from around the world of how integrated city planning is being used as a tool to build resilience and to promote transition towards a low-carbon future. This section is comprised of diverse strategies, which demonstrate good practices in integrated or city level planning. The cases were chosen for their unique approaches to site specific contexts in regions across the developed and developing world. They were analysed in terms of their comprehensiveness towards the city planning process and whether their adaptation plans proceeded in an integrated manner or sector specific approach. Each case highlights the city-level strategies used in these plans, the lessons that could be derived from them for climate resistant city planning and the role of the government in taking these strategies forward.

### Profile of the selected case studies

Country	City	Level of intervention	Type of intervention
China	Taiyuan	City Level	Emissions Trading
Thailand	Bangkok	City Level	Integrated Planning
Philippines	Bohol	City Level	Approach that Primarily Targets Poverty Reduction
Singapore	Singapore	National + City Level	Land-use + Transport mitigation
Usa	New York	State + City Level	Integrated Planning Approach
Canada	Halifax	National + City Level	Transport mitigation
Australia	Canberra	National + City Level	Separate Climate Change Strategy

### China: Low Carbon Development and 'Eco-Cities'

In China, several cities have begun implementing policies for Low Carbon Economies; there are efforts to establish a Low Carbon City in Shenzhen and a zero carbon eco-city in Dongtang. In Taiyuan, the government has implemented city-level emission trading, while in Yangzhou has used an Eco City approach since 1999. Eco City's are comprised of "integrated strategies

<sup>1</sup> This section discusses several case studies from Cities Alliance 2007. Livable cities.

for social progress, resource management, economic development, transportation, land use and industrial management through education and cooperation.” The environment guides urban planning and management strategies, influences processes, policies and decisions for sustainable urban development. These efforts exemplify good practices of sound municipal level political commitment, foresight and timeliness of response.

#### ***Thailand: Comprehensive Urban Environmental Management***

The city of Bangkok, Thailand has used a ‘Local Agenda 21’ urban management approach since 1998. The Bangkok Agenda 21 prioritizes environmental considerations and outlines sustainable economic, environmental and social development. It highlights the role of political leadership, public participation, priority setting and environmental cost benefit analysis to enable integrated urban planning with the participation of local government and private sector representatives. It comprehensively emphasizes good governance and ecotourism through its different components. The Metropolitan Master Catalogue serves as a planning tool to guide “physical development” in the city; and The Bangkok Municipal Administration (BMA) encourages public participation and has developed a Green Areas Master Plan to increase public green spaces and encourage residents to plant trees.

#### ***Philippines: Integrated and Medium Term Development***

Bohol in the Philippines has employed an Integrated Development Plan, Medium Term Development Plan (MTDP) and a Program Framework on Poverty Reduction. It uses a sustainable environmental management approach to simultaneously create employment opportunities, address poverty and raising living standards of the poor. This is an inclusive approach that considers and anticipates the impact of climate change on livelihoods and the economy. It encompasses basic health and education services as well as initiatives to provide services to underprivileged communities. City management is supported by the MTDP, which has provisions to

strengthen local bodies to deal with cross-cutting issues like climate change.

#### ***Singapore: Land Use and Transportation Policy***

Timely city-level strategies are often pushed by state and national level commitments. Singapore’s national government supported efforts to sustain energy efficiency, develop local knowledge and consolidate municipal-level expertise for energy management. The high-level commitment through its National Climate Change Strategy to employ strict and strategic urban planning guidelines has been a step towards making Singapore’s capital city climate resilient. Strategic and integrated urban planning policies have enabled the “efficient use of space” and “clustering people in smaller land areas, often through high-rise, high-density settlements” (Yuen and Kong, 2009). It is an example of effective resilience and low carbon development pursued through urban planning, effective leadership and strengthened municipal initiatives.

#### ***USA: Comprehensive Planning and Socio-Economic Preparations***

Moving to integrated planning and city level initiative examples from the developed world; the Keene Climate Resilient Action Plan<sup>2</sup> for the US state of New Hampshire examines the built, social and natural environment as distinct systems that will be affected by climate change. It uses a holistic approach, which addresses economic employment and seeks to create jobs for people who might lose sources of their livelihood, mitigate public health concerns and encourage emergency preparedness. It emphasizes the role community, city and regional stakeholders play in shaping the future of cities and highlights how flexible land use can meet the changing needs and desires of urban communities. Coastal cities like Miami are preparing themselves for changes in climate and coastal vulnerability. In 2008, the Miami-Dade Climate Change Advisory Task Force approved recommendations to focus on mitigation activities and adaptation strategies. Mitigation efforts have included reducing fossil fuel consumption, while adaptation has entailed launching processes to make the city and

<sup>2</sup> ICLEI. 2007. City of Keene, New Hampshire Climate Adaptation Action Plan Summary Report. Available at: [cbtadaptation.squarespace.com/storage/KeeneSummary\\_ICLEI\\_FINAL2.pdf](http://cbtadaptation.squarespace.com/storage/KeeneSummary_ICLEI_FINAL2.pdf)

county resilient to extreme weather. Recommendations have included commissioning detailed maps that use calibrated Light Detection and Ranging (LIDAR) and geographic information systems (GIS) for visual and spatial research (Miami- Dade, 2008).

### **Canada: Economic and Infrastructure Resilience**

The Canadian coastal city of Halifax shows evidence of the importance placed on resilience towards economic and infrastructure losses posed by climate change. A vulnerability assessment by Environment Canada highlighted the severe implications for road maintenance, transportation and infrastructure, water quality and livelihoods due to climate change. Environment Canada combined mitigation, technical developments for adaptation, research and education in an effort to address climate concerns. The Halifax municipality seeks to partner with experts and conduct detailed research into the impacts of climate change on the Halifax regional municipality and explore how climate-proofing can be conducted.

### **Australia: Comprehensive Energy Efficiency and GHG mitigation**

As a developed country with significant natural resources and national coastline, Australia's national security relies on resilience to climate change. Australia is vulnerable to extreme weather events, declining water availability, fire hazards and storms. The Australian Capital Territory (ACT) has initiated a city-wide strategy to address climate change in the capital city of Canberra. Recognizing the economic, environmental and social costs of climate change, it aims to reduce its GHG emissions by 60% in 2050. Efforts include a GHG emissions abatement scheme, energy efficiency ratings and government renewable energy purchase (ACT, 2007).

### **Denmark: Energy Re-use**

Cities across the EU are also instrumental in promoting integrated urban planning to promote resilience. Since 1990, Copenhagen has reduced its CO<sub>2</sub> emissions by 20%. It also uses a wind farm with wind turbines reaching high into the sky and

has one of the world's largest district heating system, covering 97% of city households. The city uses an innovative system to send surplus heat produced from generating electricity high into the air and has a waste management system that reuses 90% of all building waste and incinerates 75% of all household waste<sup>3</sup>. These examples of mitigation and urban heat waste management at the city level highlight the importance of municipal-led intervention strategies.

### **BEST PRACTICES – New York, London and Cape Town**

The following cities were selected for their integrated, city level approaches as examples from the developed and developing world.

The city of New York is recognized for its climate change adaptation and risk management responses to climate change. The municipal-level PLAN NYC 2030 contains an initiative to address climate change impacts on the city and its constituents and aims to create an interagency task force to protect urban infrastructure. It also includes provisions for a holistic approach towards reduced GHG emissions and seeks to expand NYC adaptation strategies beyond protecting city infrastructure such as water supply, sewer, and wastewater treatment systems. It has provisions to work with vulnerable neighbourhoods and develop specific protection strategies based on community needs. It also targets involvement of urban communities to participate in overall city planning. An education component aims to integrate community planning using "toolkits" that engage stakeholders to collaborate on community-specific climate adaptation strategies. The initiative will launch a city wide strategic planning process for climate change adaptation, which is currently still at a mitigation stage<sup>4</sup>. A separate but related climate change initiative has provisions for a strategic planning process to create a climate change resilient city. The strategy entails updating New York's Federal Emergency Management Administration (FEMA) floodplain maps while documenting urban floodplain management strategies to ensure discounted flood insurance for New Yorkers. It also entails updating and revising building code regulations and standards to address the impacts of climate change.

<sup>3</sup> Copenhagen. Climate Neutral Network. Online. URL <[www.unep.org/ClimateNeutral/Default.aspx?tabid=567](http://www.unep.org/ClimateNeutral/Default.aspx?tabid=567)>

<sup>4</sup> Plan NYC 2030. NYC Government. Online. URL <<http://www.nyc.gov/html/planyc2030/html/plan/climate.shtml>>

<sup>5</sup> City of London Corporation. 2007. Rising to the Challenge: The City of London's Corporation's Climate Change Adaptation Strategy.

The city of London<sup>5</sup> has taken comprehensive steps to prepare for the potential economic, environmental and social impacts of climate change. It has undertaken research to explore adaptation options and provide policy suggestions to address the future impact and changes. It has engaged stakeholder's engagement and sought to raise awareness, consult with and build consensus among key actors. For example, the London Climate Change Partnership (LCCP) engages the government and several urban / national level businesses and organization to guide the city-level strategies that can address climate change. London has several initiatives to curb carbon emissions and air pollution in the center of the city in order to alleviate the urban heat island effect. In 2006, the London congestion tax was reoriented into a CO<sub>2</sub> tax by Mayor Ken Livingstone, targeting heavy carbon emitting vehicles and incorporating allowances for hybrid cars. The city offers useful lessons in land use and municipal strategies as well as for sustainable behaviour change. The carbon tax in the center of the city limits vehicles and promotes use of public transportation, which is well established in the city. GHG offsetting at the municipal level is an effort that is now being replicated in other cities. It highlights the importance of spatially managing the city and its use. City of London Corporation and the private company Acclimatise have outlined a detailed adaptation strategy, which builds on climate change scenarios. It is the first climate change adaptation report from the UK and focuses on managing flood risks, water resource management, heat risks and air pollution, and managing ground conditions (City of London Corporation, 2007). The London Development Agency (LDA) has established several low carbon zones to reduce local carbon emissions. It ultimately seeks to establish a low carbon economy through sustainable/ green markets, services and jobs. Initiatives like planting trees to green the city and de-carbonize its energy supply while capturing heat 'waste.' Another initiative in the city- the London Energy Partnership (LEP) launched in 2004 works with partners across the city to promote a sustainable energy future. Under the Mayor's Energy Strategy, the LEP set up Energy Action Areas to promote low carbon development in London, while incorporating renewable energy and

efficient energy technologies. In 2008, the LEP led an initiative to set up ten low carbon zones (LCZs), examples of an integrated planning approach.

Cape Town, South Africa is one of the most environmentally rich cities in the world. However, growing urban sprawl has increased demands for natural resources and urban services<sup>6</sup>. The city's climate change response emerged out of South Africa's Department of Environmental Affairs and Tourism, which targeted adaptation issues. The city uses an Integrated Development Plan with provisions for sustainability and improved human development indicators. Cape Town has taken a number of mitigation actions to reduce greenhouse gas and prepare in advance to climate impact<sup>7</sup>. Most emissions in the city can be attributed to the coal-dominated power and transport sector (Cities Alliance, 2007). The city-level aspect of the planning process is what has defined Cape Town's efforts for resilience and low carbon development. Cape Town has also employed an Integrated Metropolitan Environmental Policy (IMEP) guided by sustainable resource use and environmental management principles, which outline environmental commitments for 15 sectors. This holistic approach to sustainable urban environmental management seeks to benefit all communities. The IMEP has successfully coordinated the management of environmental resources. It has also demonstrated the importance of consulting different stakeholders across departments and sectors. The city government has played an instrumental coordinating role in leading the response to climate change and resilience policies. However it would not have been able to do so without engaging multiple sectors, departments and actors.

Urban sustainability and environmental issues have been prioritized by Cape Town since 1990s. In 1996, it adopted its first Environmental Policy and established an urban framework. The first IMEP was devised in October 2001 and included strategies for coastal zone management, energy and climate change management strategies. Cape Town City was the first urban local body and also the first entity in Africa to adopt an Energy and Climate Change Strategy in 2007. This serves as a useful developing city precedent as it sought to reduce GHG emissions, increase sustainable

<sup>6</sup> Cities Alliance. 2007. Liveable Cities: The Benefits of Urban Environmental Planning, 87.

<sup>7</sup> UNEP. Climate Neutral Network. Online. URL <[www.unep.org/climateneutral/Default.aspx?tabid=869](http://www.unep.org/climateneutral/Default.aspx?tabid=869)>

energy use and protect vulnerable communities from the impact of climate change (Cities Alliance, 2007). The municipal government has responded to potential of sea-level rise, flooding and increased water stress through a series of integrated strategies. Cape Town's Environmental Planning Department has commissioned a framework in response to short and medium term impacts of climate change in the metropolitan area. They created a city wide 'consolidated and coordinated' approach to reducing vulnerability to climate change impact. Having identified climate induced impacts and adaptations for Cape Town, a City Adaptation Plan of Action (CAPA) for will be developed soon. It will integrate existing climate proof initiatives and adaptation across nearby municipalities. Cape Town's environmental wealth is a tourist attraction and contributes significantly to the local urban economy. A Biodiversity Strategy and an integrated citywide Coastal Zone Management Strategy has been implemented in several areas in the city (Cities Alliance, 2007).

The interventions and steps taken up by these cities hold merit considering the urgency to adapt and mitigate climate impacts and the multilevel vulnerability that cities face. Yet there is still a need to build climate resilience as a practical/ inherent part of the development planning process. These interventions largely targeted R&D, shift in mechanisms, structural adaptation and mitigation interventions and capacity building. There is still a requirement to build climate resilience as a practical part of the development planning process. The aim should be toward sustainable and climate proof cities and integrating environmental and urban planning processes. Climate change responses and adaptation processes have by far been active at national and international levels. Cities and capitals must now implement these plans and begin to prepare themselves to effectively respond to climate change. City level responses are becoming more apparent given that implementation is being led by municipal governments and local partners. This raises the issue of how to coordinate efforts from the national or state levels down to the local, municipal level. Although urban planning features in the climate change responses, it is not just government agencies that are involved in climate change mitigation. Municipal level responses have generally involved a series of collaborators and partnerships. Climate

change policies have generally emerged from one government department and after securing buy-in have been implemented in coordination with several partners, within and beyond government. Since rapid and comprehensive implementation requires local / urban governance, municipal involvement is crucial in order to engage and raise awareness amongst urban populations. Cities like Almere in the Netherlands, Stockholm and Copenhagen have been recognized for their early actions towards addressing climate concerns and municipal sustainability. Their mitigation, adaptation and resilience efforts are also a sign of accountability and responsiveness on behalf of these governments.

### **2.3 The Indian context for City-level integrated planning**

India's cities are increasingly feeling the impact of climate change and recognizing the need for adaptation as well as resilience in these urban spaces. Urban development had not been a priority for India, a country that relied heavily on rural and agricultural related economic activities. This changed in 2005, when finances were allocated to Indian cities under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). After several separate initiatives and schemes to address urban problems and several five year plans, JNNURM emerged as a flagship scheme, which adapted reform based funding approach that could help ULBs receive funds for infrastructure development and basic services for urban poor whilst updating their own capacities and systems by implementing mandatory reforms. However, JNNURM did not look at climate change as one of the priority areas for the cities, which was quite understood considering contemporary challenges in Indian cities verses knowledge of climate change impacts that was not clear, uncertain and looked distant. It was only recently when the National Action Plan for Climate Change was released that a separate mission on cities and climate change looked at the issue in an integrated manner.

The use of funds and pace of urban reforms via JNNURM has been inadequate. A study by Mehta and Mehta (2010) argues that this has been due to a lack of infrastructure to implement changes or because the reforms focused on infrastructure at the expense of services delivery. JNNURM is also

inadequate because it looks only at 65 cities out of the total 4378<sup>8</sup> urban agglomerations and towns in India. Nonetheless, JNNURM has highlighted the role of municipal financing for cities to decentralize resource allocation, and ultimately to support their resilience and low carbon development. JNNURM also holds potential in its next phase to take up some of the activities proposed under the National Mission on Sustainable Habitat which is one of the Missions under the National Action Plan for Climate Change (NAPCC). NAPCC missions aim to manage India's climate change agenda through multiple components that seem to work without cohesion. It includes a National Solar Power Mission, Enhanced Energy Efficiency Mission, National Water Mission, National Mission on Sustainable Habitat (NMSH), National Mission for Sustaining the Himalayan Ecosystem, National Mission for A Green India, National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change. Climate change features comprehensively and across departments and sectors. Each mission encompasses several sectors that either contribute GHG or will be impacted. The NMSH is the only one that deals specifically with urban areas and constituent needs (Ahmad and Choi, 2010).

NMSH is one of eight missions under the NAPCC and aims to make cities sustainable by targeting energy efficiency in buildings, managing of solid waste and shifting to mass public transport. It targets cities covered by the JNNURM and seeks to make them climate resilient by improving their green coverage. It also aims to promote sustainable energy efficiency as an essential component of urban planning (Das and Dastane, 2010). For example, it includes provisions that would expand the energy conservation building code to optimize the energy demands in the design of new commercial buildings. It also has long-term transportation plans for small and medium cities to ensure efficient public transportation options. It targets urban waste management and recycling provisions and supports the development of technologies that generate power from waste. Apart from JNNURM and NMSH, the Indian Government has identified 13 Centers of Excellence (COE) to guide the NMSH. These are partner research institutions identified for

their expertise and engaged to guide the government's urban sustainability initiatives. 4 centers will focus on urban transportation issues, while 9 centers guide urban development projects. The good thing is that NMSH is not limited to JNNURM cities, even if it views JNNURM as one of the potential carries for NMSH's agenda in cities.

For cities in the Indian context it is important to bridge the efforts by the NMSH and JNNURM and involve multiple stakeholders to overcome the lapses. For instance, neither of these missions explicitly mentions climate change resilience, although they emphasize adaptation and mitigation. Indian cities in the past have not incorporated environmentally sustainable plans into their planning processes. There has never been an overt environmental guiding principle in the planning of urban spaces. Increasingly, cities are recognizing the importance and need to green. Delhi for instance is often touted as one of the greenest cities in the world because of its efforts in recent years to plant trees. But, its rising air pollution rates are in part because of the construction of flyovers leading to increased road space and personal vehicles in the heart of the city. There are several benefits that could be derived from incorporating urban resilience and adaptation options into the city planning process as well as master planning processes. As a developing country with the growing urban populations, India will among the most vulnerable countries affected by climate change (Revi, 2008). Their infrastructural investments and plans adopted now will affect the future; therefore, infrastructure and service delivery investments made now that take into account climate change and its impact as well as strengthening urban management to enable adaptability and the ability to address changing risk profiles.

To date, there are very few examples of adaptation, resilience or sustainable environmental planning processes in Indian cities. In 2006 the Municipal Corporation of Guntur devised a Master Budget for environmental expenditures, managing their natural resources in the same way as their financial resources. For example, 'green surface areas' were recognized as an environmental indicator and the municipality allocated a baseline value of inhabitants. Short term and long term targets were set as spending limits to

<sup>8</sup> Government of India. 2010. Urban Morphology: Urban Agglomerations/Towns by Class/Category : Census of India 2001. Ministry of Urban Development. Accessed on 29 August 2010. Online. URL: [www.urbanindia.nic.in/urbanscene/urbanmorpho/urbanmorph.htm](http://www.urbanindia.nic.in/urbanscene/urbanmorpho/urbanmorph.htm)



“internalize the true environmental costs of different city level decision making efforts” (Cities Alliance 2007). This requires the stakeholder involvement while addressing physical, social and institutional dimensions of resilience. The provision of basic services, for instance, forms an obstacle to physical urban resilience. Urban planning is an effective and practical tool to promote resilience and low carbon development in cities. The variety of experiences and successes highlight the importance of sharing best practices amongst developing and developed world cities. They demonstrate not only the importance of city-level interventions, but also the diverse ways in which urban planning can address the issues facing cities. Successful approaches that are holistic and integrated in nature were highlighted in the city-level experiences from London, New York and Cape Town.

### 2.4 Policy Recommendations

The UNHABITAT has identified four areas producing GHG emissions and affecting climate change that urban planning can target to address sustainable urban development: transportation, buildings, production and poverty reduction (Karl 2010). However, urban planning can enhance the ability of cities to meet climate change goals in mitigating, adaptation and resilience if they are strategically and systematically planned (Karl 2010). Multiple stakeholders must be engaged to play a role in encouraging activities within these entry points. This includes creating incentives to use sustainable technologies and practices, promoting research and training on climate change issues while supporting new, environmentally friendly technologies (Karl 2010). The concern surrounding climate change and its impact on cities demonstrates the importance of maintaining and improving the sustainability of cities, worldwide. Urban planners can play a lead role in considering and anticipating the environment and health of different subsystems within an urban environment (as discussed in chapter 1) while planning livable cities. Environmental sustainability is increasingly being considered in urban development plans. For climate change policies to be city wide and integrated requires urban planning interventions (Yuen and Kong, 2009).

Strong urban planning can promote resilience by ensuring optimal use of space, energy and natural

resources. Some policy recommendations that can enable city-level integrated urban planning as a tool for building resilience and promoting low-carbon development should address the following areas and actions:

#### Planning

- Comprehensive city planning and integrated approaches, which involve all departments and sectors as well as expertise from various stakeholders. Keene<sup>9</sup> for instance recognizes three distinct systems that are affecting cities and will be affected by climate change – natural, built and social environments. This looks at the health of communities which is a very useful approach. Inter-sector approaches are useful because individual sector work may end up overlapping. It would be useful to integrate one common component / aspect into all planning and processes at the urban level.
- Flexible and adaptable climate change planning processes are crucial because our knowledge is still limited and we don't know exactly what might happen. The element of uncertainty associated with climate change impacts would require flexibility and adaptability within the planning processes. Ensuring sustainability as one of the key outputs of urban planning mechanisms is also a key feature.
- Engagement, education and awareness raising campaigns are a useful element within planning for development because each behaviour or activity can contribute to climate change – wasting electricity, driving cars, not recycling or reusing.

#### Governance

- Decentralized and improved local / urban governance is important for practical implementation of resilience and sustainability strategies. Cities contribute to and can reduce climate impacts caused by carbon emissions. Municipal governments are responsible for making sure that in their own administration and activities / their governance role move towards climate-neutrality. They can also influence citizens' and other actors' behavior. Reforms for example affect carbon emissions and production

<sup>9</sup> ICLEI. 2007. City of Keene, New Hampshire Climate Adaptation Action Plan Summary Report. Available at: [cbtadaptation.squarespace.com/storage/KeeneSummary\\_ICLEI\\_FINAL2.pdf](http://cbtadaptation.squarespace.com/storage/KeeneSummary_ICLEI_FINAL2.pdf)



in the industry and transport sectors. As players in the community, they can motivate others and enlist them to take part in reducing emissions.”<sup>10</sup> They take the lead in practical responses and implementing ways of addressing climate change. It is crucial to have in place responsibility and accountability mechanisms that ensure transparent and reliable urban governance. Cross-sectoral programs and strategies are best guided by governments, who are able to address issues of inclusiveness for instance. They need a role to ensure sustainable city planning processes are adopted.

- Public-private partnerships (PPPs) are an important and effective means of leveraging stakeholder expertise and forming partnerships for greater community benefits. Setting standards and regulations is possible only by the municipal governments for sustainable urban development, but the private sector needs to be involved and reigned in.
- Involving stakeholders and organizations to educate and facilitate informative processes that would address climate change and its effects. Although municipal governments should lead the way but it is up to urban constituents to react, respond and collaborate. Awareness generation towards sustainability and climate change issues would also help generate demand from the general public for efficient and timely systems to support adaptation and mitigation.
- Timely action and leadership commitment is also a crucial component for urban resilience to climate change. Livable and resilience cities hinge upon ensuring appropriate actions and strategies are taken at the right time in anticipation of the diverse impacts of climate change.

### **Technology**

- Data base generation and management comes the fore in discussions of climate change. Municipal bodies often do not have appropriate data to address planning needs and development. Similarly, a lack of climate data hampers projections

and assessment of future needs. Using integrated data management systems to store, process and manage diverse forms of data could help cities inform policy decisions based on concrete and continuous data sets. Information Technology (IT) tools like various data visualization techniques can help better inform the municipal bodies, utilities and others as well as the general citizens of the impacts and likely responses of climate change. This would also help on-going assessment, monitoring & evaluation, so that efforts remain flexible, sustainable and up to date with climate change knowledge.

- Advanced Mapping, visual and spatial technologies can promote effective resource allocation and resilience strategies in cities. Cities warrant multivariable analysis towards holistically informed urban resilience and low carbon developments. Applying information and communication technologies for spatial exploration that informs urban planning. Advanced mapping techniques such as LIDAR and GIS are being used in Miami and New York to ensure more efficient resource allocation and address climate change. GIS and other mapping tools can be used to analyse land use, urban forestry and urban agriculture are important applications.
- Participatory community data gathering and sharing is also enabled to involve communities in managing their environments and protecting their communities in the context of climate change. Technology enable global and cross sector information sharing and generation. In contemporary cities, knowledge sharing is power and is facilitated in the urban context by technological advances. Municipal engagement and emergency alert systems can provide up to date city data on websites and disseminate it via smart phones, SMS and social networks. Leveraging virtual networks could also enable and activate rapid social response systems. The potentials to generate and use data for resource allocation have immense potential in the face of climate change.

<sup>10</sup> UNEP. Climate Neutral. Online. URL <[www.unep.org/ClimateNeutral/Default.aspx?tabid=349](http://www.unep.org/ClimateNeutral/Default.aspx?tabid=349)> UNEP. Climate Neutral. Online. URL <[www.unep.org/ClimateNeutral/Default.aspx?tabid=349](http://www.unep.org/ClimateNeutral/Default.aspx?tabid=349)>







# CHAPTER 3

## Disaster Risk Reduction and Adaptation

Vidyunmala Veldore, G J Lingaraj and Sreeja Nair

### Key messages

- Many definitions, interpretations and approaches exist for quantification of disaster risk and assigning critical thresholds beyond which an event/ hazard can be termed a disaster.
- Assessment of the changing profile of hazards due to climate change can provide key inputs for the disaster risk reduction and risk management efforts in cities.
- While DRR and adaptation efforts aim towards safeguarding development and poverty reduction in many direct and indirect ways, there are many differences in the basic nature of the issues they address.
- Owing to differences in the concept of DRR and adaptation, their convergence largely remains in a conceptual form. Financial resources are often concentrated in current risks, developmental priorities and relief and rehabilitation efforts after a disaster occurs rather than planning for future risks.
- Convergence of DRR and adaptation in cities is essential not only for managing current risks but also potentially higher risks in the future.
- India's XI Five Year Plan's (FYP) focus on disaster mitigation, rather than simply disaster response, provides an opportunity to integrate disaster mitigation into the development process. Win-win strategies need to be promoted for planned disaster risk reduction

### 3.1 Introduction

Despite decades of investment into urban infrastructure and risk reduction and management options in developed nations, disasters such as Hurricane Katrina and New Orleans were stark examples of how inadequacy of disaster preparedness and resilience planning can lead to large-scale losses (Satterthwaite et al, 2007). Examples from developing and least developed countries reveal that social capital often acts as a stronger buffer in the face of disasters compared to infrastructural investments. Gupta et al, 2010 define disaster as a “severe disruption to a community’s survival, resources and livelihood systemsthatresultfromvulnerabilitytohazardimpacts and results in loss of life, property or environment on a scale which overwhelms their capacity to cope unaided”. The United Nations International Strategy for Disaster Reduction (UNISDR) refers to Disaster Risk Reduction (DRR) as “structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards”. Climate change adaptation refers to “an adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits benefit opportunities” (IPCC, 2007). Many definitions, interpretations and approaches for quantification of disaster risk and assigning critical thresholds beyond which an event/ hazard can be termed a disaster, have often been contested. This is primarily because the definition of disaster in terms of indicators such as loss of human lives, damage to infrastructure, social capital etc. varies depending

on the region and systems that are impacted and the temporal and spatial scale of impacts. Agreement on a common approach becomes more tenuous when the climate perspective comes into consideration, owing to inherent uncertainties and non-linearities with respect to future changes in the climate system.

The strategic goals enshrined in the Hyogo Framework for Action (2005-2015) and agreed upon by 168 nations, include “*integration of DRR into sustainable development policies and practices, development and strengthening of institutions, mechanisms and capacities to build resilience to hazards and systematic incorporation of DRR approaches into the implementation of emergency preparedness, response and recovery*” (Prasad et al, 2009). Though many countries in South Asia have adopted the South Asian Regional Framework and developed national frameworks for DRR based on the Hyogo Framework of Action, however region-specific tools and methodologies for DRR are still lacking (Chakrabarti, 2010). This chapter discusses these issues interspersed with case study examples and presents key elements of Disaster Risk Reduction (DRR) and adaptation to climate related extreme events and their inter-linkages.

### 3.2 DRR and adaptation: divergence and convergence

It is well understood that disasters, including extreme events contribute to spiralling already vulnerable and low-income communities deeper into poverty and hence impede the achievement of developmental objectives such as those enshrined in the Millennium Development Goals. So while DRR and adaptation efforts aim towards safeguarding development and poverty reduction in many direct and indirect ways, there are many differences in the basic nature of the issues they address. Box 3.1 lists the differences and opportunities for convergence between DRR and climate adaptation.

Climate-related disasters or hazards represent only one among a range of geological, hydro-meteorological, biological, technological hazards that the society faces. On the other hand, adaptation entails more than reducing risks in a business-as-usual condition that is covered under DRR (Venton and Trobe, 2008). Gupta et al (2010) argue that approaches towards building resilience need to consider the concept of ‘hazards’ as the pivot for discussion rather than focus on actual ‘disasters’ per se. The argument

#### BOX 3.1 COMPARISON OF DRR AND ADAPTATION (ADAPTED FROM MITCHELL AND AALST, 2008)

##### Differences

- While DRR is relevant to all hazard types, adaptation is limited to climatic hazards
- DRR focuses more on managing current risks while adaptation also focuses on the ability to deal with future risks and impacts
- DRR is often rooted in local practices and indigenous knowledge; these practices may however be redundant or inapplicable under new or enhanced risks in the future

##### Points of convergence

- Current climate variability (as also considered within DRR) is an entry point for basing future adaptation strategies
- There may be opportunities to link indigenous knowledge with modern technology or scientific know-how with mutual learning for DRR and adaptation
- It is increasingly being recognized that adaptation tools and techniques are essential and that these should imbibe learning from established DRR tools

is based on the premise that resilience not only entails recovery but also ‘building back better’. Hence the focus needs to be on factors or conditions that create risk and vulnerability, rather than the event itself. In terms of DRR initiatives, ‘one-size-fits all’ strategies are sparse in number, in terms of the benefits they offer or the extent of risks they reduce. For example, the impacts of structural measures such as embankments sought to protect a certain population, may have spill-over impacts on those residing outside these protective structures, hence displacing the risk and vulnerability elsewhere (Moench, 2010).

Owing to such differences in the concept of DRR and adaptation, their convergence largely remains in a conceptual form. This can also be attributed to the fact that financial resources are often concentrated in current risks, developmental priorities and relief and rehabilitation efforts after a disaster occurs rather than being committed for reduction of exacerbated risks in the future (Mitchell and Aalst, 2008). Convergence of DRR and adaptation in cities is essential not only for managing current risks but also potentially higher risks in the future. This is important because several large-scale infrastructural investments are being made in cities, and not considering the sustainability aspect of



DRR may lead to mal-adaptation i.e. enhancement of risks in the long term. This is important because these investments are often based on an extrapolation of past and current risks into the future and with climate change there are likely to be many non-linearities in the way these risks and impacts emerge (Venton and Trobe, 2008). The next section discusses application of a particular approach- referred to as ‘climate risk-screening’ for integrating DRR into developmental efforts.

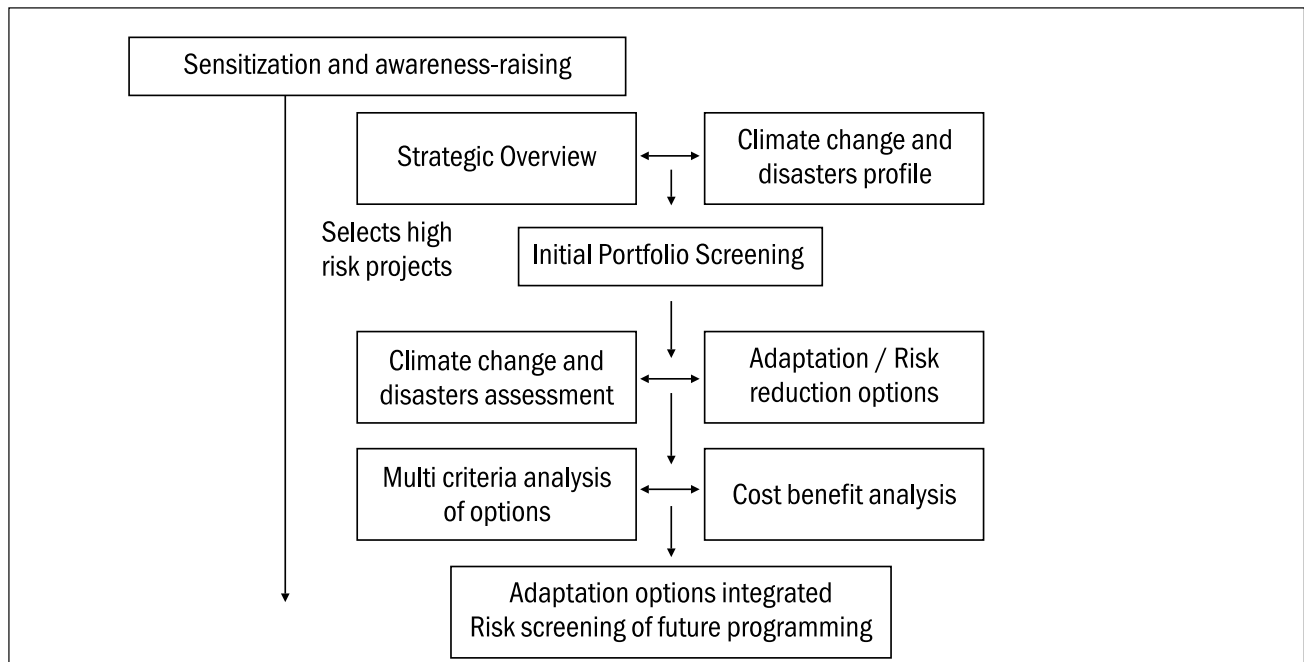
**3.2.1 Climate-risk screening for mainstreaming DRR**

Climate-risk screening is an approach for reducing climatic risks to developmental objectives and integrating DRR and adaptation options within developmental programmes at the national and sub-national levels (Tanner et al, 2007). The steps involved in climate risk screening (Figure 4.2) include:

- Assessment of current and future impacts of climate change on developmental objectives of a programme;
- Assess the ways in which the developmental programme already contributes towards vulnerability reduction and risk reduction
- Identify potential entry points to integrate climate risk management strategies into the scope of the programme

- Prioritisation of the selected strategies based on specific criteria
- Conducting cost- benefit analyses of the selected strategies.

An example of how the CRS approach was applied for the Urban Service for the Poor programme of DFID-India in two states of India-West Bengal and Madhya Pradesh is presented ahead. The objective of the Kolkata Urban Services for the Poor (KUSP) is to support infrastructure improvements in slums, including water supply, sanitation, drainage and access roads. The primary objective of the Madhya Pradesh Urban Services for the Poor (MPUSP) is to strengthen governance at the level of the State and urban local bodies to address access and affordability issues of the poor related to basic urban services. Identified climate risks to the objectives of KUSP and MPUSP include water logging and flooding due to projected increase in high precipitation events, consequently impacting drainage, wastemangement, water supply and sanitation and community health services. While some of these risks are covered under the current programme portfolio, there are additional opportunities for DRR and adaptation, as shown in Table 3.2.



**Figure 3.1 The Climate Risk Screening Process (Tanner et al, 2007).**

This Climate Risk Screening Process is also known as ORCHID (Opportunities and Risk from Climate Change and Disasters) Developed by DFID-Bangladesh and IDS, UK.

**Table 3.2 Example of Climate Risk Screening conducted for Urban Services for the Poor programmes in Kolkata and Madhya Pradesh, India (Tanner et al, 2007)**

Identified climate risks	Climate Risk Management (CRM) and adaptation		
	Current practices		Additional opportunities for CRM and adaptation
	KUSP	MPUSP	
Urban flooding	In- situ slum up-gradation		<ul style="list-style-type: none"> <li>• Strengthening O and M activities with periodic monitoring and evaluation</li> <li>• Comprehensive urban planning considering climatic risks (includes construction of adequate drainage channels)</li> </ul>
Health risks due to contamination of water supplies	Operation and Maintenance of existing water supplies and drainage systems	Enabling ULBs to develop and follow environmental standards for sanitation and drinking water	<ul style="list-style-type: none"> <li>• Development of a spatial and temporal database for water quality surveillance</li> <li>• Raising plinth level of toilets</li> <li>• Better insulation of toilet pits to reduce seepage into the soil and groundwater</li> </ul>

### 3.3 Global and Regional case studies

#### ***Water and Flood Adaptation Program: Hanoi, Vietnam***

This programme seeks to improve the flood preparedness and prevention through strengthening the dikes, improving the performance and efficiency of dike management teams; building storage structures upstream of the reservoir to control the pressure from floodwaters in Hanoi (World Bank and ISDR, 2008).

#### ***Climate Risk Management and Adaptation: New York City, USA***

The climate risk management framework of New York City has a nine-step adaptation assessment process- including risk management, infrastructure, and policy changes that are prioritized in terms of timescales, investment costs and risks. The focus is multi-sectoral and covers water supply, sewerage and wastewater treatment (Prasad et al., 2009).

#### ***Coastal Flooding in Thames Barrier, London (UK)***

One million Londoners are potentially exposed to coastal flooding. They are defended by a complex system involving fixed flood defenses, the mobile Thames Barrier, which is closed before a surge arrives, and a suite of warning systems that are used to decide when to close the barrier. The design life of the barrier is until 2030, when rising flood levels due to a combination of global sea level rise and more local changes will reduce the residual flood risk to a below 1-in-1,000 year standard. Given the long lead-time to upgrade the defences, planning to the flood defences to 2100 is already in its early stages.

#### ***Landuse planning and management in Cuba***

In Cuba, national land-use planning and management are integrated with disaster risk reduction. Initiatives in land-use management and urban planning have involved communities in the identification of local problems, in the planning process and in implementing the decisions taken about land-use management. The increasing exposure to the impact of disasters has motivated the government to support studies on coastal land-use management. In this context hazard maps for storm surges and additional vulnerability maps have been produced. The city of Havana provides an example of urban planning in a coastal zone; the city has a conspicuous breaker wall, stretching seven kilometers along the sea to reduce the impact of the storm surges that periodically strike the city's coast (UNISDR, 2004).

#### ***Disaster Risk Management Program as per the Second National Strategy and Action Plan: Nam Dinh Province, Vietnam***

The Second National Strategy and Action Plan of the Nam Dinh Province, Vietnam integrates a Program on Disaster Risk Management (DRM). The DRM program also facilitates long-term adaptation through some strategies such as:

- Afforestation of upstream forest watersheds to reduce impacts of floods on downstream regions
- Building of large- and medium-scale reservoirs upstream to retain flood water
- Strengthening of dike systems to resist flood levels
- Building flood diversion structures
- Clearing of floodways, building flood diversion



structures and emergency spillways along the dikes

- Conducting training and awareness campaigns for the communities on DRR
- Developing early warning systems and river flood forecasting models (World Bank and ISDR, 2008)

### **Heat wave plan: London, United Kingdom**

The Heat Wave plan of London city details a 'heat-health watch' that operates from June 1 to September 15 each year. It defines 4 levels of response based on threshold temperatures: Level 1- Awareness; Level 2- Alert; Level 3- Heat wave; Level 4- Emergency. In addition, the plan sets out the responsibilities of the various health and social services bodies. For example, the Health Protection Agency is responsible for surveillance of heat-related illnesses and reporting to the Department of Health (DoH). Met Office is responsible for providing three day forecasts, notifying DoH when these predict threshold temperatures, confirming when thresholds have been met and forecasting the likely duration of heat waves. The DoH, in collaboration with Met Office and Strategic Health Authorities, will issue advice to the public and to health and social service professionals in affected regions via the media. Furthermore, regional directors of public health are required to work with utility companies to maintain continuity of water and power supplies to those in affected regions (World Bank and ISDR, 2008).

### **3.4 India in context**

The 1990s witnessed the gradual institutionalization of disaster management efforts by the Government of India, with the engagement of various ministries and departments. However, DRR was focused more on disaster relief and rehabilitation measures. Post Latur earthquake of 1993 and Orissa super cyclone of 1999; a high-powered committee on disaster management was set-up in India for the preparation of disaster management plans. This was the National Disaster Management Authority (NDMA) in 2005, formed under the Ministry of Home Affairs, after the Disaster Management Bill of 2005 was passed. DRR and disaster management occurs at different levels in India:

- National level: The NDMA operates at the national level and has set up Disaster Mitigation Funds and created the National Institute for Disaster Management (NIDM) to conduct training for planners and trainers at different levels including local communities for disaster risk reduction and management.
- State level: Some states have set up State Disaster Management Authorities with engagement of relevant departments such as Water Resources, Agriculture, Drinking Water Supply, Environment and Forests, Urban Development, Rural Development etc. The States have been advised to enact Disaster Management Acts and some states such as Gujarat and Madhya Pradesh already have these Acts in place.
- District level: Apart from relief and rehabilitation, the District Magistrate is the nodal person for coordinating activities related to disaster prevention, risk reduction and better preparedness in the district. District Disaster Management Committees have been formed in multi-hazard prone districts across the country.
- Local level: There are plans of creating Block/taluka level Disaster Management Committees in the 169 multi-hazard prone districts of the country.<sup>1</sup>

The Swaminathan Committee report<sup>2</sup> (2007) which was set up to review the working of coastal regulation zone in India reiterated the need to embed climate change concerns in coastal zone planning and management. With the passing of the Disaster Management Act, 2005, along with guidelines for development of National and State disaster management plans, the National Disaster Management Authority was set up in India (GoI, 2008). It lays down a framework for disaster management and coordination across all scales. The approach of India's XI Five Year Plan's (FYP) (2007-2012) also marks a shift from only relief and rehabilitation to a proactive disaster risk reduction approach.

The integration of adaptation within DRR however still remains to be realized in practice. One Indian example where DRR and adaptation has been integrated at a city level is from Pune city in the state of Maharashtra. The city has a population of nearly 5

<sup>1</sup> GoI, Disaster Management in India. Accessible at <http://www.unisdr.org/eng/country-inform/reports/India-report.pdf>

<sup>2</sup> Swaminathan Committee Report was set up to review the working of coastal regulation zone in India. Details available at <<http://envfor.nic.in/news/janmar05/swaminathan.pdf>> last accessed on 21 - 07-10

million persons. For several decades, Pune has been prone to rampant floods, being located at the merger point of three rivers - Mutha, Mula and Pavana. Along with the current impacts due to floods, the future impacts due to a likely increase in the frequency and intensity of floods under a changing climate have also been considered by the city and a comprehensive climate change adaptation plan has been developed. Under this Adaptation Plan the following steps have been undertaken with the engagement of the Municipal government as well as civil society in the city:

- Assessment of likely flood risks in low-lying areas of the city by recording hourly rainfall intensity.
- Development of a city drainage map to identify current drainage channels (natural and constructed) and how these connect to the flood-prone areas
- Afforestation, watershed conservation and building of small check dams to reduce impacts of floods in the hilly regions
- Improvements in flood monitoring and early warning systems (UNISDR, 2009).

### 3.5 Policy recommendations

India is one of the 168 countries that have ratified Hyogo Framework for Action (HFA). The HFA Priority Action 1 focuses on ensuring that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation. Therefore it is necessary on the part of the government to ensure appropriate implementation of HFA and integrate DRR concerns in strategic decisions on development. Some priority steps for converging DRR and adaptation concerns in cities are discussed ahead.

- A *systemic risk analysis of cities to climate change induced extreme events* is needed. Although there are macro- level assessments on assessing the impacts of climate change induced extremes like the ones mentioned above there is a need for more city specific bottom up studies for all hydro meteorological disasters. These risk assessments should focus on analysis of biophysical exposure to climate change induced disasters and socio economic sensitivity of people in the cities.

They would provide useful information on key infrastructure and settlements at risk, which would aid in devising, appropriate long-term adaptation strategies.

- *Stricter implementation of existing rules and regulations.* There are flood zone regulations, land use guidelines, cyclone guidelines, coastal regulation zone (CRZ) notifications that detail out a set of actions for development activities in the vulnerable regions. A good example in India is the 1991 CRZ Notification where no new construction is permitted in zone 1, which is within 500 m of the high tide line. However improper implementation of these regulations has resulted in continuous development in vulnerable areas increasing their sensitivity to disasters. Therefore there is need for supporting and strengthening the existing rules and regulations through better implementation and monitoring.
- To ensure disaster resilient development in cities, there is a need for *better inter – agency coordination* across Ministries and departments such as urban affairs, housing, water resources, environment, transport, home/internal affairs, power, communications, municipal governance amongst others at national, state and local levels along with many non- governmental organizations and civil society<sup>3</sup>. This is extremely crucial for efficient action for disaster resilient development in cities.
- *Science and policy interface:* One of the priority actions of HFA is to promote and improve dialogue and cooperation among scientific communities and practitioners working on disaster risk reduction, and encourage partnerships among stakeholders, including those working on the socioeconomic dimensions of disaster risk reduction.
- *Promotion of strategic knowledge on disasters:* It is important for governments to support scientific research on risk assessments, disaster prediction, modelling and monitoring methods, early warning systems and communication tools. It is also important to identify training needs of relevant stakeholders in disaster management and sensitise them about latest developments in the field of DRR and adaptation research.

<sup>3</sup> Living with Risk: A global review of disaster reduction initiatives, 2004 version (ISDR 2004), Chapter 2.3 Risk Assessment, p. 63 <[http://www.unisdr.org/eng/about\\_isdr/bd-lwr-2004-eng.htm](http://www.unisdr.org/eng/about_isdr/bd-lwr-2004-eng.htm)> last accessed on 21 - 07-10

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# CHAPTER 4

## Urban services and resilience

Sneha Balakrishnan and Sreeja Nair

### Key messages

- The impacts of climate change on urban services are expected to vary depending on the geographical setting and associated climate of the urban agglomeration; the nature, size and density of settlement; and the existing coping capacity of the society and its economy.
- Unabated growth of urban population and high incidence of marginal employment and urban poverty have aggravated the accumulated backlog of shortages of basic urban services such as water supply and sanitation, drainage and sewerage and has also resulted in the proliferation of slums and squatter settlements.
- Informal settlements are often inadequately connected to basic urban services, and often located in low-lying areas prone to direct and indirect risks due to environmental degradation and changes in the climate.
- Government investments for the development of infrastructure and provision of basic services have not been spatially balanced during the past few decades leading to high levels of inequity across urban centres in India.
- Unplanned development in most of the fast growing urban centers of India has contributed to a widening gap between demand and supply of infrastructure services, especially for the urban poor.
- There are potential entry points for enhancing service delivery in urban centres through programmes such as JNNURM, Rajiv Awas Yojana, NMSH and India's XI Five Year Plan.

### 4.1 Introduction

Across the globe, the future of hundreds of millions of people in urban areas, dependent on efficient delivery of basic amenities and services, is likely to be affected by the complex and interlinked impacts of rapid urbanization and climate change. The impacts however are expected to vary depending on the geographical setting and associated climate of the urban agglomeration; the nature, size and density of settlement; and the existing coping capacity of the society and its economy. Impacts of climate change will only exacerbate existing vulnerabilities, bringing more cities and more people at risk. As most cities in the world are on the path of rapid expansion in terms of their size, population and economic activities, it is critical to keep in mind that actions taken on the side of development do not adversely affect climate actions (including disaster risk reduction strategies) and vice-versa, thus creating an urgent need for vibrant and efficient urban governance systems that can deliver adequate services and improve living conditions. The five urban services under the portfolio of the Ministry of Urban Development of India are discussed in this publication- viz. water supply, sewerage, solid waste management, drainage and urban transport (discussed in Chapter 6).

With 310 million people and 5,161 cities and towns, India ranks as the second largest urban system in the world (Misra, 2010). The provision of urban infrastructure and services has been among the primary functions of the government where the finances for service delivery is sourced out of tax revenues or other direct or indirect user charges levied on the services provided. These basic services have generally been considered as social goods, to be provided by the government for free or

at nominal prices to users. However, government investments for the development of infrastructure and provision of basic services have not been spatially balanced during the past few decades leading to high levels of inequity across urban centres in India. Unabated growth of urban population and high incidence of marginal employment and urban poverty has widened the service demand and supply gap. As per the latest NSSO survey reports there are over 80 million poor people living in the cities and towns of India. The Slum population is also increasing and as per estimates of 2001, over 61.80 million people were living in slums<sup>1</sup>. Figure 4.1 presents the proportion of poor and slum households in select Indian cities as per records for the year 2001.

Data provided by the 58th round of the National Sample Survey (NSS) indicate large disparities in levels of access to water supply by urban households across states in India. Service delivery in the water supply sector has not been able to match the needs of the increasing urban population as illustrated by the example of the mega-city of Delhi. For example, the National Capital Region of Delhi faces a severe water shortfall and is competing with irrigated agriculture upstream. Drinking water is being transported to meet the demands of this city of 15 million, from over 300km, and yet unaccounted-for water losses are over 40 per cent in the city. Rising temperatures and therefore energy demand for cooling, increasing precipitation variability, a lower number of rainy days, over-extraction of groundwater and a heavily

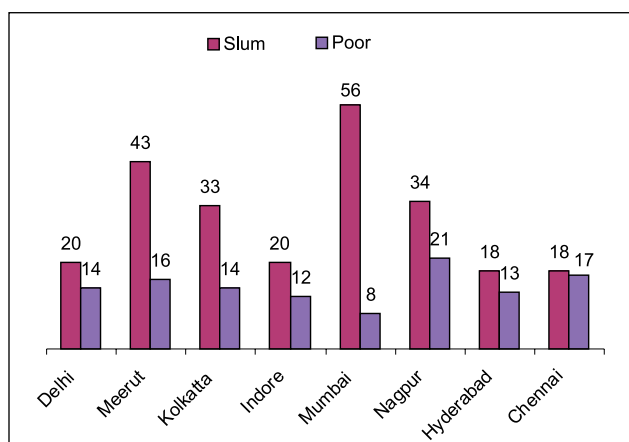


Figure 4.1 Proportion of slum households and poor households in selected cities, India, 2005-06 (Gupta et al, 2009)

polluted river system could make the Delhi mega-urban region, with its projected population of over 30 million, unsustainable (Satterthwaite et al, 2007). Cities are now reaching out to far away sources for their water supply needs, which are not only expensive but also energy intensive (TERI, 2009).

Data on sanitation services also indicate considerable state-wise variations. Sanitation standards are the lowest in the urban areas of Bihar and Madhya Pradesh where more than 45 per cent of the population has no access to any type of latrine (Table 4.1). In most cities, the sewerage system covers only part of the population and the treatment facilities for wastewater are at best primary. Furthermore, increasing coverage of infrastructure is not matched by improvement in the service levels or service quality (Box 4.1, Figure 4.2).

Solid waste quantities generated in urban centres are also increasing due to rise in the population and

**BOX 4.1 INFRASTRUCTURE COVERAGE VERSUS SERVICE DELIVERY IN URBAN INDIA (RASTOGI, 2006)**

Water delivery in terms of hours per day has been declining in Chennai, Bangalore, Hyderabad, Vizag, Guwahati, Dehra Dun, Coimbatore and Ahmedabad. The cities which used to have 15-24 hours of supply per day (Bangalore and Hyderabad) have to do with only couple of hours of daily water supply in the last few years. In other expanding cities as well, water delivery has dropped to a couple of hours a day. Water availability, measured as litres per capita per day is quite high for almost all Indian cities but delivery, computed as water supply in hours per day in the city is rather poor in spite of adequate availability of water.

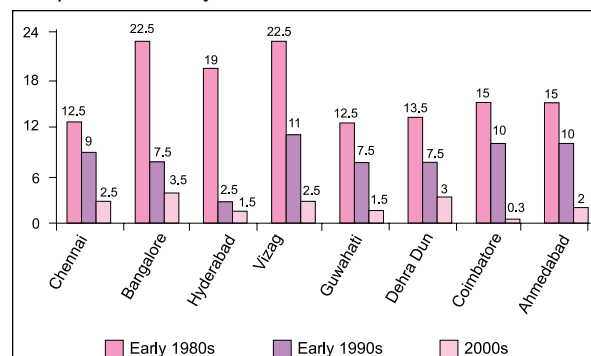


Figure 4.2 Water Delivery (hr/day) in select Indian Cities since 1980s

<sup>1</sup> India: Urban Poverty Report 2009. Summary. Available at: [data.undp.org.in/poverty\\_reduction/IUPR\\_Summary.pdf](http://data.undp.org.in/poverty_reduction/IUPR_Summary.pdf), Accessed 5 August 2010

**Table 4.1: Access to Sanitation Facilities for the Major Indian States for Urban Households (per cent) (1998) from 54th Round of NSS (Rastogi, 2006)**

	No latrine	Service latrine	Septic tank	Pour flush latrine system	Sewerage system	Other
Assam	2	20.1	61.1	3.3	1.0	12.5
Kerala	5.1	3.6	48.8	25.5	7.8	9.2
Punjab	14.8	1.3	23.4	6.5	50.3	3.7
West Bengal	15.2	5.1	55.8	7.2	11.0	5.7
Maharashtra	15.8	1.6	30.3	4.6	47.4	0.3
Gujarat	21.1	1.8	33.8	7.2	35.8	0.3
Rajasthan	25.5	5.2	33.3	19.3	7.2	9.5
Uttar Pradesh	28.2	17.7	32.2	10.7	11.0	0.2
Karnataka	30	1.8	22.0	18.1	27.4	0.7
Andhra Pradesh	30.8	1.2	42.9	4.6	17.9	2.6
Tamil Nadu	32.5	3.0	33.8	6.5	22.3	1.9
Haryana	32.9	9.7	7.5	16.5	32.3	1.1
Orissa	35.8	7.7	50.5	3.4	0.8	1.8
Madhya Pradesh	45.2	6.2	40.3	4.9	3.5	0.0
Bihar	45.3	5.2	45.2	3.6	0.2	0.5
Total	25.5	5.9	35.2	8.4	22.5	2.5

increase in the per capita waste generation rate. With the urban population growing at 2.7 per cent to 3.5 per cent per annum, the yearly increase in the overall quantity of solid waste in the cities will be more than 5 per cent (Rastogi, 2006). Typically one- to two-thirds of the solid waste that is generated in cities is not collected by the municipal systems (Zhu et al, 2008). Waste that is collected is often disposed off in open dumpsites or burned. In low-income or squatter settlements, waste collection is often nonexistent, often because the settlements are informal and unplanned (World Bank, 2008).

### 4.3 Impacts of climate change on urban services and service delivery

#### 4.3.1 Water Supply and Sanitation

- Changes in precipitation patterns may lead to reductions in river flows, falling groundwater tables and, in coastal areas, saline intrusion in rivers and groundwater—all leading to a net decline in the water resources available for supply to urban areas.
- Water quality problems may also increase where there is less flow to dilute contaminants

introduced from natural and human sources. The increase in water temperature can alter the rate of operation of bio-geo-chemical processes (degrading and cleaning) and lower the dissolved oxygen concentration of water (Khatri and Vairavamorthy, 2007). This may lead to increased load on water treatment plants for bringing the water to a recommended standard before it can be released for human consumption and use in the cities.

- Water-supply abstraction and treatment plants, which are generally situated near water sources, may be affected due to disasters such as floods. In severe riverine floods with high flow velocities, pipelines, electrical switchgear and pump motors may get damaged (Satterthwaite et al, 2007).
- Climate related disasters such as floods, cyclones, storm surges etc can also increase the vulnerability of sanitation infrastructure to structural damage. The main impact of climate change would be, on on-site sanitation systems such as pit latrines, is likely to be through flood damage (IPCC, 2007).
- Flooding may also cause septic tanks and sewers to overflow. Since sanitation infrastructures (or

the lack of them) are the main determinant of the contamination of urban floodwater with faecal material, damage to these presents a substantial threat of enteric and other water-borne diseases.

### 4.3.2 Solid Waste Management

Climate change has the potential to impact waste management services and sites (Bebb and Kersey, 2003), by:

- Damaging some on-site waste management facilities such as some gas and leachate collection systems, weighbridges etc
- Disruption of transport facilities impacting the collection of waste from source points and delivery of waste to the management site.

### 4.3.3 Sewerage and Storm water drainage

An adverse impact on water supply is most likely to have negative effects on sewerage and drainage systems in the city. In case precipitation is very high, it can decrease the capacity of the system making it susceptible to flooding and sewer overflow during rainfall extremes. It is important to note that the existing urban drainage system maybe designed to operate under specific weather conditions for a specific area. The age of the system can vary and, in some parts these may not be adequate to deal with future conditions of intense flooding (Berggren et al, 2008).

## 4.4 India in context

The Ministry of Urban Development and the Ministry of Urban Employment and Poverty Alleviation constitute the nodal authorities at the national level responsible for formulating policies and guidelines, designing programmes, coordinating and monitoring activities of various central, state and urban local bodies concerning all issues of urban development in the country. A number of policies and programs, schemes and development projects are already under implementation for various urban sectors and services. These include:

- **Jawaharlal Nehru National Urban Renewal Mission (JNNURM)** (Figure 4.3), which aims at improving urban service levels in a financially sustainable manner in 63 identified cities. The

JNNURM Directorate has also launched the **Peer Experience and Reflective Learning (PEARL)** to facilitate sharing of success stories and best practices (GoI, 2009). For the cities not covered under JNNURM, GoI had launched the **Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT)**. UIDSSMT seeks to improve the urban infrastructure in towns and cities by enhancing public-private-partnership in infrastructural development, and promoting planned integrated development of towns and cities<sup>2</sup>.

- The MoUD has **Standardized Service Level Benchmark (SSLBs)** for benchmarking certain indicators for key urban services such as water supply, sewerage, solid waste management and storm-water drainage (TERI, 2009).
- The GoI announced the **National Urban Sanitation Policy (NUSP)** in November 2008 to comprehensively deal with the challenges in urban sanitation in India’s cities. The policy envisages transforming all towns and cities of India into 100 per cent sanitized, healthy, and livable spaces; and ensuring sustained public health, and improved environmental outcomes for all its citizens. The main components of the policy are awareness generation and bringing about behavior change; achieving open defecation-free cities; sanitary and safe disposal of waste; promoting proper usage and maintenance of household, community, and public sanitation facilities; extending access to

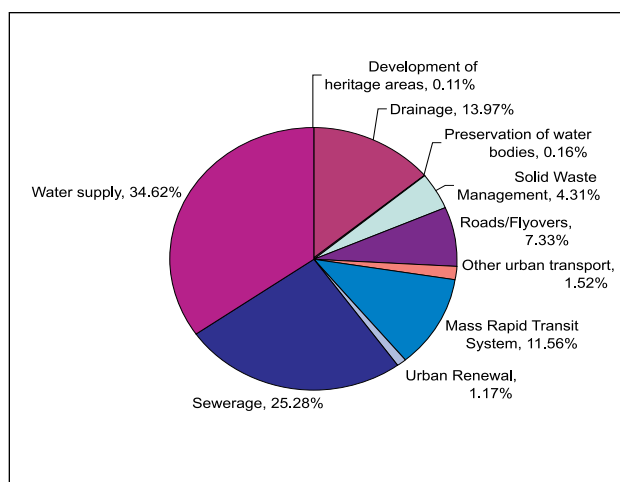


Figure 4.3 Sector-wise sanction of projects under JNNURM as of January 2009 (as % of total project value)

<sup>2</sup> <http://www.cmao.nic.in/Resources/JNNURM/Guidelines/UIDSSMT-%20GUIDELINES.pdf>, accessed on 17 August 2010



sanitation facilities for poor communities and un-served settlements; and strengthening Urban Local Bodies (ULBs) to provide sanitation services by supporting need-based capacity building and training at the state level.

- The **Rajiv Awas Yojana** (RAY) was announced in 2009 and aims at providing low-cost housing for the urban poor. National Urban Housing and Habitat Policy 2007 emphasizes on in-situ development of slums and preparation of a special action plan for slum dwellers with particular reference to the socially disadvantaged groups of urban population. Recognizing that the rise of slums is rooted in the lack of proper urban planning, the RAY focuses on issues that lead to the development of slums- such as shortage of land, housing infrastructure and basic services. (Mathur, 2009). If the RAY is oriented towards urban reforms, it can also be an important vehicle to mobilize the National Strategy for Inclusive Growth as well as the National Urban Housing & Habitat Policy 2007 that aims at improving the living conditions in slums and providing low-cost and alternate housing (Singh, 2010). The specific activities as envisaged under the RAY include:
  - Integrated development of notified and non-notified slums
  - Provision and/or improvement of access and provision of basic services to the urban poor. These include water supply, sewerage, drainage, solid waste management, road access, street lighting, community toilets, market access, livelihoods centres etc.
  - Liaisoning with other schemes for the urban poor, related to water and sanitation, health, education, livelihood support, infrastructure, connectivity etc.
  - Development of low-cost and affordable houses along with basic infrastructure and services (for ownership, rental or both).
- The **Eleventh Five Year Plan** (GoI, 2007) lists the following urban services targets to be achieved by the end of the plan period (2012). These include:
  - Urban Water Supply- 100% population coverage
  - Urban Sewerage and Sanitation- 100% population coverage (which includes 70% population to be provided with sewerage and

sewage treatment and 30% population with low cost sanitation, septic tanks etc).

- Solid Waste Management- 100% population coverage
- Drainage- 100% population coverage to provide comprehensive drainage system in towns / cities wherever needed to help control flooding of urban centres due to rainfall and spread of sewage over streets.
- The **National Mission on Sustainable Habitats** lists key action points for the promotion of solid waste management. These include:
  - Recycling of the waste material.
  - Urban waste management.
  - Development of technology of producing power from waste.
  - R&D on biochemical conversion and wastewater management

#### **Some success stories from India are discussed here.**

##### *Service contracts in Chennai*

In 1992, contracts were issued for the Operation and Maintenance of 14 sewage pumping stations. Following the success of this contract, 61 more pumping stations and O & M of four water boreholes were issued contracts. These stations have demonstrated cost- reductions by nearly 45-65% in comparison to Chennai Metropolitan Water Supply and Sewerage Board operating independently (GoI, 2007).

##### *Model Municipal Laws*

The Municipal Laws in India often do not enable the ULBs to implement reforms. Thus a Model Municipal Law (MML) was developed by GoI in 2003 giving power to the States to enact municipal legislations. The main objective of the MML is to empower ULBs to leverage public funds for development of urban sector and ensure effective service delivery. Rajasthan, Bihar, Orissa and Sikkim have prepared their municipal laws on lines of MML. In this context, the Rajasthan Municipalities Ordinance of 2008 has many enabling provisions to implement reforms under JNNURM. The Ordinance also divided various municipal functions into core, government assigned and other functions. However, water supply and sewerage is not identified as core function but a state assigned function (Vaidya, 2009).

### *Public-Private Partnership (PPP) for solid waste management in Nagpur*

The Centre for Development Communication (CDC) in Nagpur and the Municipal Corporation worked on a PPP mode for complete coverage of the city by door-to-door garbage collection. The objective of the initiative was to improve solid waste management in the city through a low-cost method, while also providing livelihood support to ragpickers. The revenue savings for the NMC (Nagpur Municipal Corporation) through this initiative has been about Rs 20 million. Owing to the better handling and disposal of the waste, the city drains are not clogged during floods and related health concerns have been addressed in a major way (TERI, 2009).

## 4.5 Policy recommendations

### *Water supply*

- A comprehensive database on the water supply network should be developed to enable urban planners and water managers to assess the coverage and improve service delivery.
- Construction of roof-top rainwater harvesting structures (where feasible) and artificial recharge to be mandated in buildings.

### *Solid waste management*

- A nodal unit should be established at the central or state level to coordinate the activities related to urban waste management. Furthermore, it is essential to decentralize the municipal functions upto the zonal and ward level to improve operational efficiency.
- Promoting Public-Private Partnerships: Municipal laws should be amended to encourage PPP for cost-

recovery from efficient waste disposal techniques, and building the technical expertise for effective waste management.

### *Sewerage and drainage*

- Full coverage of sewerage, sewage treatment and low cost sanitation facilities as proposed during the XI plan period, may be achieved through a mix of conventional sewerage and sewage treatment facilities and on-site low- cost sanitation facilities.
- Projections of extreme precipitation as indicated by climate models also need to be considered while upgrading the capacities of storm-water drainage systems.
- Amendments in municipal bye-laws are needed to mandate city residents to connect the toilets to the existing sewerage connections, especially in areas prone to flooding.
- There is a need to encourage decentralized sewage collection and treatment, promote reuse of grey water for irrigation or flushing to reduce the load on the city's sewerage capacity. Green buildings can reduce the demand placed on sewerage systems by promoting reuse of grey water and treatment of wastewater before disposal (TERI, 2009).
- Filter drains and permeable pavements for percolation of rainwater and groundwater recharge need to be constructed within the urban landscape, where possible (TERI, 2009).
- Continuous coordination with waste disposal agencies at the ward level need to be maintained to ensure regular street sweeping and avoid choking of drains with waste and litter.





# CHAPTER 5

## Green buildings: a policy perspective

Hina Zia and Priyanka Kochhar

### Key messages

- Construction sector is resource consuming in its entire life cycle-right from extraction of materials to manufacturing, transportation, construction and operation of the infrastructure/building. Buildings form a big part of this construction sector.
- Climate change will further increase resource consumption by buildings as people shall seek to maintain comfort levels in more extreme conditions. One of the ways to bring down this resource consumption without impacting the comfort and productivity is by promoting green buildings.
- Green buildings have minimal adverse impacts on the built and natural environment.
- Policy instruments of various types have the potential to rightly promote green buildings directly and indirectly.
- Success of a policy instrument varies from country to country. India has also implemented a number of policy instruments to promote energy efficiency and to some extent green buildings, with different degree of success.
- An integrated approach to promoting green buildings policies to create both supply push and demand pull.

### 5.1 Introduction

Construction sector is one of the key elements for economic growth, directly and indirectly. The sector (including buildings) typically provides 5-10% of employment at the national level and generates 5-15% of GDP (UNEP, 2007). At the same time, this sector is resource consuming during the entire life cycle-right from extraction of materials to manufacturing, transportation, construction and operation of the infrastructure/building. Energy consumption in buildings gives rise, directly and indirectly, to as much as 40%<sup>1</sup> of CO<sub>2</sub> emissions and represents more than a third of global consumption. The demand for energy to run appliances such as televisions, air conditioning and refrigerators is also increasing substantially with rise in living standards. This puts additional pressure on the emissions balance, which needs to be countered by achieving energy efficiency improvements. Climate change will further increase site energy demand as people shall seek to maintain comfort levels in more extreme conditions.

IPCC, 2007 report clearly states potential low hanging fruits (cost-effective and easily implementable) to reduce energy consumption in buildings and thereby mitigate carbon emissions from the sector. Most of these ways have been intuitively known but for want of a clear cut implementation methodology supported with relevant legal tools and market dynamics could not be realized. Policy instruments play a very crucial role for wide-scale implementation of any program and capable of transforming market in the desired direction

<sup>1</sup> Source: [www.wbcsd.org](http://www.wbcsd.org)



if implemented in an integrated manner. Green buildings entail promotion of energy efficiency, land sustainability, water efficiency, resources efficiency and better building environment. Such buildings have minimal adverse impacts on the built and natural environment. They are designed to minimize the total environmental impact of the materials, construction, operation and deconstruction while maximizing opportunities for indoor environmental quality and performance; saving money, reducing waste, increasing worker productivity and creating healthier environment for people to live and work. A sustainable building minimizes the demand on non-renewable resources, maximizes the utilization efficiency of these resources when in use and maximizes the reuse, recycling and utilization of renewable resources. It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient lighting, air-conditioning; efficient daylighting integration; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions. In a nutshell, such buildings look at the design, construction and operation of a building in an integrated manner. Green buildings thus have a paramount role to play in mitigating emissions from the building sector.

This chapter attempts to analyse globally and nationally key policy tools used to integrate energy and resource efficiency with brief mention of key strategies/policy packages and consequent reduction in energy consumption and CO<sub>2</sub> emissions (wherever data is available). The policies implemented in most of the countries, however focus more on energy efficiency measures and the resultant CO<sub>2</sub> emission reductions. Also, these policies are limited in scope in terms of wider implications of urban resilience.

## 5.2 Policy tools and instruments: Global scenario

The policy instruments used world over for promoting green buildings (in an integrated way or only energy efficiency improvement) could be classified into the following categories (summarized in Table 5.1):

- *Regulating instruments* that due to direct or indirect intervention influence the volume of the energy or emissions used;

- *Economic/ market-based instruments* usually based on market mechanisms and contain elements of voluntary action or participation, although often initiated/promoted by regulatory incentives;
- *Fiscal and financial instruments*, such as taxes, levies for self financing systems, subsidies and grants, which either increase the price of polluting to the polluter or decrease the price of being cleaner, and thereby accelerate action to invest in energy efficiency, abatement, adoption of renewable; and
- *Supportive actions*, that aim at the improvement of knowledge levels and market transparency through various ways and are always essential to integrate with any/all of the above instruments either through R&D, public leadership programs, awareness raising, education and information campaigns, training, voluntary certification and labeling, and a systematic evaluation and monitoring of policy implementation (UNFCCC, 2001).

### 5.2.1 Regulatory instruments

Such instruments are commonest in buildings sector and are defined as organizational rules which aim to directly influence the environmental performance of polluters by regulating processes and products used, by prohibiting or limiting the discharge of certain pollutants, restricting the consumption of resources, restricting activities to certain periods or areas

European Union has been actively pursuing energy efficiency measures. In 2006 two directives impacting design, use and marketability of buildings in respect of their energy efficiency came into force which, all the 27 EU Member States have to implement in full into the laws within a predetermined time. The two directives entail altering their building codes so that all new buildings constructed from the end of 2020 meet high energy-saving standards and existing buildings upgraded for better efficiency where possible. The **Energy Performance of Buildings Directive** was introduced in January 2006 whose key requirements are:

- Develop methodology for calculating the total energy performance of buildings forming the basis of Building Regulations requirements.
- Review Building Regulations at no more than five-yearly intervals.
- Develop a national system of energy performance certification of buildings, based on whole building

methodology. These certificates will be obligatory for every new building; existing privately owned buildings when sold, existing rented buildings at change of tenant and all public buildings with built-up area greater than 1000 m<sup>2</sup>.

- Every building larger than 1,000m<sup>2</sup>, when undergoing a major refurbishment, must have the latest energy saving technologies installed, insofar as is economical and practical.

The **Energy End-use Efficiency and Energy Services Directive** was initiated in May 2006, whose key requirements are:

- National energy reduction targets of 9% over a nine-year period beginning 2008 through specific measures like double/triple glazing, passive heating and solar energy.
- The 27 Member States of EU have to produce “Energy Efficiency Action Plans” showing how these targets will be achieved.
- The public sector is required to play an exemplary role in energy saving and communicating with citizens.
- Obligations are placed on energy companies to introduce schemes which will give incentives to their customers to install energy saving measures.
- National agencies must be established to take overall responsibility for achieving these targets and plans.

#### 5.2.1.1 Appliance standards

Appliance standards are commonly used in developed and developing countries to achieve energy efficiency of appliances used in commercial and residential buildings. These cover all end-uses and fuel type products, ranging from appliances, lighting, heating and cooling instruments (Box 5.1). The advantage with appliance standards is that it is cost-effective as it reduces transaction costs for consumers and producers. However, often it does not provide enough incentive for innovation beyond the target. Also, standards require continuous testing of products.

#### 5.2.1.2. Building codes

Building codes address the energy consumption of an entire building or systems. These codes are of two types: prescriptive codes that set separate performance levels for envelope (wall, roof, fenestration, glazing),

#### BOX 5.1 TOP-RUNNER PROGRAM, JAPAN

The “Top Runner Program (TRP)” was introduced in 1998 for the energy conservation standards for home/office appliances and the fuel economy standard of automotives. From 2006, the standards under TRP are applicable to 21 types of equipment and heavy duty vehicles as follows; air conditioners, electric refrigerators, electric freezers, electric rice cookers, microwave ovens, fluorescent lights, electric toilet seats, TV sets, VCRs, DVD recorders, computers, magnetic disk units, copying machines, space heaters, gas cooking appliances, gas water heaters, oil water heaters, vending machines, transformers, and passenger/freight vehicles. TRP requires all new products must meet by a specified date the efficiency level of the most efficient product of that category at the time the standard was set. Information such as manufacturer’s name, item code, price, electricity consumption in use and in stand-by mode, target achievement ratio, estimated annual electricity consumption and cost, etc. is readily available in print and electronic form.

equipment, lighting, systems and; performance based codes which prescribe only an annual energy consumption level (thus providing more scope for innovation). The prescriptive codes are obviously easier to implement whereas performance based require interventions from specialized professionals. Building codes need to be regularly updated to remain effective, as technologies improve and costs of energy-efficient features/appliances decline with market penetration.

Building codes exist in almost all developed countries and more and more developing countries. However, their effectiveness varies from country to country based on compliance and enforcement structure. Germany is one of the few countries where it is more effective as it caters to both new and existing buildings. Another interesting example is seen in Austin city, Texas, U.S. where the city has adopted a comprehensive green building programme. One of the components of this programme is building codes that incorporate strict efficiency characteristics. The city also has a detailed monitoring mechanism to monitor the impacts of various initiatives on new and existing structure. As a result, from 1991 to 2007, the city’s energy consumption has reduced by 142 427 MWh and reduced demand by 82.8 MW.

### 5.2.1.3. Procurement regulations

These are provisions for energy efficiency (and/or water efficiency) in the public procurement process. Since such tools are applicable for public sector it could be very effective in countries with large share of the public sector. The government, as a very large purchaser of energy using products, has an immediate impact on manufacturers, none of whom want to be left out of the government segment of the market. Some examples include:

- The US with its Federal Energy Management Program (FEMP) has one of the most stringent legislative frameworks for procurement which states that all federal agencies are required to purchase ENERGY STAR or FEMP designated products.
- In Japan, “Green Purchase” is part of the government policy. Under this policy official organizations such as the government can purchase only green goods. The government procurement of energy efficient products is mandatory by “Law on Promoting Green Purchasing”.
- Mexico has executed an extensive PEPS (Promoting an Energy-efficient Public Sector) program in support with USAID to provide support to municipal governments, federal agencies, and other local organizations to improve the energy efficiency of the public sector, through energy-efficient procurement and overall public sector energy management. It has already covered more than 30 cities and providing support to develop procurement policies tailored to the cities’ specific needs.
- Since 2002, China started working on energy-efficient procurement policy. In 2004, the Ministry of Finance and the National Development and Reform Commission issued a policy document on “Implementation of Government Energy Efficiency Procurement,” calling for a staged, 3-year program to establish energy-efficient purchasing practices at all levels of government in China. The energy-efficient procurement program went into effect in 2005. All Government organizations are required to purchase efficient products. Interestingly, this also includes water efficient products.

### 5.2.1.4. Mandatory certification and labeling

This is an informative instrument and provides information to end-users about the energy-using/

water-using performance of products and even buildings. Labeling programs are extensively used in most of the developed countries and of lately in developing countries like India, China, Brazil, South Africa. Labeling is often combined with appliance standards. Some examples include:

- The Energy Performance of Buildings Directive in the European Union requires the obligatory energy certification of new and existing buildings as well as display of this certification in public buildings. Building certification is however more expensive than labeling of appliances.
- In August 2007, London implemented a Home Improvement Packet (HIP) and Environmental Performance Certificate (EPC) programme. 2009 onward, all homes that are bought and sold need to have HIPs, which contains all necessary legal documents, as well as an EPC. EPC rates a building on a scale from A to G and also contains information regarding potential for improvements.
- Singapore has a green labeling scheme with mandatory provision for use of energy-labelled refrigerators and air-conditioners. It also has a water efficiency labeling scheme, which labels products for water efficiency, allowing consumers to compare the water efficiency of different products such as washing machines. As a result, domestic water consumption has fallen from 165 litres a day in 1999 to 160 litres a day in 2005.
- In Australia, mandatory efficient labelling standards called WELS (Water Efficiency Labelling and Standards) have been introduced for appliances including showerheads, washing machines, dishwashers, water closets, taps and urinals. This was achieved through identical legislation being adopted nationally, as well as by each state and territory. The WELS Scheme aims to address the issue of high domestic water consumption by providing nationally consistent water efficiency information to consumers at the point of purchase, and by encouraging manufacturers to design more water-efficient products in domestic and commercial areas whilst maintaining individual choice and accounting for regional variations in water supply in urban Australia ([www.waterrating.gov.au](http://www.waterrating.gov.au)).

### 5.2.1.5. Mandatory audit programs

Mandatory audit and energy management in commercial, industrial or private buildings is done



under this and is usually subsidized by the government. Financing for such audits and the follow-up measures is a big challenge. Also, the effectiveness of such audits loses ground if the suggested improvements implementation part is not subsidized/ supported. In U.S, 0.1 million homes are annually upgraded as a result of auditing with financial support from the Government (Gillingham et al, 2006).

#### 5.2.1. 6. Utility demand-side management programs

It covers utility-sponsored programs that increase energy efficiency and water conservation or the management of demand and includes planning, implementation and monitoring of such activities. These cover a wide palette of initiatives ranging from individual advise and counselling, energy management and auditing, advice regarding new installations, informative electricity bills, show and display rooms, articles, advertisements, educational campaigns, street lighting, distributing CFLs, etc.

### 5.2.2 Economic and market-based instruments

#### 5.2.2.1 Energy performance contracting/ESCO support

Under this, a contractor (usually an energy service company ESCO) guarantees certain energy savings for a location over a period of time; implements the energy conservation measures and in return is paid from the estimated energy cost reductions achieved through the energy savings (EFA 2002). Success rate for this mechanism varies from country to country. It is effective in countries like Germany, US, China and Brazil whereas Denmark, India, etc. are still struggling.

#### 5.2.2.2. Energy efficiency certificate/white certificate schemes

An ESC is an instrument issued by an authorized agency guaranteeing that a specified amount of energy savings has been achieved (ESCs can be issued either ex-post (based on the measurement of actual performance) or ex-ante (based on engineering estimates). Each certificate is a unique and traceable commodity carrying a property right over a certain amount of additional energy savings and guaranteeing that the benefit of these savings has not been accounted for elsewhere.

- New South Wales instituted the first program in 2003, and since then, programs have been started

in a few European countries: first in Italy, then followed by Great Britain, and most recently in France.

- Italy's ESC program became operational in January 2005. Since then, Italy has achieved significantly more energy savings than required by its annual program target (Vine, et al, 2008).

### 5.2.3 Fiscal and financial instruments

#### 5.2.3.1. Energy or carbon taxes

Direct taxation either as CO<sub>2</sub>-tax or as energy tax has also been attempted by countries like Denmark, Finland, Norway, the Netherlands and Sweden and is based either on the carbon content of the fuel or on the actual energy use. These have not yet been tried in developing countries due to their subsidized electricity tariffs.

#### 5.2.3.2. Tax exemptions and reductions

Tax exemptions in the form of income tax credits or property tax rebates are often used in various countries. For its effectiveness, experts suggest that they should be adopted for advanced technologies to overcome the first-cost barrier and should be sufficiently high. In India, some municipalities have associated property tax rebates with solar water heating/rainwater harvesting/solar lighting integration.

#### 5.2.3.3. Capital subsidies, grants, subsidized loans, rebates

This is a very commonly used tool for increasing energy and water efficiency/conservation in buildings. Subsidies are often used in residential sector (Box 5.2). Such programs should be well supported with information campaigns and limited in time to avoid free-riders. Brazil has an extensive national electricity conservation program known as PROCEL started in 1985. It provides grants to energy efficiency projects carried out by state and local utilities, state agencies, private companies, universities, and research institutes and an estimated 5.3 terawatt-hours per year (TWh/yr) of savings was achieved from 1986-1998 (Geller et al, 1999).

India has an extensive program on providing incentives for renewable integration at building level through the Ministry of New and Renewable Energy (explained in the subsequent section).

**BOX 5.2 EXAMPLES OF INCENTIVES AND DISINCENTIVES**
**Germany**

- Support for Passive House(PassivHaus)
  - 100% mortgages at below base rate.
  - Grants at similar rates for renovation projects.
  - Local & Regional councils often offer further incentives
  
- Exempt from Ecological Tax:
  - Combined heat and electricity systems with an efficiency rate of at least 70 percent.
  - Natural gas power plants which convert at least 57.5 percent of the energy into electricity.
  - For electricity generated from renewable sources.
  
- Motivation for Green Roofs:
  - In Munster 80% of the charges for storm water fee is reduced
  - In Stuttgart there is annual budgetary allocation for new and replaced roof as green roof development for public buildings. It is required by regulation that all flat and slightly sloped roofs (up to 12 degrees) of new development to be extensively greened to certain standards.
  
- Loans for energy efficient buildings from KfW
  - Kreditanstalt für Wiederaufbau (KfW) supports renovations in buildings with the aim of improved energy performance. Loans are available for renovations and new constructions that meet the stipulated standards and can go up to 75.000 Euro and are interest rate free during the first year.

**United Kingdom**

- Electricity generated by renewable means is exempt from the Climate Change Levy
- Photovoltaic rebate of 40-60%
- Bio-energy capital grant scheme between 25000-1 million GBP.
- Energy Supplier Green Energy Funds giving feasibility funds between 5000-30000 GBP

**5.2.4. Supporting action**
**5.2.4.1 Voluntary certification and labeling programs**

This instrument is mostly used for appliances than for buildings. In the long run, mandatory labeling is more effective as voluntary mode can allow for inefficient appliances avoid labeling.

The US Energy Star Program is one of the popular successful voluntary labeling programs with an estimated cumulative savings of 833 Mt CO<sub>2</sub> eq. by 2010(Gillingham et al 2006).

**5.2.4.2. Voluntary Green Building assessment systems/rating tools**

Building assessment systems which look at the overall sustainability aspects of a building are strong tools to motivate the building industry and market forces. Rating systems are evaluation tool to measure environmental performance of a building through its life cycle. Rating systems are instrumental in raising awareness and popularizing green buildings. There are different rating systems/assessment systems in different countries. For instance, Building Research Establishment Environmental Assessment Method (BREEAM) in the United Kingdom, Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) in Japan, Leadership in Energy and Environmental Design (LEED) (developed and piloted in the U.S, now popular in many countries including India), Hong Kong Building Environmental Assessment Method (HK-BEAM) in Hong Kong, Green Rating for Integrated Habitat Assessment (GRIHA) in India.

**5.2.4.3. Awareness raising, education and information campaigns**

This is a very important tool and act as a supplement with any/combination of other policy instruments to achieve the desired objectives. Public information campaigns are designed to change individual behaviors, knowledge, attitudes. Such tools are more effective in residential sector, where other regulatory tools are not so effective. To create market pull, basic consumer understanding about the significance and benefits of building 'green', both economically and environmentally is very important. California, US had a very successful information campaign called 'Flex your power' in 2001 to reduce peak demand and enable energy savings. With the help of media advertisements, provision of toolkits to teachers,

partnerships with businesses, special events with manufacturers, the programme managed to reduce 8.9% of peak demand and 6.7% of energy consumption (Bender et al, 2004).

### 5.3 Policy tools and instruments: Indian scenario

Though India is not legally bound to a specific limit on energy related carbon emissions, the country is committed to “achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of greenhouse gas emissions” (NAPCC, 2008). Various initiatives of the Indian government are described briefly as follows.

#### 5.3.1 Standards and Labelling Scheme

The Bureau of Energy Efficiency (BEE), a statutory body under the Ministry of Power, Government of India has several programs which target high energy end use equipments and appliances to lay down minimum energy performance standards. Energy labelling on voluntary basis was launched in May 2006 and currently applies to equipments/appliances (Frost Free refrigerator, Tubular Fluorescent Lamps, Room Air Conditioners, Direct Cool Refrigerator, Distribution Transformer, Induction Motors, Pump Sets, Ceiling Fans, LPG, Electric Geysers and Colour TV). Each appliance is ranked on a scale of five stars, with more stars indicating higher efficiency and more power savings – thus the program motto of “More Stars, More Savings”. The labels provide information about the energy consumption of an appliance, and thus enable consumers to make informed decisions. The benchmark for energy performance of appliances is reviewed periodically by the BEE and so far, progressive standards for various appliances have been established up to 2015 (Box 5.3).

#### 5.3.2. Energy Conservation Building Code 2007

The Energy Conservation Act 2001 provides for the establishment of state energy conservation agencies to plan and execute programs. The Act led to the formation of Bureau of Energy Efficiency that started the formulation of the Energy Conservation Building Code (ECBC). The objective of the ECBC is to reduce the baseline energy consumption by setting minimum energy performance standards for commercial buildings, including for building

#### BOX 5.3 ENERGY SAVINGS POTENTIAL FOR FAST GROWING URBAN SETTLEMENTS- MUMBAI

The assessment on future energy saving potential for the fast growing Mumbai city focuses on energy efficiency for the residential sector in the city and in particular on the reduction in electricity demand when efficient labelled appliances for visual and thermal comfort are introduced in new households. The research findings indicate that the total energy savings until 2025 are approximately 7.8 TWh, and represent 1.6 years of base year consumption. It is also found that the demand side energy consumption would reduce by 11.8% by 2025 if use of highest rated CFLs, fans and air conditioners is mandatory by 2011 (Zaina. D. and TER I, 2010).

envelopes, mechanical systems and equipment, including heating, ventilation and air conditioning (HVAC) system, interior and exterior lighting system, service hot water, electrical power and motors.

Under section 14 (p) of the Energy Conservation Act, 2001, Central Government has powers to prescribe ECBC for commercial buildings (at present having a connected load of 500kW or contract demand of 600kVA) or building complex for efficient use of energy and its conservation. State governments have the flexibility to modify ECBC to suit local or regional needs. The ECBC is presently voluntary but is expected to be made mandatory in future. In order to mainstream compliance with ECBC, the BEE has taken several initiatives.

- ECBC shall be mandated in eight states of India, namely, Delhi, Haryana, Maharashtra, Andhra Pradesh, Tamil Nadu, West Bengal, Gujarat and Uttar Pradesh by 2012 .
- Extensive training of architects, engineers and consultants is being undertaken by the BEE across India.

According to BEE figures, an ECBC compliant building uses 110 kWh/m<sup>2</sup>/year as compared to the national benchmark of 180 kWh/m<sup>2</sup>/year. To encourage adherence to ECBC code, the BEE has supported the following activities in Government/ Public Sector buildings:

- Ministry of Health and Family Welfare – Ministry of Health and Family Welfare is developing six All India Institute for Medical Sciences (AIIMS) like

institutions under the “Pradhan Mantri Swasthiya Yojana”(PMSSY) scheme at Bhopal, Jodhpur, Rishikesh, Patna, Bhubanshewar and Raipur. These are being developed as ECBC compliant buildings. BEE is providing assistance to them through their empanelled ECBC expert architects.

- National Thermal Power Corporation - BEE is providing assistance to NTPC for their Administrative cum Lab Building of Energy Technologies at Greater Noida for being compliant to ECBC. The expert architect is providing suggestions on their existing plans for building envelope, electrical systems, HVAC and lighting to meet with the code requirement to the extent possible.
- The Government of Delhi has approved mandatory implementation of ECBC in government buildings/building complexes (new construction) including buildings/building complexes of municipalities/local bodies, boards, corporations, government aided institutions and other autonomous bodies of the city government.
- Further, the National Mission on Sustainable Habitat, which is a part of the National Action Plan on Climate Change released by the Prime Minister’s Council on Climate Change, emphasises promotion of energy efficiency in the residential and commercial sectors through the extension of the Energy Conservation Building Code (ECBC), use of energy efficient appliances and creation of mechanisms that would help finance demand side management; providing further impetus to the policy initiative.

### 5.3.3 Green Rating for Integrated Habitat Assessment

Endorsed by the MNRE, Green Rating for Integrated Habitat Assessment (GRIHA) is a five star rating system for green buildings which emphasises passive solar techniques for optimizing indoor visual and thermal comfort encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort. In order to address energy efficiency, GRIHA encourages optimisation of building design to reduce conventional energy demand and further optimise energy performance of the building within specified comfort limits (Box 5.4). A building is assessed on its predicted performance over its entire life cycle from inception through operation. GRIHA has been

#### BOX 5.4 SUSTAINABLE BUILDING- CENTRE FOR ENVIRONMENTAL SCIENCES AND ENGINEERING AT IIT KANPUR

Centre for Environmental Sciences and Engineering at IIT Kanpur is the first 5 star GRIHA rated building, in which an integrated approach has been adopted to comply with the design, construction and operation guidelines set forth by GRIHA. Quantitative and qualitative measures have been incorporated to achieve and surpass GRIHA established performance benchmarks for key resources such as energy and water. Building design and envelope has been optimised through selection of appropriate wall and roof construction and thorough adoption of solar passive measures and integration of shading devices for windows and roof, which reduce energy demand to condition the spaces. The energy performance index has improved from an initial of 240kWh/m<sup>2</sup> per annum to 98kWh/m<sup>2</sup> per annum, registering an energy savings of 58% through GRIHA compliance UNEP-TERI (2010).

developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions, and indigenous solutions. It integrates all relevant Indian codes and standards for buildings and acts as a tool to facilitate implementation of the same. From January 2010, it is mandatory for all government and public sector undertakings (PSUs) to make future buildings compliant with GRIHA.

Various GRIHA compliant projects that integrate appropriate design measures for the building envelope, integration of day lighting with artificial lighting, use of efficient air conditioning systems, use of controls and integration of passive strategies have registered energy savings up to 60%.

### 5.3.4 Scheme for star rating of office buildings

In order to accelerate the Energy Efficiency activities in commercial buildings, the Bureau of Energy efficiency (BEE) has developed the scheme for star rating of buildings. The programme is based on actual performance of the building, and rates office buildings on a 1-5 star scale with 5-Star labelled buildings being the most energy efficient. The Star rating Programme provides public recognition to energy efficient buildings, and creates a “demand side” pull for such buildings. Buildings with a connected load of 500 kW are considered for BEE star rating scheme.

### 5.3.5 Development of building regulations and guidelines for energy efficiency

Various government agencies (at State and City level) across the country have taken specific initiatives to integrate energy efficiency guidelines in the existing bye-laws. Compliance with these guidelines by the building sector offers immense potential to avoid emissions. To name a few, Ahmedabad, Hyderabad, Kolkata, Haryana and Bengaluru have been proactive in integrating energy efficiency guidelines with building byelaws (Box 5.5).

### 5.3.6 Initiatives of the Ministry of New and Renewable Energy (MNRE)

MNRE has initiated several programmes focusing on the utilisation of renewable energy sources in buildings. The MNRE has a solar buildings programme that provides financial support for the design and construction of energy efficient and solar passive buildings. Emphasis during the tenth five-year plan (2002-2007) was to provide central financial assistance for the development of efficient building guidelines to be implemented by community housing development organizations or corporations and to encourage the adoption of building integrated photovoltaics (BIPV).

The ministry has taken the following supportive measures to promote the installation and use of solar water heating systems.

- MNRE provides Central Financial Assistance (CFA) at 50 % of the cost of Detailed Project Reports (DPR) for public or private institutional buildings to a maximum of two lakh rupees, 50 % released on completion of DPR and rest at beginning of construction. MNRE also covers 10 % of the cost of construction of public, governmental, or State Nodal Agencies' buildings to a maximum of 50 lakh rupees, with 25 % released on commencement of construction and rest dependent on progress. The goal was to construct 10 solar buildings in 8 states in 2006-2007 alone.
- The MNRE also provides financial support for workshops, seminars, and orientation courses related to solar buildings for engineers, planners, builders, architects, housing financing organizations, and potential house owners up

#### BOX 5.5 DEVELOPMENT OF BUILDING REGULATIONS AND GUIDELINES FOR ENERGY EFFICIENCY, BENGALURU (TERI UNIVERSITY, 2009)

Bengaluru, the silicon valley of India is experiencing rapid growth in population. The power demand from the buildings that house this population is resulting in rapid growth of energy demand in the metropolis. Demand is projected to increase from 1850MW in 2010 to 3950MW in 2020. This has thrown up the challenge of increasing energy efficiency in the city, a major part of which includes energy efficiency in its buildings. This is because buildings alone are major contributors to energy consumption and energy efficient buildings provide huge opportunities for conservation of energy resources. The current building by-laws of Bangalore do not cover all aspects of energy efficiency that are required to be integrated in the built-environment of the city. Hence, TERI University in partnership with a few other organisations has developed a framework to integrate energy-efficiency regulations with the existing building by-laws of the city.

The guidelines include aspects like solar passive design for new buildings, roof treatment to reduce heat absorption by the buildings, installation of energy efficient lighting systems, use of equipment and appliances that are labeled by the Bureau of Energy Efficiency (BEE), solar water heating systems and mandatory energy audit. According to the framework, these guidelines should be integrated with existing building bylaws as a mandatory requirement, technical guidelines designed for them and their benefits should be pointed out. This integration will help to convert the city into an energy-efficient metropolis. It has been studied that mandatory integration of energy efficiency requirements, benchmarks and renewable energy within the existing building codes of Bengaluru - as recommended by this project shall have significant impact on mitigating emissions from the building sector over time. Mandatory compliance with the energy efficiency guidelines (for the commercial built up area alone) starting from the end of the current five year plan (i.e. by 2012) shall contribute to reducing approximately 55% emissions in 2012 alone. The specific energy efficiency guidelines recommended to avoid upto 55% of carbon emissions from the building sector in the city of Bengaluru have been detailed around the following broad strategies:

- Solar passive design for new buildings;
- Roof treatment to cut heat gains;
- Window design for day lighting, ventilation and to reduce solar heat gains;
- Energy efficient lighting design; and
- Energy efficient HVAC design.

<sup>2</sup> The projected demand has been validated through inputs received during stakeholder workshops held across various climatic zones of India.

to two lakh rupees. MNRE funds publications of documents on solar building including popular literature, technical books and manuals, promotional material in different languages, and award competitions, for up to two lakh rupees per activity.

- MNRE has partnered with the Center for Innovation, Incubation and Entrepreneurship to implement the Solar Innovation Program, which incorporates research and development of technologies related to solar thermal, photovoltaics, and passive solar building design. The Solar Innovation Program is essentially a competition open to teams of entrepreneurs, researchers, and students to design new applications for solar for rural or urban areas within India.
- In addition to states such as Haryana, West Bengal, Karnataka, Rajasthan, Uttaranchal, and Andhra Pradesh, cities such as Bangalore, Thane, Nagpur and Rajkot, solar water heating is mandatory/ incentivised for certain types of buildings.
- The MNRE has also launched and incentivised GRIHA (Green Rating for Integrated Habitat Assessment) as a national rating system.

### 5.3.7 Energy Auditing

In March 2007, the conduct of energy audits was made mandatory in large energy consuming units in nine industrial sectors. These units, notified as “designated consumers” are also required to employ “certified energy managers”, and report energy consumption and energy conservation data annually. BEE and the Central Public Works Department (CPWD) have also partnered to train a team of energy audit consultants to perform audits of several important government buildings and to contract the implementation of the recommendations. They expect annual savings of more than 30 GWh per year with payback of less than two years. BEE has continued the training and accreditation of new energy auditors and has proposed to expand energy audits beyond governmental buildings and to commercial and even residential buildings.

ECBC and its large scale adoption by the building and construction industry through various strategies such as large scale awareness generation on the code, integration of ECBC within GRIHA and integration of the code within the National Habitats Mission has led to a market demand for energy

systems, materials and products compliant with the ECBC. Even though the ECBC is available for voluntary adoption by the commercial buildings, its integration within the GRIHA framework and mandatory compliance if the building project is GRIHA compliant has generated a pull and demand for expertise on the code.

The BEE has set up discussion forums for stakeholders associated with supply of various ECBC compliant materials and energy systems. Further, ESCOs and energy auditors are currently being accredited by the BEE in order to meet the demand generated for the specific professionals. As a part of an ongoing project with the Asia Pacific Partnership and the BEE, TERI has prepared an estimate of future market demand for various building materials, lighting systems, HVAC systems and equipments that would be required to mainstream ECBC compliant high performance commercial buildings in India. The findings of the study<sup>2</sup> indicate:

- Demand for various products such as wall and roof insulation, glass and efficient energy systems is likely to rise significantly in future.
- ECBC compliant roof insulation is likely to rise over 11 times from 2011 up to 2030.
- ECBC compliant wall insulation and glass is likely to rise over 2.5 times from 2011 up to 2030.
- ECBC systems is likely to rise over 9 times 2011 up to 2030.

### 5.4 Barriers and challenges

Each of the above discussed policy instrument has its own advantages and challenges. Studies point that a combination of regulatory and market tool, with a well laid-out educational campaign is very effective (Koeppel et al 2007; TERI, 2009). An integrated approach to building green buildings policies to create both supply push and demand pull is effective than any in isolation. For instance, building codes “push” the market by creating the minimum performance requirements while incentives/tax exemption encourage compliance with code and capacity building targeted at both the industry and end-users help in overall implementation. Finding the most effective set of policy tools for a country is challenging and influenced by the stage of development, cultural factors, government efficacy, industry development, etc. It is however, very difficult to quantitatively analyse the implication

of such policy packages; though qualitatively such evaluation has been attempted (Koeppel, et al, 2007).

Guiding the construction sector towards a greener and less energy intensive path by means of policy instruments has their own set of challenges and barriers as discussed below:

- **Economic barrier:** This is the commonest barrier faced in developed and developing countries. Consumers either do not have the capacity to bear the high up-front costs (developing countries) or they don't know/believe in benefits of energy/water efficiency investments.
- **Hidden costs/benefits:** Green buildings also have hidden costs and benefits which often remain hidden to end-user in the financial flows. For instance, transaction costs associated with green building solutions, extended time duration, incompatibility of technological solutions especially in case of retrofits, etc. Similarly, associated benefits such as healthier indoor and outdoor air-quality and its health/efficiency impacts remain unaccounted for as they are not directly visible.
- **Market failures:** Market failures that result in split incentives, e.g. the ' developer-buyer' split where the developer invests extra efforts, money and time to make a project green and has to sell the property without any extra premiums and the buyer/end-user enjoys the benefit by paying less for the energy and water bills and enjoying a healthier environment; 'tenant-landlord' split where business tenants pay the energy bills but landlords control the properties and associated energy services.
- **Behavioral constraints:** Howsoever green/energy efficient/water efficient one may design a building, the net saving depends on the behavioral pattern and lifestyles of end-users which is the most difficult part to achieve. This is a challenge faced by both developed as well as developing countries.
- **Information barriers:** Lack of knowledge by various stakeholders including designers, architects, engineers, construction people and end-users is often a big hurdle both in developed and developing countries for wider implementation of any green building/energy efficiency program. This information barrier could be different for different stakeholders such as end-

users do not know the significance, monetary and environmental benefits of green homes/offices; architects, engineers and construction people are not trained during their education to cater to the needs of green buildings, etc.

- **Political constraints:** Selection of right policy tool and having the will to enforce requires strong political desire. There could also be possibilities of inter ministerial clash. Government might not be interested in promoting green buildings or even if it knows the benefits there could be resistance from builders lobby, industry people, etc., which therefore, requires a very strong motivation and grit to enforce the right policy tool in the right manner. Water tariffs, especially in developing countries are highly subsidized/skewed (one of the prime reasons for over consumption/misuse) and government do not want to touch these in fear of public resistance. Thus, political barrier
- **Enforcement barriers:** Policy instruments which have the largest potential of making an impact such as building codes/energy codes, their enforcement is a big challenge. It requires details like compliance manuals, forms, compliance software, institutional capacities with well trained officials, effective monitoring and verification system, and above all a strong political will for implementation.

## 5.5. Policy recommendations

With regard to these policy instruments, India is at a very interesting stage. Certain policy instruments have already been put in place and others will roll out with implementation plan of the ambitious Sustainable Habitat Mission. To implement a combination of the above mentioned policies, following is recommended at National and State level:

### National level

- A National Green Building policy which can be made a part of the National Urban Policy by the Ministry of Urban Development. This will serve as the guiding document for all the states to build their own state specific Green Building policy and model legislation.
- All new construction in all the Central government Ministries and Public Sector Units are already trying for green rating as per the recent Government Order. On similar lines all existing

buildings of Central government ministries should undergo energy and water audits and implement the recommendations in a limited time frame.

### **State level**

- Each State should prepare a state specific Green Building policy and to legislate the preparation of Building bye laws incorporating principles of Green Buildings by each Development Authority.
  - The State should also issue a statutory order to make a mandatory provision that all public buildings to be built in future will be green buildings (at least ECBC compliant) and to make a plan for energy and water audits of all prominent government buildings which should be retrofitted with energy and water conserving measures.
  - Procurement legislations for energy and water saving equipments, appliances, fixtures should be introduced for all public buildings in at least Class I and Class II cities by the State government.
  - Each Development authority should amend the Building bye laws of municipalities and Corporation coming under their respective jurisdiction in a defined time frame.
- Apart from these minimal mandatory requirements, building certification system (e.g., GRIHA) should be popularised to recognise high performance buildings. Financial, Height and/or density bonuses could be provided to all rated buildings.
  - Benchmarking and certification of buildings at the time of rental and sale should be put into place and initially should be made mandatory for all commercial buildings with a built-up area above a certain range. To begin with, the certification system should be simple and just a quantitative assessment of total energy consumption over the year per square metre.
  - Mandatory and subsidized audits (energy and water) for already existing public buildings, followed by high efficiency retrofit to make them role model/ demonstration projects.
  - Mandatory audits could be done for industrial and commercial buildings above a certain built up area and energy use.
  - Voluntary audits of other private buildings should be incentivised through appropriate measures.
  - Create a new wing in the local government especially dedicated to 'Green Buildings' or convert the existing units of "Energy Efficiency Cell" (wherever present) to a holistic "Sustainability Cell". This wing would take inputs from building centers (wherever available), research centers, state designated agencies of new and renewable energy besides giving building approval. The cell would also get inputs from the Sustainability cell at State level.
  - Builders: Builders are apprehensive of the incremental cost they bear to build green buildings whose benefits automatically get transferred to the consumers. This could be overcome once there is enough demand in the market for green buildings which is possible through market transformation and a strong education and public outreach program.

### **ULB level**

- Building byelaws and codes need to be revised and rewritten at ULB level integrating aspects of Green buildings (stated in the earlier section) and Energy Conservation and Building code and various policies at the federal level. This should be done in consultation with all the stakeholders.
- These regulations should include a combination of mandatory rules and voluntary guidelines such that minimum energy performance standards should be compulsory for all new buildings with flexibility in the ways to achieve the same.
- A minimum energy performance/prescriptive requirement should be made mandatory at least for commercial buildings and for high rise and big residential buildings with a built up area greater than some range.



Table 5.1 Review Of Key Policy Instruments (Excluding Supportive Action)				
Policy Instrument	Description	Mode	Leading examples	Estimated reduction in CO <sub>2</sub> emissions
Regulatory				
Appliances/equipment	Popular tool used in both developed and developing countries; Shift the distribution of energy-efficient models sold in the market upward by removing the inefficient ones; Requires industry involvement, testing procedures and protocols	Mandatory/voluntary	<ul style="list-style-type: none"> <li>Japan: Top Runner program very effective and innovative</li> <li>US: Long history of appliance standards; first implemented by California state in 1974</li> <li>China (started in 1989; very extensive in terms of the number of appliances and equipments covered)</li> </ul>	<ul style="list-style-type: none"> <li>Japan (estimated 31 Mt CO<sub>2</sub> in 2010)</li> <li>US (estimated reduction of 108 Mt CO<sub>2</sub> from 1990-1997)</li> <li>China (estimated reduction of 250 Mt CO<sub>2</sub> in 10 years)</li> </ul>
Buildings	More effective if mandated; could be prescriptive or performance based; easier to implement for new construction than for existing buildings; need legal framework, compliance infrastructure, skilled staff; Need to be regularly updated	Mandatory/voluntary	<ul style="list-style-type: none"> <li>U. K: 40% of new buildings comply</li> <li>Japan (voluntary mode)</li> <li>Singapore (mandatory)</li> <li>Germany: applicable for both new and existing buildings</li> <li>India: voluntary code for new construction (ECBC)</li> </ul>	
Procurement regulations	Effective tool where there is a large share of public sector; needs to be well supported with legal framework, existence of other policy measures such as labelling	Mandatory/voluntary	<ul style="list-style-type: none"> <li>US: very effective through the Federal Energy Management Program (FEMP)</li> <li>Italy: It is mandatory for energy efficiency but still compliance is low</li> <li>China: Introduced recently in 2004, evaluation of the success rate not available</li> <li>Mexico: Interesting case where federal program failed but streamlined city level initiatives in four municipalities were successful</li> </ul>	US (estimated 9-31 Mt CO <sub>2</sub> reduction in 2010) China (estimated 3.6 Mt CO <sub>2</sub> reduction)
Certification and labelling	Mandatory provision of information to end users about the performance of products and buildings	Mandatory/voluntary	<ul style="list-style-type: none"> <li>EU: Energy Performance Directive requires obligatory energy certification of new and existing buildings</li> <li>China: Mandatory labelling for few and voluntary for other appliances/equipments</li> <li>India: voluntary program of BEE appliance/equipment labelling scheme</li> <li>Australia: Mandatory WELS (Water efficiency labelling and standards) scheme for water efficiency</li> </ul>	
Mandatory audit programs	Could bring diverse results but necessarily need to be combined with financial incentives and adequate capacity building; need to be combined with effective implementation of recommendations	Mandatory	<ul style="list-style-type: none"> <li>US: RESNET(National standard for home energy audits) applies to existing homes and quite successful in US with almost 1,00,000 homes annually getting upgraded as a result of auditing</li> <li>India: Energy audits mandatory since 2007 for “designated consumers” in large energy consuming units in industrial sector</li> </ul>	US (estimated 22-30% savings)

## Climate Resilient and Sustainable Urban Development

Policy Instrument	Description	Mode	Leading examples	Estimated reduction in CO <sub>2</sub> emissions
DSM programs	Utility driven demand-side management programs are often effective They are often boosted by regulatory incentives or mandatory charges on electricity prices (public benefit charges)	Mandatory/voluntary	US	US ( estimated savings of 36.7 Mt of CO <sub>2</sub> in 2000)
Economic and market-based				
Energy performance contracting/ ESCO support	It means a contractor guarantees certain energy savings for a location over a specified period; implements the appropriate measures and is paid from the estimated energy cost reductions; need a mature financial sector willing to lend for energy efficiency projects, unsubsidized energy prices and supportive legal, financial and business environments.	Voluntary	US: First and most successful country (comparison basis) in terms of energy performance contracting China: Started in 1994-95 the program is mostly successful with few defaulters; well supported program by the Federal government; high potential of ESCO industry to grow further Brazil: ESCOs have been able to take advantage of financial resources from electric power utilities, developing projects for utility customers as one means to meet energy efficiency investment requirements mandated by ANEEL, the national electric power regulatory agency, under Brazil's public benefit wire-charge mechanism	US (estimated savings of 3.2 Mt CO <sub>2</sub> )
Energy efficiency certificate /white certificate schemes	Tradable certificates for energy savings, often called "white certificates"; have high institutional costs; more suited for countries with existing trading scheme for renewable energy	Voluntary	Italy: Operational since January 2005 and the initial reports suggest high success rate	Italy (In the first year of implementation, estimated savings of 1.3 Mt CO <sub>2</sub> )
Fiscal and financial				
Energy or carbon taxes	Implemented as carbon or energy taxes; reduce emissions in two ways by reducing the overall demand and providing revenue base for reinvestment by the government in green building programs Price elasticity for energy should not be low	Mandatory	Denmark, Finland and Poland have taxes based on carbon content of the fuel Germany and Norway have taxes based on energy use	Denmark (energy consumption in residential sector reduced by 15% between 1977-1991)

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# CHAPTER 6

## Mitigating the emissions from the urban transport sector

Akshima Tejas Ghatе and Malanchа Chakraborty

### Key messages

- Metropolitan cities in developing countries are fast becoming one of the key drivers of economic growth, which has resulted in increasing per capita income in these cities. Increasing per capita incomes have had direct impact in terms of growing motorization rates in these cities, which has been the precursor to most of the urban transport related challenges that these cities face.
- It is expected that by 2020, the number of motor vehicles in the world will double from the present level and will increase to about 1.3 billion, the fastest growth being in the growing cities of Latin America and Asia.
- Developing countries' cities are experiencing an undesired trend of declining share of public transport and non motorized transport.
- The current urban transportation situation in Indian cities is adopting a high energy and carbon intensive pathway as the share of personal modes is increasing rapidly and public transport and non-motorized transport shares are declining.
- Cities need to arrest their current pattern of transportation growth in order to bring down their CO<sub>2</sub> emissions, which calls for a shift of urban traffic movements to mass transport having least tail-pipe emissions and to non motorized systems. Cities should adopt an 'Avoid, Shift and Improve' approach in their transportation planning. The main goals should be to:
  - Reduce utilization of personal modes of transport,
  - Increase usage of public transport and non motorized transport, and
  - Promote use of clean fuels and technologies in addition to properly maintaining the in-use vehicular fleet.

### 6.1 Background

Transport sector in most developing countries' cities is experiencing an increasing share of personal motorized traffic, which has had impacts in terms of increasing traffic congestions, travel times, road accidents, pollution and most of all increasing dependence on fossil energy. The increasing use of fossil fuels in urban transport sector has resulted in rising GHG emissions. According to IPCC (2007), 95% of the total energy used in transport sector globally comes from a single fossil resource, petroleum. The sector was responsible for 23% of the world's energy-related GHG emissions (6.3 Gt) in 2004, about three quarters of which came from on-road vehicles. The share of non-OECD countries in the total global CO<sub>2</sub> emissions from transport sector in 2004 was 36%. This is expected to increase to 46% by 2030 if the current trends of transport growth in these countries continue (IPCC, 2007). According to the World Energy Outlook 2009, global energy-related CO<sub>2</sub> emissions are expected to increase to over 40Gt by 2030, of which emissions from transport sector would be around 9Gt (more than one-fifth) despite significant mitigation policies built into the reference scenario (ITF, 2010). The current trends of per capita increase in diesel and gasoline consumption in transport sector of many developing countries indicate the beginning of this trend (Figure 6.1).

It is implicit that of all the transport sector emissions, cities represent a significant proportion due to concentration of transportation activities within their administrative boundaries. It is estimated that the on-road passenger transport activities in twenty three million plus cities in India had a share of about 25% in country's total on-road passenger transport activities in 2001 (Ghate and Sundar, In press). A

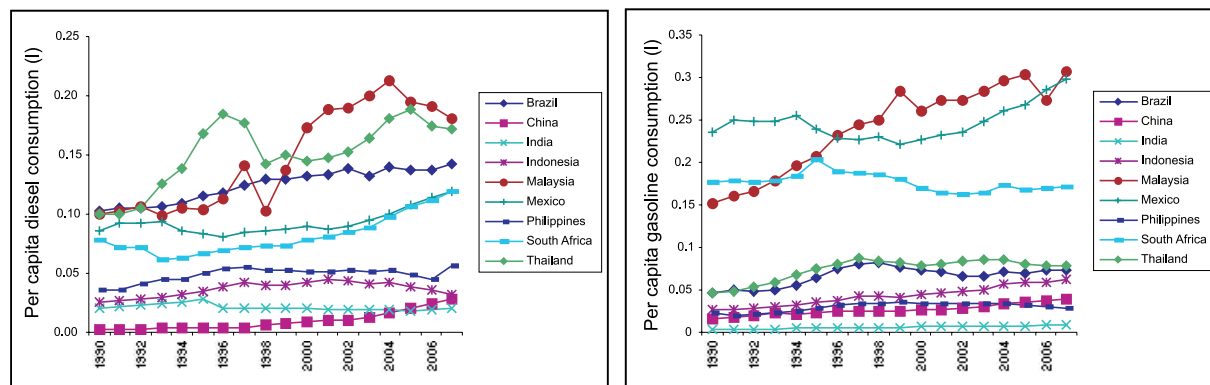


Figure 6.1 Growth in per capita consumption of diesel and petrol in transport sector of select developing countries (World Bank indicators)

recent study conducted by World Bank in China estimates that the urban transport sector of 17 select Chinese cities contributed 54 Mt CO<sub>2</sub> in 2006 (WB, 2009). According to the World Bank, the share of CO<sub>2</sub> emissions and energy use by urban transport in China is significant and likely to grow very rapidly. The current shares of urban transport sector of developing cities in CO<sub>2</sub> emissions are expected to increase very rapidly if the current trends of motorization continue. In the current era, when it is universally agreed that there is a need to bring down CO<sub>2</sub> emissions in view of the climate impacts it has, it becomes imperative to arrest the CO<sub>2</sub> emissions from urban transport sector of developing countries' cities. This calls for action on part of cities to identify and implement mitigation interventions that will reduce their transport sectors' impact on climate change. The paper discusses the typical growth trends of developing countries' cities, with a focus on Indian cities and suggests mitigation options to respond to these trends.

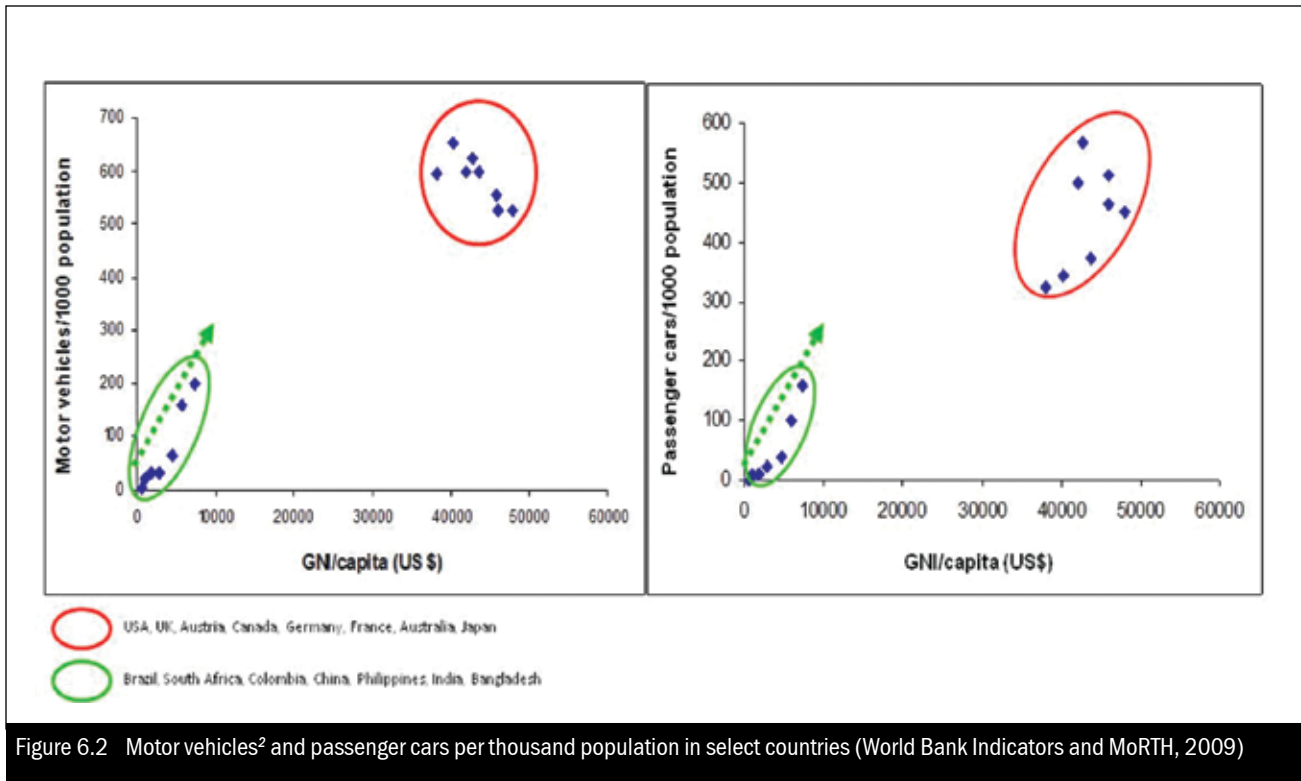
## 6.2 An overview of urban transport sector in developing countries' cities

Developing countries of the world are experiencing a very rapid pace of population growth, especially in the urban areas, which has put tremendous pressure on infrastructure services in these countries. The growing concentration of population in a few large cities is a phenomenon typical to most countries.

Metropolitan cities are fast becoming one of the key centres of economic growth, which has resulted in increasing per capita income in these cities. Increasing per capita incomes have had direct impact in terms of growing motorization rates in these cities, which has been the precursor to most of the urban transport related challenges that these cities face. Figure 6.2 shows the vehicle ownership levels in a few developed and developing countries of the world. It is evident that with the increase in per capita income, vehicle ownership levels increase, a trend that is occurring in most of the middle income developing countries like South Africa, Brazil, Colombia, etc. Although vehicle ownership in these countries is low at present, it is observed that the motorization pattern in most developing countries bears strong similarity to US, which implies that cities in developing countries are most likely to follow the mobility pattern similar to that of cities in US (Acharya S R, 2005). It is expected that by 2020, the number of motor vehicles in the world will double from the present level and will increase to about 1.3 billion<sup>1</sup>, the fastest growth being in the growing cities of Latin America and Asia (Sperling and Clausen, 2000).

Though Figure 6.2 does not include two wheelers; but in the context of developing countries, the growing number of two wheelers is a phenomenon that cannot be ignored. Growing number of motorized two-wheelers has been one of the main reasons for fast

<sup>1</sup> This figure does not include motorized two-wheelers.



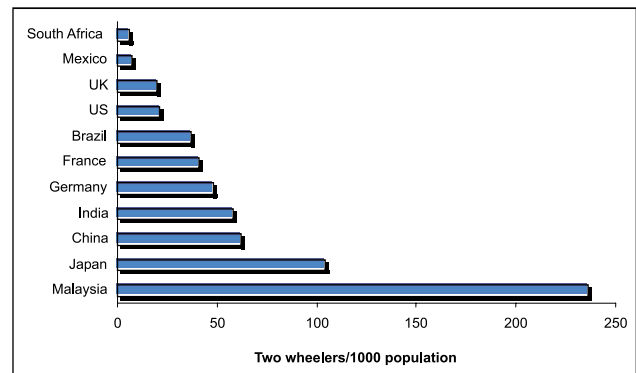
motorization in developing countries. As an example, two wheeler population had a share of about 72% in the total registered vehicular fleet of India in 2006. The exponential growth in number of two-wheelers in developing cities can be linked to the affordability levels of vehicles in these countries where middle income class has been expanding over time. Figure 6.3 depicts the two wheeler ownership levels in a few developed and developing countries. Developing countries like India and China have already surpassed many developed countries in terms of two-wheelers per 1000 population, a trend that is fast catching up with other developing countries also.

In addition to growing rate of motorization, specifically, passenger cars and motorized two-wheelers, developing countries' cities are experiencing an undesired trend of declining share of public transport and non motorized transport (NMT). According to ADB (2009), public transport shares have been eroded by either motorized two wheelers or cars in most developing cities. The current trends of transport sector growth in most developing countries' cities have resulted in increasing dependence on fossil

energy, a trend that needs to be arrested in order to reduce CO<sub>2</sub> impact of the sector.

Cities need to arrest their current pattern of transportation growth in order to bring down their CO<sub>2</sub> emissions, which calls for a shift of urban traffic movements to mass transport having least tail-pipe emissions and to non motorized systems. The main goals should be to:

- Reduce utilization of personal modes of transport,



<sup>2</sup> Motor vehicles given in the figure include cars, buses and freight vehicles but do not include two-wheelers. Motor vehicles and passenger cars ownership data for India is for 2006



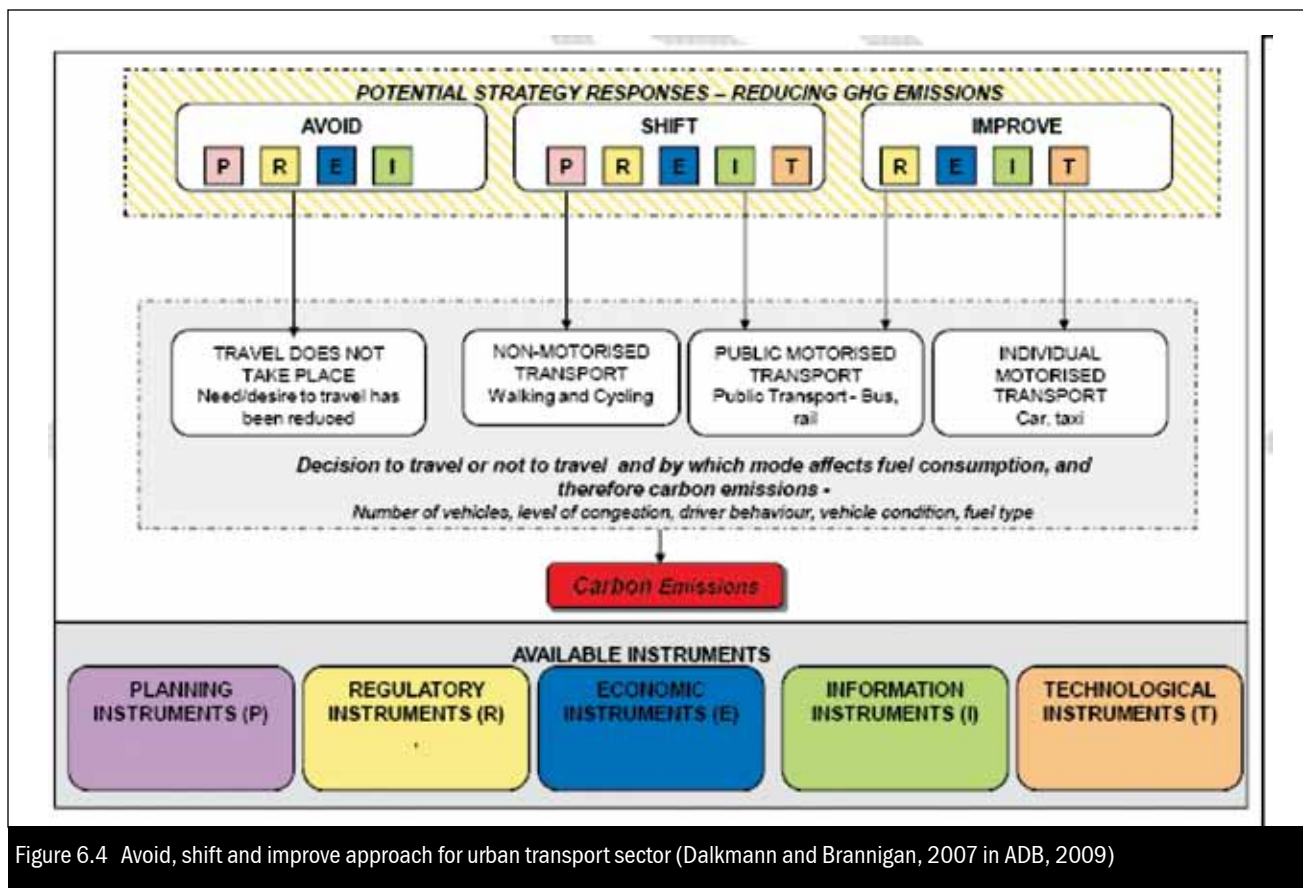


Figure 6.4 Avoid, shift and improve approach for urban transport sector (Dalkmann and Brannigan, 2007 in ADB, 2009)

- Increase usage of public transport and non motorized transport, and
- Promote use of clean fuels and technologies in addition to properly maintaining the in-use vehicular fleet.

To achieve the above goals, cities need to adopt the 'Avoid, Shift, and Improve' approach in transport planning as advocated by the Asian Development Bank (ADB, 2009) and reiterated by the Bellagio Declaration<sup>3</sup> in May 2009 (figure 6.4). The approach focuses on:

- Avoiding the need to travel (Avoid);
- Shifting travel to more sustainable modes (Shift); or
- Improving the sustainability of modes (Improve) (ADB, 2009).

In line with the mitigation strategy that needs to be adopted for transport sector in cities, following are the key action areas that cities need to:

- Practice integrated transport and landuse planning

- Improve and augment public transport and non motorized transport systems (both in terms of capacity and quality)
- Discourage use of personal vehicles by using appropriate policy and planning instruments
- Ensure efficient movement of traffic by implementing relevant traffic demand management measures and technologies)
- Other action areas
- Encourage use of clean fuels and technologies
- Adopt mandatory standards for fuel economy and emissions
- Ensure proper monitoring of the performance of in-use vehicular fleets
- Use information technology as substitute to physical mobility

A few cities have successfully implemented a few of the above approaches, either with a generic goal to improve their existing transport situation or a specific goal to reduce their CO<sub>2</sub> emissions impact. A few global best practices are discussed in the next section.

<sup>3</sup> <http://www.slocat.net/bellagio-process/targets-and-progress/>, last accessed on 18 July, 2010.

### 6.3 Global best practices

The global best practices documented in this paper include initiatives by city authorities to improve their urban transport situation. City authorities have realized that the key solution to the current urban transport problems is to arrest the declining rate of public transport share and reduce the utilization of personal modes. Different cities have adopted different approaches to achieve this modal shift. These initiatives are cited as international best practices by various researchers, organizations and governments and are a model example to be followed by the other cities. Few case studies that have been discussed in this chapter include:

- Curitiba started practicing integrated transport and landuse planning to achieve modal shifts.
- Bogota planned and successfully implemented a dedicated bus transport system, supported by demand management measures.
- Singapore adopted an integrated approach to transport sector that focused on planning, operation and management aspects.
- London used a pricing tool (congestion pricing) to reduce the use of personal modes in the Central Business District.
- Shanghai has developed integrated schemes to develop public transport and NMT infrastructure in the city.

#### 6.3.1 Integrated transport and landuse planning in Curitiba

The transportation system of Curitiba began to evolve in the late 1960s with the formulation of the master plan for the city. The master plan of Curitiba focused on integrated land-use and transport planning as a tool to meet the challenge of growing urban limits rather than the policy of large scale highway construction followed by most other Latin American cities. Road hierarchy and land control system, assigning priorities to buses, and proper zoning laws were put into effect. Integrated systems with trunk and feeder routes, express lines and inter-district routes were introduced in addition to night routes, special education routes and automatic combined ticketing. To increase convenience and boarding efficiency, Curitiba developed boarding tube stations and low floor buses with turbo engines and wider doors. Regular maintenance and renewal of fleet in every ten

years ensures that the buses are in good conditions and pollution level is under control. The integrated transport network in Curitiba is managed by URBS (Urbanizao de Curitiba), a state owned company created in 1963. URBS monitors and coordinates the system, operates the bus lines and maintains the infrastructure of the system. Consequently, Curitiba ranks first in the use of public transport system among all the Brazilian state capitals, with 75% of commuters using the system on weekdays. The fuel consumption of Curitiba is 30% lower than the fuel consumption of eight comparable Brazilian cities (TERI, 2009).

#### 6.3.2 Strategies to improve transport system in Bogota

In the 1990s, Bogotá implemented effective programs to simultaneously restrain vehicle ownership, improve conditions for walking and biking, and enhance bus transit. In the late 1990s, the government opened two lines of a planned 22-corridor bus rapid transit system (modeled after Curitiba's), built 200 kilometers of a planned 300-kilometer network of bike lanes, expanded numerous sidewalks, added a 17-kilometer pedestrian zone, and implemented a number of demand management measures. Cars with license plates ending with one of four numbers were not allowed to operate within Bogotá during the morning and evening peak, parking fees doubled, gasoline taxes were increased 20 percent, and bollards were built on sidewalks to prevent people from parking illegally. All these measures were boosted by occasional car-free days, car-free Sundays, and other promotional efforts. In the first four years, the percentage of trips made by private cars and taxis dropped from 19.7 percent to 17.5 percent, and bike trips increased from 0.5 percent to 4 percent of all trips (Sperling and Clausen, 2000).

#### 6.3.3 Singapore's land transport policy

The Land Transport Policy of the Ministry of Transport, Singapore aims to develop a quality land transport system—one that would be integrated, efficient, affordable, with smooth flowing traffic, and which will meet people's needs and support economic and environmental goals. To meet this goal, the Ministry identified a four-pronged approach that included the following.

- Integrating land use and transport planning
- Increasing public transport penetration
- Managing the demand and use of private vehicles

- Expanding the road network and optimizing road capacity

A white paper prepared by the LTA (Land Transport Authority) in 1996, charted out the measures Singapore needed to take in order to have a world class transport system. Buses were identified as the major public transport in Singapore and recognizing this, the LTA, together with the bus operators, made a number of bus improvements, which included giving priority to buses, offering differentiated services, providing services for new towns and settlements, better information systems, better pedestrian access facilities, refurbishing bus stops with amenities like drinking water, telephones, proper lighting, and so on. In Singapore, the PTC (Public Transport Council) regulates bus service standards, routes, and fares while balancing the commuters' interests with the need to remain financially viable. Singapore has been able to demonstrate a successful public transport system by simultaneously restraining the ownership and utilization of private vehicles by introducing the vehicle quota system and electronic road pricing, respectively (TERI, 2009).

#### **6.3.4 Congestion Charge in London**

London suffered the worst traffic congestion in the UK. It was estimated that the city lost between £2-4 million every week in terms of lost time caused by congestion. The Mayor of London, who was appointed in 2000, enacted a scheme to meet the travel demands of the city. He introduced the congestion charge in 2003, as a part of a wider, comprehensive transport strategy. Payment of the charge allowed one to enter, drive within, and exit the charging zone. The aim was to reduce traffic congestion and improve journey times by encouraging people to choose other forms of transport if possible. All funds raised from congestion charging are spent on London's transport facilities (Ghate and Sundar, In press)

#### **6.3.5 Transport planning in Shanghai**

Shanghai has a sophisticated planning organization that coordinates transportation decisions with other land use and city planning policies. The municipal government has considerable control over land use and can coordinate housing and transit investments. It has built grade-separated lanes for bicycles and slow-moving scooters along most major roads and separate

sidewalks for pedestrian traffic, and is building an extensive rapid transit rail system to serve new satellite cities. Shanghai is executing an ambitious plan to decentralize the extremely crowded city, with coordinated investments in rail transit and major highways. Shanghai has adopted strong disincentives for car ownership, including high taxes on vehicles and registration caps (Sperling and Clausen, 2000).

### **6.4 Urban transport in India**

As the transport demand in Indian cities has increased substantially in the past few years, the intra-city transport provision has been an important subject of concern. Increasing number of personal motorized vehicles, increasing household incomes, and economic development in cities have added to this growing demand, which is usually larger than the available capacity of transport infrastructure and systems and has led to problems like congestion, pollution, road injuries and fatalities, etc. The transport handicap in Indian cities can be attributed to the shifting modal split in favour of personal vehicles and reduction in the use of public transport system; inadequate transport infrastructure and its inefficient use. In 2006, the twenty-three metropolitan cities in India, each with over one million population, accounted for about one-fourth of the total vehicles registered in the country. As indicated in figure 6.5, about 41% of the total cars and 23% of the two-wheelers in the country were registered in these metropolitan cities in 2006 (MoRTH). The public modes in most Indian cities, on the other hand constitute only 2-3% of the entire vehicular fleet (TERI, 2008).

Public transport system in Indian cities has not been able to keep pace with the increasing demand for urban transport. In most cities dedicated public transport is absent and a combination of para-transit modes like jeeps, autos etc. acts as public transport further accentuating the problems of heavy atmospheric pollution, congestion, high costs, higher energy consumption and safety. The bus services in urban areas are either run by publicly owned State Transport Undertakings (STUs) or private bus operators. Whereas dedicated city bus services are known to operate only in 17 cities; rail transit exists only in 4 out of 35 cities with population in excess of one million (Singh S.K, 2005). Inadequacy, poor condition, overcrowding, of public transport system has resulted in shift of passengers from public

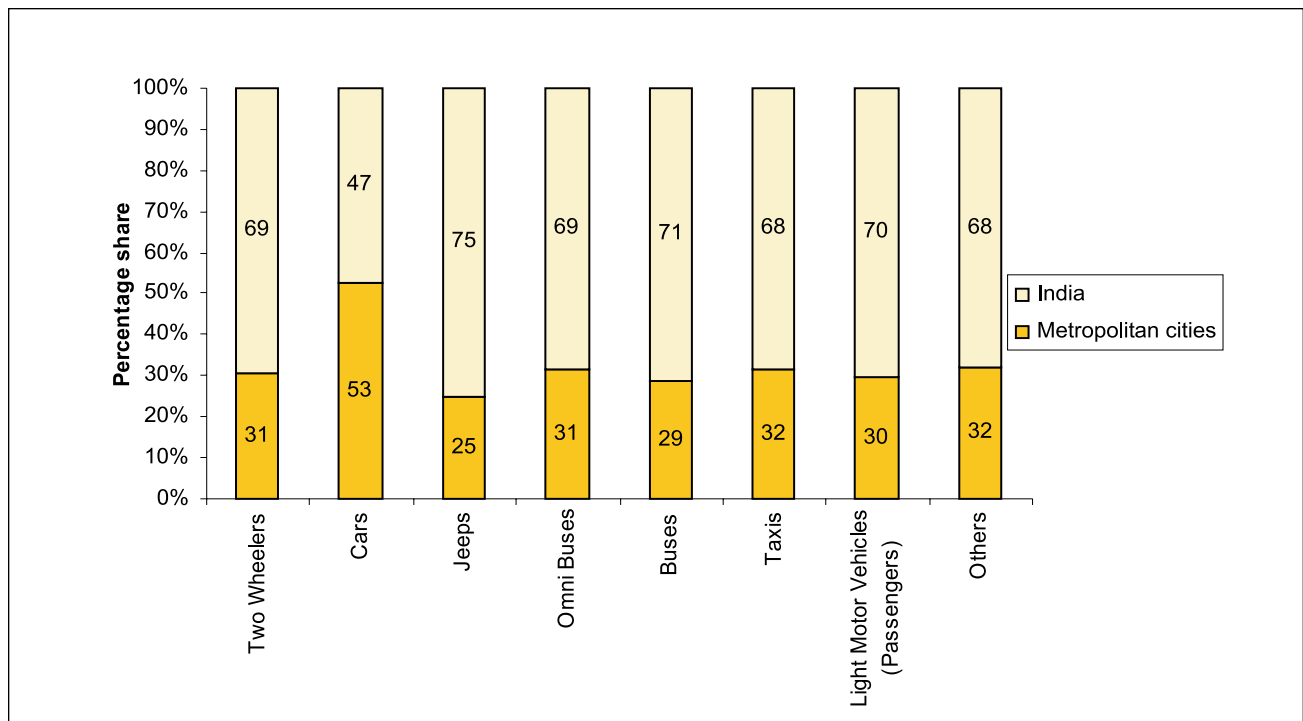


Figure 6.5 Comparison of share of vehicles registered in metropolitan cities with the rest of the country in 2006 (MoRTH, 2009).

transport to either two-wheelers or cars or various other modes of intermediate public transport (three wheelers auto-rickshaws and taxis). This trend has been a major cause of most of the transport related problems in Indian cities. There have been a few initiatives on part of the government and urban authorities to improve the current state of transport in cities. A few good examples pertaining to policies and projects being implemented in India are discussed in this section.

#### 6.4.1 National Urban Transport Policy, India

The Government of India announced a National Urban Transport Policy (NUTP) in 2006 to meet the challenge of India's rapid urbanization phenomena and the resultant increase in the urban travel demand. The policy aims at meeting the mobility needs of the current and projected population and ensuring sustained flow of goods and people in urban areas.

Some key objectives of the policy are listed below (GoI, 2006):

- Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement
- Encouraging integrated land use and transport

planning in all cities so that travel distances are minimized and access to livelihoods, education, and other social needs, especially for the marginal segments of the urban population is improved

- Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus
- Encouraging greater use of public transport and non-motorized modes
- Enabling the establishment of quality focused multi-modal public transport systems that are well integrated, providing seamless travel across modes
- Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems
- Introducing Intelligent Transport Systems for traffic management
- Reducing pollution levels through changes in travelling practices, better enforcement, stricter norms, technological improvements, etc.
- Building capacity (institutional and manpower) to plan for sustainable urban transport and establishing knowledge management system that would service the needs of all urban transport

professionals, such as planners, researchers, teachers, students, etc

- Promoting the use of cleaner technologies

#### **6.4.2 Jawaharlal Nehru National Urban Renewal**

##### **Mission**

The Government of India launched the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in 2005, which aimed to rejuvenate the urban milieu through implementation of a number of projects with active private sector participation. Cities with million-plus population, state capitals, and cities of cultural and tourist importance were to be included under the Mission. This major initiative sought to bring about comprehensive improvements in urban infrastructure, by commitment of substantial funds for this purpose and required a series of reforms that would make the investments sustainable. Some of the policy objectives in the NUTP are being realized as proposals and projects under the Jawaharlal Nehru Urban Renewal Mission (JNNURM), which has selected 63 cities in India and is implementing an urban reforms agenda of which urban transport is a component (GoI, 2006 and GoI, 2005)

#### **6.4.3 National Action Plan on Climate Change's Mission on Sustainable Habitat**

The Prime Minister's National Action Plan on Climate Change (NAPCC) outlines desired actions within the transport sector that would influence energy efficiency and would help reduce transport emissions. National Mission on Sustainable Habitat in NAPCC emphasizes the need for a modal shift towards public transport and better urban planning for reducing the need to travel and to shorten travel distances. The Mission suggests setting up of Unified Metropolitan Transport Authorities in all million plus cities, besides setting up of Traffic Information Management Control Centres in all million plus cities for better traffic management to reduce congestion and idling of vehicles. The mission supports granting financial assistance on the basis of reform based agenda like that of JNNURM. It proposes similar dedicated central urban transport fund through levy of cess on private vehicles and fuels and then direct the funds to states and cities to implement transport related reforms. The mission also advocates the need for capacity building measures in urban transport

sector in order to respond to the growing challenges in the sector (GoI, 2008).

#### **6.4.4 Traffic and transportation planning and BRT in Indore**

Indore is a fast growing industrial city of Madhya Pradesh with a population size of about 1.6 million in 2001. Like any other metropolitan city, Indore is facing the challenges of growing urban population and the resultant transport demand. In line with the objectives of the National Urban Transport Policy, a Comprehensive Traffic and Transportation Plan for Indore (CTTPI) was prepared in 2004 with a focus on planning for a public transport system that meets the increasing travel demands of the city in an efficient, convenient, safe and economical manner. The plan has proposed development of an extensive road network system of radial and ring corridors, development and operation of Light Rail Transit System, development and operation of bus system, development of passenger and goods terminals, a parking policy, traffic management particularly in the CBD and establishment of metropolitan transport authority.

Indore City Transport Services Ltd (ICTSL) has been established as a Special Purpose Vehicle (SPV) to provide the public transport services in Indore. ICTSL is also developing a Bus Rapid Transit System (BRTS) in the city. A pilot corridor has started functioning with approximately 1000 buses operating on the corridor every day. It is planned that the existing bus service of ICTSL will operate on BRTS corridors along with the New High Capacity Buses with certain modifications. Special low floor buses are being used, which are convenient for people to board; are accessible to the physically challenged and assure level boarding. An optimum fare structure has been evolved to provide equitable access to poor and to make BRTS more attractive to the upper middle class as against their personal vehicles. ICTSL has come out with a business model for collection of fares using Smart cards. Overall the pilot corridor and other upcoming corridors of BRTS in Indore are well planned and coordinated by a single agency i.e. ICTSL. Other important features of the system include Passenger Information System, well-managed common infrastructure, security services, common ticketing facilities, etc. The sources of revenue for the entire

system include fare-box collection, advertising right along the corridors and on the buses, parking charges and revenue through multi application of smart cards (Indore City Transport Services Ltd, 2006).

#### 6.4.5 Delhi Metro

The Delhi Metro Rail project, comprising of two phases of approx. 65 km and 124 km respectively, of at-grade, elevated and underground trains, is an example of a world class technology being implemented successfully in an Indian city. The system consisting of automated fare collection machines, passenger information systems, feeder services and state-of-the-art operating technologies, was awarded the best transit project by MoUD for its planning, implementation and maintenance practices. It was also awarded as the best environmental friendly project by the Ministry. Delhi Metro became the first railway project in the world to be registered at the United Nations under the clean development mechanism (CDM) scheme, enabling it to earn carbon credits. The Delhi Metro Rail Corporation will earn Certified Emission Reductions (CERs) for use of regenerative braking system in its rolling stock (trains). The money from sale of CERs will be used to offset additional investment and operation costs incurred in implementing the project activity, to stimulate research and development to reduce emission of green house gases and to give extensive training to train operators for optimum regeneration (Annual Report 2008-09, Ministry of Urban Development, Government of India).

#### 6.4.6 Ahmedabad BRTS "Janmarg"

Ahmedabad is in the process of creating a complete BRT system, called "Janmarg", which will match the international standards of a BRT system. It will connect the central city with outlying industrial, institutional and residential areas through a network of over 88 kms. Key features of this project including:

- Overall length - 88 km (to be covered in two phases)
- Furnish of 4 minutes through peak hours
- Average speed of buses - 26-28 km per hour
- Number of buses operating per day - 23
- Total passengers per day more than 36 thousand.

The system has focussed on all traffic, vehicle and user related aspects, and includes buses with wide central

doors, low floor, 90 persons capacity and clean fuel Euro-III Standard. The BRTS also has features like an Intelligent Transport System, viz. operations control, automatic vehicle tracking system, electronic fare collection, real-time passenger information systems and traffic management. All these elements are classified as high-end, making Janmarg the first full BRT system in India. Ahmedabad BRT has received prestigious (international) Sustainable Transport Award 2010 during TRB, US Conference besides a National Award for best mass transit project in India in 2009 during Urban Mobility India Conference<sup>4</sup>.

#### 6.4.7 CNG in Delhi

During the 1990s Delhi was declared as one of the most polluted cities in the world. Not only were the complaints of respiratory diseases in Delhi rising but the pollution was becoming visible too. The SPM levels in the city had recorded to as high as 7.6 times the permissible limits by the year 1998. It was realized that the sulphur content in diesel, if reduced could lead to a decrease in the level of emission to a great deal. On the other hand, though, in India, the diesel consumption had grown by nearly 70% between 1990 and 1997. After the launch of 'Right to Clean Air Campaign of the Centre for Environment (CSE) and subsequent pressure from public and the civil society; The Supreme Court of India took 'suo-moto' note of the situation and asked the Government for an action.

The Supreme Court of India in 1998 issued a number of measures to be implemented in Delhi. These measures among others included:

- Replacing all pre-1990 autos and taxis with new vehicles using clean fuels by March 2000
- Replacing all buses more than eight years old to CNG or other clean fuels by March 2000
- Converting the entire city bus fleet to CNG by March 2001.

The initial protest by the politicians and auto-manufactures (anti CNG lobby) was nipped by the Supreme Court of India by imposing a fine on delay (Rs 500 per bus per day). It also charged a penalty of Rs 20,000 on the Union Government for failing to ensure supply of CNG. The Government set up two committees to ensure uninterrupted supply of CNG and prepared an action plan to ensure inspection of all

<sup>4</sup> <http://www.ahmedabadbrts.com/Photo%20Gallery/Photo%20Gallery.htm>, last accessed on 18 March 2010



CNG retrofitted buses and supported to implement the CNG conversion. By end of year 2002, all buses in Delhi had been converted to CNG (MoEF, 2010).

## 6.5 Way forward for Indian cities

The current urban transportation situation in Indian cities is adopting a high energy intensive pathway as the share of personal modes is increasing rapidly and public transport and NMT shares are declining. Cities are faced with numerous challenges like increasing population, vehicle ownership levels, sprawls, and travel demands that need to be addressed in the most energy efficient way. Cities need to respond to these challenges through a combination of urban planning, infrastructure, policy and technological interventions, which can be effective in altering the current path of transport development and make it less energy intensive and more sustainable. Most of the best practices discussed in the paper indicate that modal shift as a result of integrated transport planning, improved public transport and reduced use of personal vehicles has a significant impact on reducing energy use and CO<sub>2</sub> emissions. However, such best practices are very few in case of Indian cities. Cities in India, therefore, need to adopt an 'Avoid, Shift and Improve' approach in their transportation planning. They need to plan appropriate interventions to reduce reliance on personal vehicles, make them more fuel-efficient and increase the share of public transport and non-motorized transport that will lead to a significant reduction in energy consumption. Way forward for transport sector in Indian cities is recommended below:

### *Necessary city-level interventions*

- The focus of development in urban transport should be on increasing shares of public transport trips as they are more clean, energy efficient and socially integrating. Owning and driving personal vehicles should be made difficult using fiscal instruments (congestion charges, high parking fee, tolls, etc.) and at the same time the quality of public transport facilities should be improved significantly in order to attract the personal vehicle users.

- Integrated transport planning needs to be practiced in the cities. The National Urban Transport Policy encourages state governments to adopt transport policies in consonance with the NUTP. It also calls upon state governments to discourage the use of personal vehicles and increase the share of public transport. The JNNURM has made funding for transport projects in cities conditional upon the proposals being in conformity with the NUTP. There is a need to ensure the right implementation of NUTP and JNNURM funding.
- Measures that discourage the use of personal motor vehicles would have to go hand-in-hand with measures that encourage the use of non-motorized modes, as they are "greener" modes of travel. All safety concerns of cyclists and pedestrians have to be addressed by encouraging the construction of segregated rights of way for bicycles and pedestrians. This can be done by (i) investing in a segregated right of way for bicycles and pedestrians; (ii) converting crowded areas like marketplaces into no-vehicle zones; (iii) improving bicycle technology; (iv) providing safer parking facilities for bicycles in workplaces; and finally, (v) promoting cycling and walking as healthy activities (TERI, 2007).
- Institutional arrangements for dealing with urban transport are fragmented between ministries. The Ministry of Road Transport And Highways is responsible for administering the laws relating to public transport and laying down emission standards; the Ministry of Urban Development has formulated the NUTP and is responsible for promoting sustainable urban transport and the Ministry of Heavy Industry is responsible for the automobile industry. All three ministries have suggested/laid down policies that will help to discourage the use of personal vehicles and promote public transport. However, these are not being implemented in an integrated manner. There is a need for a unified system where various facets of transport like planning, pricing, operations, management, enforcement, etc. are dealt together. The concept of Unified Metropolitan Transport Authority (UMTA) for overseeing all activities



related to urban transport in a city should be encouraged.

### ***Necessary interventions at National level***

Other recommendations for reducing impact of urban transport on climate change include:

- There is need to establish fuel economy standards in the country as many studies have shown that the introduction of fuel economy standards will result in a significant reduction in energy consumption. The US, Europe, Japan, China and Mexico have mandated fuel economy standards while India is yet to do so. These standards are achievable and need to be introduced immediately.
- Promotion of clean alternative fuels and technologies like biofuels, hybrid vehicles, electric vehicles etc. by subsidizing the introduction of these technologies.
- A well established mechanism for periodic inspection and maintenance of in use vehicles has to be put in place.

- Old vehicles (personal and commercial) need to be phased out by subsidizing the scrapping of old vehicles.
- Private investment in public transport should be encouraged by amending the laws relating to public transport.
- Roadmap for emission standards after 2010 needs to be laid out immediately.

The recommendations discussed above can go a long way in reducing the energy consumption and resultant CO<sub>2</sub> emissions from transport sector of Indian cities. There is a need to develop a detailed and integrated strategy for urban transport sector, which is in line with NUTP, NAPCC and other sustainable mobility principles. This strategy needs to be implemented by developing integrated institutional mechanisms and capacities in the cities.



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# Glossary

## **Adaptation**

Adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.

## **Climate**

Climate is described in terms of the mean and variability of temperature, precipitation and wind over a period of time, ranging from months to millions of years

## **Climate variability**

Climate variability refers to variations in the mean state and other statistics (standard deviations, occurrence of extremes, etc.) of climate on all spatial and temporal scales beyond that of individual weather events.

## **Climate change**

Climate change refers to a “change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

## **Disasters**

A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

## **Geographic Information Systems**

Software used to store, analyse, manage and present data in its geographic and spatial context.

## **Green buildings**

Green buildings entail promotion of energy efficiency, land sustainability, water efficiency, resources efficiency and better building environment. They are designed to minimize the total environmental impact of the materials, construction, operation and deconstruction while maximizing opportunities for indoor environmental quality and performance; saving money, reducing waste, increasing worker productivity and creating healthier environment for people to live and work.

## **Hazards**

A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

## **Integrated Urban Planning**

Integrated Urban Planning entails comprehensive spatial planning across sectors, which takes a holistic approach towards improving a city.

## **Low-carbon development**

A strategy for development that doesn't rely on carbon emission processes and promotes the use of non-fossil fuels.

**Light Detection and Ranging (LIDAR)**

A remote sensing technology that measures properties of scattered light to find the range of a distant object by emitting laser pulses and calculating its reflection.

**Mainstreaming**

Integration of climate change related policies and measures into developmental planning process and decision-making.

**Mitigation**

Human interventions to reduce the sources or enhance the sinks of greenhouse gases

**Public-Private Partnerships**

A service or venture which is funded and operated through a partnership between the government and private sector actors.

**Resilience**

The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined

by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

**Risk**

The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions

**Sustainable city**

A city where achievements in social, economic, and physical development are made to last and it has a lasting supply of the natural resources on which its development depends (using them only at a level of sustainable yield).

**Urban sustainability**

The capacity of cities to endure change while promoting integrated resource use that aims to meet human needs while preserving the environment and promoting improved quality of life.