Urbanisation - Poverty - Climate Change

A SYNTHESIS REPORT - INDIA

Volume I

Rockefeller Foundation
Innovation for the Next 100 Years

ACCCRN Asian Cities Climate Change Resilience Network

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November, 2013

This synthesis report forms deliverable of Asian Cities Climate Change Resilience Network (ACCCRN, www.acccrn.org) India Phase III.

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- Poverty -
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ABOUT THIS REPORT

1.1 BACKGROUND

The cities across the developing world are facing the challenges of rapid urbanization, growing poverty and climate change related risks. Most of the cities are already facing hydro-meteorological risks-both high intensity disasters like floods and cyclones as well as perpetual challenges like water scarcity and health.

The developing countries have are still facing rapid population growth, resulting in reducing per capita natural resource availability (land, fisheries, forests etc.). Rapid urbanization is creating point-sources of demands in already resource scarce areas (e.g. semi-arid regions). Also, the cities already facing resource and service inadequacy cannot take additional stress, without rising conflicts over services. High land prices have marginalized slum dwellers to high risk areas with inadequate and often unsafe lifeline services resulting in higher disaster and environmental health risks.

Expansion of cities have resulted in ever increasing demands for land, water, food energy and other basic needs like housing and industrial goods to support the growing population. With limited investments available with the local bodies, most cities are unable to provide services to meet the existing and growing demands, where a significant section of the urban society lives in poor living conditions. Slums and low income settlements with limited or no access to lifeline services have increased the vulnerability of the poor arising out of any changes in the environment. The push migration from the rural hinterlands due to narrowing of livelihood base, amplified by recurrent droughts and floods, further stresses the city's lifeline infrastructure. The climate change is expected to exacerbate the risks in the infrastructure/resource deficit urban environments across the country.

Indian urban challenge can be analysed through framework of Legacy-Current context-Future issues. Legacy of very dense pockets of enclave villages and irregular settlements lacking basic infrastructure (e.g. roads, water supply, and sewerage), essential services, control over resources like water, land use and development control regulations are faced by almost every Indian city. Conflicting demands for sustaining population growth and need for industrial growth to sustain the economy are pressing current issues that need to be addressed in the context of emerging demands on sustaining the cities. These past and current issues are resulting in vulnerability of significant proportion of urban population. Shrinkage of livelihood options in rural areas combined with low skill levels of people creates additional challenges of migration to the cities and urbanisation of poverty. While future technologies and emerging models of e-governance systems can be opportunities for change, the legacy and current context constrain realisation of these opportunities. Unbundling and understanding the interface between these three issues would be essential to explore options based on paradigms shift from the past legacies of unmet demands and institutions. Radical changes in the technologies, planning and governance paradigms would be essential to ensure universal and adequate access of services, reduction of vulnerability and improving resilience of Indian urban systems.

Increasing risk and growing exposure of poor can increase vulnerability of urban population, especially the poor. Climate change is likely to further amplify the hydro-meteorological risks, where increasing number of urban people in developing world are expected to be exposed to additional risks. These risks and impacts are likely to be differential, with some sections of population able to afford mitigative, coping and resilience measures, while the rest are exposed to higher risks with little or no protective measures.

Considering growing size of vulnerable population and lag in infrastructure & services as well as erosion of formal protective mechanisms, the cities of developing world need to develop resilience at a much faster pace than the developed world. While proportion of poor is decreasing, the actual numbers are growing. The poor are already subjected to repeated daily stresses from limited access to lifeline infrastructure and services, thus requiring building on local knowledge based coping mechanisms that can be formalized and strengthened. Since the technical and financial capacities of the cities are limited, the resilience building in these cities would require contextualized solutions.

ACCCRN is one of the early initiatives to develop, test and demonstrate practical strategies for responding to the impacts of rapid urbanisation, poverty and climate change. Covering ten Asian Cities across four countries, it aims to develop replicable strategies that can be

applied across the cities-especially urban areas across the developing world. The ACCCRN network partners focus on developing city level climate resilience, while sharing and advocating the success stories and lessons to country, regional and global levels. This network aims to expand and deepen the base of urban climate change resilience practice that can be contextualised to other cities in the developing world.

In India, the ACCCRN Phase I (2008) identified and shortlisted a set of three core cities for developing resilience strategies and demonstrate them. Surat, Indore and Gorakhpur were selected based on criteria of rapid urbanization, poverty and vulnerability to climate change impacts and interest to engage with ACCCRN. During the Phase II (2009-2010), the team worked with city level stakeholders to deepen the understanding of current city level risk and vulnerability, potential climate change impacts and possible impacts over different sectors. The city stakeholders undertook several sector studies and pilot projects, which facilitated learning and capacity building of city stakeholders. This process led to development of city resilience strategies and action plans. The Phase III (2011-2014) focuses on implementation of urban resilience strategies through active participation of local partners in implementing demonstration projects and to disseminate the lessons and success stories with national and international partners. In addition a large number of cities are part of the replication efforts (of Bashirhat, Bhubaneswar, Gorakhpur, Indore, Jorhat, Leh, Mysore, Panaji, Saharsa, Shillong, Shimla, Surat and Guwahati).

1.2 AUDIENCE

This synthesis report forms deliverable of Asian Cities Climate Change Resilience Network (ACCCRN, www.acccrn.org) India Phase III. This is the first synthesis report produced under ACCCRN India programme. It is intended mainly for urban local bodies, policy makers, business, community based organizations, individuals and researchers engaged in the subject of urban development and management, climate change and urban resilience.

1.3 REPORT PRESENTATION

ACCCRN works at the nexus of climate change, vulnerable and poor communities, and urbanization. ACCCRN programme through its collective knowledge and evidence pooling had built an emerging practice area of urban climate change resilience (UCCR). This synthesis report considers the effort undertaken in India during the last five years and also showcases the evidence from cities involved in developing the City Resilience Strategy and practical interventions adopted to create urban resilience. Synthesis Report on ACCCRN India is brought out in two volumes. Volume 1 contains five chapters. This chapter lays out a brief overview of the current urban situation and outline of the report. Continuing with the analysis of Urbanization - Poverty- Climate change challenges, the second chapter explains the urbanization trends in the country and prognosis. It explores the trends in terms of size and distribution of Indian cities and their expected expansion over coming decades. It explores the trends in terms of size and distribution of Indian cities and their expected expansion over coming decades. It also analyses the main challenges of urbanization including resources, governance, infrastructure and services situation and emerging challenges that cities will face in the future. The third chapter discusses the Future scenarios of urban growth and challenges. The Fourth chapter discusses on the vulnerability of Indian cities towards climate change. It gives an overview to the factor which increases the vulnerability of the cities for example poverty, gender, age composition and illiteracy. Beside this the chapter also discusses other factors like the soft nature of the state and behaviour aspects of the population which impact the vulnerability of the cities.

Volume 2 of the Synthesis Report is a collection of City Resilience Strategy (CRS) from core ACCCRN Cities (Gorakhpur, Indore, Surat) and one Replication City (Guwahati). The information to Volume 2 is provided by key ACCCRN partners engaged with the local government and city institutions in the development of CRS. The subsequent version of the synthesis report will bring in information from cities of Bashirhat, Bhubaneswar, Jorhat, Leh, Mysore, Panaji, Saharsa, Shillong and Shimla.

The complete list of activities under ACCCRN is available in the website www.acccrn.org.

1.4 USE OF TERMS

Climate change resilience is the capacity of an individual, community, or institution to dynamically and effectively respond to shifting climate impact circumstances while continuing to function at an acceptable level. Simply, it is the ability to survive, recover from, and even thrive in changing climatic conditions. *ACCCRN Website, www.acccrn.org*

Resilience is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change. *IPCC, Fourth Assessment Report, 2007.*

Urban Climate Change Resilience (UCCR) is relatively new and constantly evolving. UCCR brings together researches, policy makers, practitioners and community leaders from multiple disciplines and backgrounds including climate science, development agencies, organizations working in hazard mitigation, disaster risk reduction and emergency relief, global donors, and institutions focusing on globalization, urbanization and sustainability. One of the distinguishing features of UCCR is its focus on systems. Cities depend on both natural ecosystems and engineered services, draw on distant resources as well as utilizing local resources to meet basic needs, and function through complex social and governance systems which can result in the marginalization and increased vulnerability of groups within the community. Cities form a complex web of inter-dependencies, whereby the functioning of the whole system relies on the effective functioning of its constituent parts. *ACCCRN Website, www.acccrn.org*

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. *IPCC, Third Assessment Report, 2001.*

2

URBANISATION AND RISK PROFILE

2.1 CITIES, RESOURCE BASE AND RISKS

Most of the Indian cites have evolved from small towns formed along river banks, trade centers, administrative centers and army cantonments. At the time of their formation, they were reliant on local sources of water, since pumping and long distance water conveyance technologies did not exist. Therefore, access to year round water sources was one of the main considerations for the formation and survival of these towns. The rise and fall of cities were often linked with water resources ever since Indus valley civilization. A majority of those towns are river bank or coastal towns.

Indian cities present diversity in hydrological situations ranging from river banks (e.g. Delhi, Kanpur, Kolkata, Cuttack) to upper catchments/small river basins in semi-arid regions (e.g. Bangalore, Hyderabad, Indore). Water resource base of the large riparian cities has been exploited upstream, especially over last two centuries of intense development of irrigation infrastructure. This has led to saline water intrusion in to the local sources in many coastal cities especially Calicut, Mangalore and Surat. With agricultural development upstream and the city growth, competition and conflict over traditional sources of water, large cities like Delhi, Agra and Bangalore have been impacted.

The cities across India are already facing insufficient access to lifeline services and infrastructure to cater the existing population. Both urban population growth (31% over 2001-2011) as well as change in lifestyles has led to increase in total water demands. The decadal gross water demand growth can be more than 50%, considering both the factors. For large cities, additional demand implies tapping distant water sources, which need large investments or unsustainable levels of ground water withdrawal as the case of Indore and Bangalore.

India has renewable resource availability of only about 1,550 cubic meters (cum)/capita/year with 30.5% accounted by resources flowing from outside the country. India is already a water deficit country with the total renewable water resources of about 1,907 cu.km. per year, as against a minimum need of about 4,000 cum/capita/year of water required for all uses[1]. (FAO, 2010). With the expansion of cities and water demands, new water infrastructure depending on distant sources are necessary to enable cities to expand to sizes beyond their local resource base as discussed previously.

The quality of life has suffered in the urban centres due to the cities' inability to meet growing demands of lifeline services as well as overcrowding. Although small towns are numerous, the 400 odd cities harbouring about two-third of India's urban population(offering diverse employment opportunities and means of livelihood) are the main centres of attraction for migration, despite the fact that physical infrastructure in terms of housing, drinking water supply, drainage are inadequate and unreliable. Therefore, quality of life has suffered in these urban centres not only due to migration, but more so due to expanding gap between the demand and supply of necessary services and other infrastructure facilities. Unchecked land prices and unaffordable housing forced the poor to search for informal solutions resulting in mushrooming of slums and squatter settlements (Mundu & Bhagat 2008). Slums usually develop to meet these unmet demands on peripheral and marginal lands on the outskirts of city, on hill slopes and low lying areas, drainage lines, and also on the land where the owners have either no control or ownership is uncertain and not contested.

Growing traffic and congestion is another major challenge arising out of high density and preference of private vehicles for commuting. As reported earlier, neglect of public transport over decades has given rise to this situation along with formal and informal Para-transit system trying to fill the gap. The cities have resorted to knee jerk actions of building flyovers, ring roads and bypasses, without paradigm shift towards better public transport systems. Only recently, some of the cities have chosen to opt for metro railway systems or Bus Rapid transport systems. With already congested narrow-road dominant central business districts, it would be a challenge to extend these public transport systems to bring about a radical shift to public transport.

With natural growth as well as push migration from rural hinterlands, most of the cities are likely to expand significantly over the next few decades and the risk profile expected to worsen. Improved access from new bridges and growing real estate demand,

1 It includes water required for agriculture and industrial production, drinking water and environmental services to support a person.

the cities have expanded from one bank to both banks of rivers, thereby constricting the flood plains. As the city expands, the demand for high value land within and periphery leads to blockage of natural drainage, encroachment of flood buffers (reservoirs and tanks) by landfills, narrowing of river channels and flood plains. These encroachments increase the flood risks of the cities. The haphazard peripheral growth led by the private sector and individual houses by multiple land owners further add to the complexity of the challenge. As the cities expand by multitude of land developers, natural drainage is often blocked and increase in impervious areas as well as filling of lakes have increased the pluvial flood risks.

Growing gap between master plan projections and actual expansion of the cities can lead to increased risks of floods, water logging as well as water scarcities in many cities over coming decades even without any significant change in precipitation pattern. The recurrent floods and water scarcities in cities like Delhi, Ahmedabad, Vadodara, Pune, Surat, Cuttack, and Kolkata highlight this challenge. While urban planners are expected to incorporate these issues in developing expansion plans and master plans, in practice the hydrological issues are not incorporated in master plans.

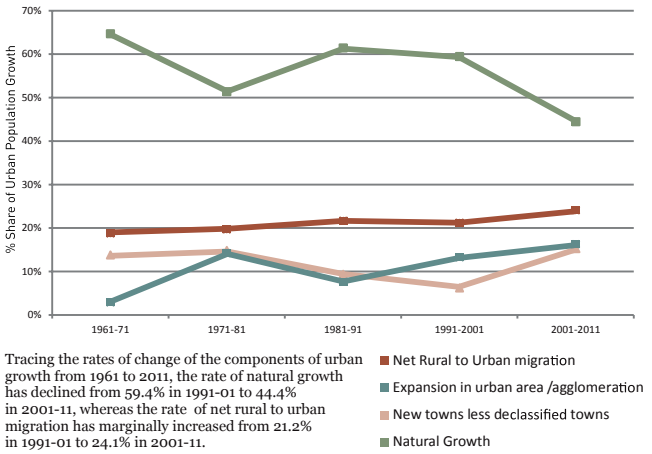
2.2 DEMOGRAPHIC PROFILE

For the first time since 1921, increase in India's urban population was more than the rural population during 2001-2011. At 833.1 million, India's rural population today is 90.6 million more than 2001, while the urban population is 91 million higher. The national decadal population growth rate was 18%, with the urban growth rate of 32% and rural growth rate was 12%. The Urban Rural Growth Differential[2] (URGD) is a rough and ready index of the extent of rural-urban migrations, which is 19.8% for 2011 Census, which is the highest in 30 years. Decreasing per capita agricultural land as well as agrarian crisis are some of the factors driving push migration.

The birth rate in India was 20.97 births/1,000 persons, whereas in urban areas it is 18.5 (Census 2011). The population, however, continues to grow, as the decline in the birth rate is not as rapid as the decline in the death rate. Beside the natural growth of the city, other factors like migration, net reclassification and expansion of the city boundaries also affect the overall population growth.

Natural growth, migration, expansion of the boundaries and net reclassification has contributed to the urban population growth. In 2011, almost one fourth of the urban population growth was accounted by net rural-urban migration to the cities. With the expansion of boundaries from peripheral rural to urban areas is also taken in to account, the proportion of growth increased to 40% of the total urban growth (2001-2011). With decreasing per capita land and lack of alternate livelihood opportunities, rural to city migration is likely to increase over coming decades.

Figure 2.1: Source of increase in urban population (in %)



Tracing the rates of change of the components of urban growth from 1961 to 2011, the rate of natural growth has declined from 59.4% in 1991-01 to 44.4% in 2001-11, whereas the rate of net rural to urban migration has marginally increased from 21.2% in 1991-01 to 24.1% in 2001-11.

Source: IIHS Analysis based on Census of India, 2011; NSS 64th Round; Sivaramakrishnan, Kundu and Singh (2005) SRS, Vol.45 No.1, 201

Source: IIHS 2011

2.2.1 Current growth scenario of Indian cities

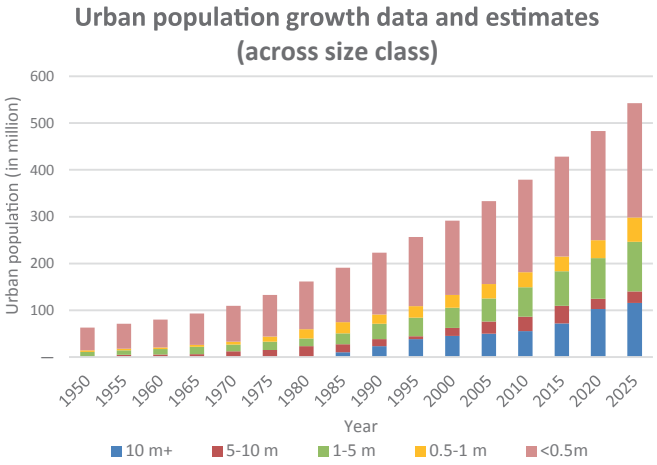
India shows a lag in urbanization compared to other developing countries, especially across Asia. Total population of India has increased from 238.4 million in 1901 to 1.210 billion in 2011 (5 times), while the urban population has increased from 25.8 million to 377 million (14 times). The urban agglomerations (UA)/ towns have increased from 5,161 in 2001 to 7,935 in 2011–a rough rate of five new towns per week for 10 years running. The total includes 4,041 statutory towns and 3894 Census towns[3]. The following Figure 2.2

2 Urban Rural Growth Differential is the difference between the rates at which rural and urban populations expanded in each decade

3 Settlements with i) A minimum population of 5,000; ii) At least 75 per cent of the male main working population engaged in non-agricultural pursuits; and iii) A density of population of at least 400 persons per sq. km.

presents the distribution of urban population across different size classes of cities.

Figure 2.2: Population growth trend and projection by size class across India



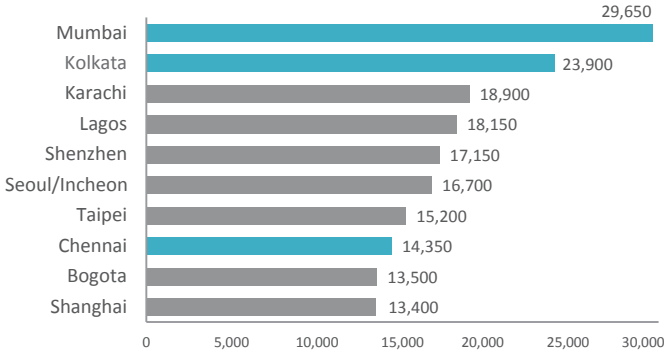
Source: UN Population Division 2011

In 2011, there were 468 Class I cities (population >0.1 million). These cities are expected to drive the urbanization process in the coming decades. Out of these, about 160.7 million persons (or 42.6% of the urban population) live in 53 Million plus UAs/Cities. 18 new UAs/Towns have been added to million plus city list over last decade.

There are three mega cities, Greater Mumbai UA (18.4 million), Delhi UA (16.3 million) and Kolkata UA (14.1 million), accounting more than 12 % of urban population as per Census 2011 or 16% as per UN projections (UN 2012). These trends show growing importance of larger cities in driving the urbanization. These trends also imply that the large cities will demand very high amounts of water and food, which cannot be met by local resources, especially in semiarid and dry regions of the country. With the gross population densities of more than 10,000 persons per sq.km. (most cities of >5 million population) the annual demand for domestic water alone can be as high as 0.5 million cum/sq.km. or 500 mm equivalent of rainfall.

In 2011, the top 10 cities of India accounted for almost 8% of India's total population and produced 15% of total economic output but occupied only 0.1% of the total land area. Similarly, the 53 million plus cities account for 13% of the population produce about a third of total economic output and occupies only 0.2% of the land. The top 100 cities, account for 16% of the population, produce 43% of India's total output and occupy 0.26% of the land (IIHS 2011).

Figure 2.3: Top 10 cities of the word with highest density (per sq.km.)



Source: City mayors statistics (2007)

India has 3 out of 10 highest density cities of the world with two Indian mega cities Mumbai (29,650) and Kolkata (23,900) occupying first two ranks. Chennai is ranked as eighth city with highest population density of 14,350 people per sq.km. In India, Delhi (11,050) is the fourth most densely populated city, followed by Bangalore (10,100) and Hyderabad (9,100). With low FSI limits (mostly less than 2) in most cities, this means a combination of very low allocation of land for public use (roads, parks etc.) and low per capita residential floor areas and dominance of low rise buildings. With nearly 93 million people (MHUPA 2011b) living in slums (with mostly overcrowded single or two storied informal buildings) and an equal amount of persons living in low income semi-formal settlements, the urban population densities are no doubt very high, despite having low FSI limits.

> Even though urban planning has changed relatively little in most countries since its emergence about 100 years ago, a number of countries have adopted measures like strategic spatial planning, use of spatial planning to integrate public-sector functions, new land regularization and management approaches, participatory processes and partnerships at the neighbourhood level, and planning for new and more sustainable spatial forms such as compact cities and new urbanism. However, in many developing countries, older forms of master planning have persisted. Here, the most obvious problem with this approach is that it has failed to accommodate the ways of life of the majority of inhabitants in rapidly growing and largely poor and informal cities, and has often directly contributed to social and spatial marginalization.
>
> *- UN Habitat (2009)*

Low Rise High Density Paradigm: During the 1970's and 1980's "preventing congestion" was the conceptual basis of urban planning that shaped most Indian cities. The problems of high private vehicle ownership due to longer commuting distances or traffic jams were still unknown. The urban development debate in India evolved from low-rise high density (LRHD) built-form and single use zoning of 1980s to compact form with high density, mixed land use and efficient public transport planning of the proposed future.

Compact city paradigm: The National Mission on Sustainable Habitat has recently initiated compact city debate in the context of urban transport. Unfortunately, with fragmented and overlapping roles of different stakeholders in the urban development sector, implementation of compact city paradigm may take many years to be implemented. Examples of New York and Hong Kong are often used to drive the compact city argument for better public transport with high density use. Unfortunately these debates have ignored the fact that the Indian cities are some of the densest cities in the world, even with low FSIs and low floor area per persons no more increase is possible without severe congestion of streets and increasing the vulnerability of population to vagaries of unreliable lifeline service delivery.

The City master plans did not integrate landuse with spaces for transportation, power and communication networks. This has resulted in major challenges to introduce public transport with dedicated corridors. Considerable retrofitting as well as land acquisition etc. is necessary to commission Bus Raid transport systems in the cities recently. Their success would depend on actual availability of free road spaces for public transport.

The major challenges to shift towards compact cities would include universal coverage of lifeline services and round the clock availability of energy and water services and shift to public transport on a large scale. With low per capita built spaces and overcrowding on one hand and old and decrepit lifeline infrastructure networks(especially underground water supply and sewerage networks), further increasing the FSI would subject these services to additional loads and possible increase in frequency of breakdowns. This would make larger proportion of the population vulnerable.

Such transformation options would need to start with addressing infrastructure and service networks including roads (including traffic planning, and street congestion), electricity, water supply and sewerage. Universal access as well as reliability of lifeline services like energy and water would be critical for transformation to a compact city. With densities of more than 10,000 persons per sq.km., installing and maintenance of new higher capacity networks and resources would be challenging in overcrowded, dense built environments. In an energy and water hungry country, with little control over population growth and densities, compact cities can result in increasing risks of lifeline services failures as evidenced by routine power cuts, water supply disruptions and traffic jams even in low rise high density environments.

> In developing countries, where there is an enormous range of people, cultures and economies, the size of the problem (explosive urbanisation) is immense and growing fast. Nevertheless, there are a number of points of comparison. Compactness appears to be an aspiration and a hoped-for solution to the problems of the explosive growth of urban areas, and it has some meaning when applied to the intensification of many sub-centres within a metropolitan region. Mixed use does not feature as an issue, as the vitality exists in abundance and problems are more likely to arise from there being too much rather than too little of it.
>
> Good public transport exists, and in some cases is better than that found in developed countries, although this is the exception rather than the rule. Even so, public transport use is generally much higher in developing countries, but this is more usually the result of low per capita incomes rather than any explicit sustainability policy. The ease with which traffic becomes saturated is a function of dense urban forms, and these in turn become highly polluted. Pollution is a problem even in rich cities like Hong Kong, and while 'clean technology' may help its reduction, it would give no alleviation to congestion. Concerning the other characteristics, neither environmental controls nor urban management measure up to those found in developed countries. In all but a few countries, local government controls are weak.
>
> *- Jenks (2000)*

In India, one of the major issues has been the soft state and weak governance with limited control of ULBs over the urban growth. The existing rules are often anachronistic to the emerging needs and major shifts in paradigms and policies (e.g. from LRHD to Compact city) would be time consuming and require cooperation

between different departments within the ULBs with fragmented and overlapping roles.

Major changes in land use or decongestion in Indian cities are often unpopular causing "unresolvable conflicts," especially in core areas, where land prices and stakes are too high. Elected bodies are constrained by public opinion to introduce such measures. Major disasters provide window of opportunities as indicated by partial decongestion of Surat after plague of 1994. Most of the cities miss such rare opportunities as indicated by inaction followed by earthquakes, recurrent floods in some of the major cities across the country. Unless sufficient land areas are allocated for lifeline networks and public spaces, simply increasing FSI is only going to complicate issues of street congestion, traffic jams and power cuts in high energy dependant built spaces.

The debate on urban development is likely to lead to a shift towards high FSI led growth over low public space/ narrow road environments without sufficient dedicated spaces allocated for public transport or other common facilities. Even though compact city paradigm has come to the forefront, concrete action is yet to take root under the prevailing political and policy context. More intense planning efforts are necessary to understand available options for transforming our cities from low-rise, high-density- low public space areas (roads, parks etc.) to more energy, land and water efficient urban systems.

2.2.2 Urban sprawls

Beside large population and high urban density, urban outgrowth/urban sprawl is another characteristic of Indian cities today. Recently, the urban sprawls have given way to isolated multi-storied gated communities due to high land prices. Cities has the tendency to grow outwards of their traditional boundaries due to congestion and high land prices. The total number of urban Agglomerations/Towns is 6,166 in the country (Census 2011). During 2001-2011, number of urban agglomerations has increased from 385 to 468 comprising of more than 900 peri-urban outgrowths with limited or negligible access to lifeline urban services of the main city. The number of towns has increased by 2,774 during 2001-11 period.

Most of the highways have emerged as Desakota regions; some of those regions are likely to form new urban areas over coming decades. This process is also catalysed by new highway/ freight and industrial corridors being planned across the country.

LAND REGULATIONS AND URBAN SPRAWL

"Combined effect of multiple layers of poorly conceived central, state and municipal regulations contribute to an artificial urban land shortage. As a result urban land prices are abnormally high in relation to India's household income, and households consume less floor space than they could afford if the regulatory environment were reformed. In addition, some regulations have a negative impact on the spatial structure of cities. By unreasonably reducing the amount of floor space that can be built in centrally located areas, and by making land recycling difficult, some regulations tend to "push" urban development toward the periphery. As a result, commuting trips become longer, public transport become difficult to operate and urban infrastructure has to be extended further than what would have been the case if land supply had been unconstrained"

- Bertaud, 2002

Since Independence, several urban development authorities (UDA) were set up by the state governments for overseeing and sanctioning construction and infrastructure development (roads, water supply, sewerage, storm water drainage, street lights etc.) and build townships in the suburbs of the respective cities. The UDAs are responsible for land use change from agricultural/other uses to urban uses and they derive most of their incomes from sale of developed lands and buildings. In most cases, rural settlements engulfed by the cities (enclave villages) are left to densify themselves within the larger developed area leading to a mix of chaotic pockets amidst of planned development. Unfortunately, many of these UDAs act as real estate developers and hand over the partially developed areas with inadequate services to the ULBs. The ULBs are then saddled with the additional responsibilities of rebuilding infrastructure and augmentation of services. Urban sprawls and spatial mismatch are result of intensive development in the periphery, especially newly areas developed by the service sector industries.

Another reason for the increasing urban sprawl is blurred rural buffers and formation of Desakota regions. Due to the better connectivity and development

of corridors, the nearby villages and hamlets are getting connected to the cities and are becoming part of the growing city as people move daily for work from these areas. Also, changing livelihood patterns (from primary activities to secondary and tertiary activities) in large villages lead to formation of towns in situ, and emergence of new unplanned development in these new towns driven by market forces.

Urban sprawls are expensive to live in due to high capital costs of basic infrastructure as well a high recurrent costs of service delivery and transport due to long distance from the core city. They also tend to form exclusive gated cities predominantly owned by upper socio-economic classes. They consume large tracts of land, often very good quality agricultural lands and floodplains causing additional risks of flooding. Also they become high fossil fuel consumers due to distances from the main business districts and proliferation of private vehicle ownership. Also, with poor infrastructure and services, these areas mostly depend on ground water and lack of sewerage, storm water drainage and solid waste disposal results in contamination of surface water bodies and aquifers. Since the real estate developers have no long term stakes, the buyers of the developed and land and buildings or the ULBs end up retrofitting infrastructure and services as the city limits expand.

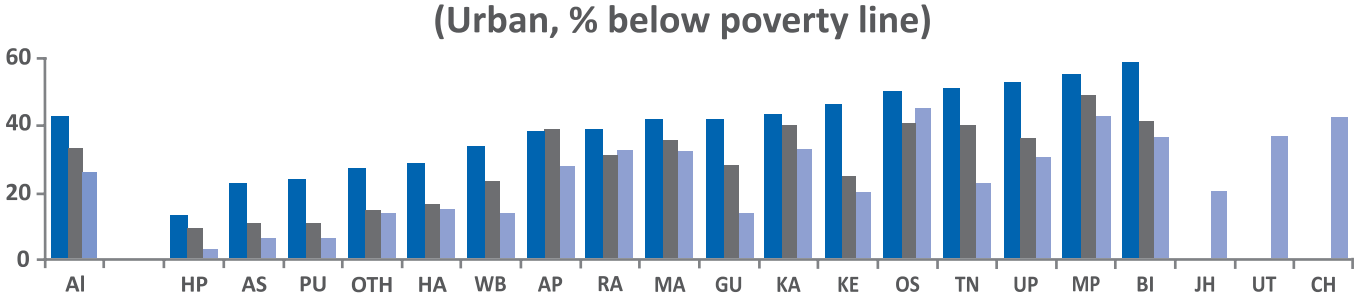
2.3 URBAN POVERTY

The poverty estimates are some of the most contentious issues in India. Earlier, India used to define the poverty line based on a method defined by a task force in 1979. It was based on expenditure for buying food worth 2,400 calories in rural areas and 2,100 calories in urban areas. The World Bank's definition of the poverty line for under developed countries is US$ 1/day/person (Rs. 60 at current exchange rate) or about Rs. 21,900/yr).As per this definition, more than 75% of all Indians are probably, below the poverty line (Wakeupcall website).

In 2011, the Suresh Tendulkar Committee defined the poverty line on the basis of monthly spending on food, education, health, electricity and transport. According to this estimate, a person who spends Rs. 27.2 in rural areas and Rs. 33.3 in urban areas a day are defined as living below the poverty line. The provisional results of NSSO 68th round livelihood surveys indicate that the bottom 10% of the urban households have daily per capita expenditure of less than Rs. 23.40 only. This is less than 0.5 USD/capita/day (Moneylife website). Other indicators like accessibility of lifeline services are equally relevant for delineating poor in urban context, since lack of access of these services severely handicaps the households to pursue their livelihoods.

The poverty status across states and years is presented in Figure 2.4 (World Bank, 2011). In addition to slum dwellers with lack of access to basic services, at least an equal number of low income socio-economic class exists in most of the urban areas. These communities have poor access to most urban services due to marginalization by the rest of the socio-economic groups and neglect by the service providers. As they are unlikely to have access to lifelines services like water supply, they are unable to get benefit to subsidies on these services and forced to purchase water and other services at market prices or more.

Figure 2.4 Percentage of urban population below poverty line 2011



Notes: Poverty rates for the newly created states of Chhattisgarh, Jharkhand and Uttarakhand only reported after states were formed. For comparability over time, poverty trends reported for Madhya Pradesh, Bihar and Uttar Pradesh in all three years are for the divided states. States sorted in ascending order of 1983 poverty rates.

Source: World Bank (2011) for poverty estimates.

In most cities of India, urban poor and slum dwellers who constitute about 25% of the city population occupy not more than 3-5% of city land space (MoHUPA, 2011b). Out of a total of 78.9 million urban households, 13.7 million were slum dwellers (17%) in 2011 (Census 2011). About 38% of the slum households were reported 46 Million plus Cities (Census 2011). Official poverty rates in large cities (with population of one million or more) are dramatically lower than that in small and medium towns.

In 2009, there were a total of 48,994 slums reported from across the country (NSSO 2009). Out of them 50.6% were notified slums and rest were categorized as non-notified slums. The 2011 Census categorised slums into Notified (37,072 numbers), Recognised (30846) and Identified (40,309) categories.

Informal sector

Seasonal labour demand (especially in single crop areas) and low wages in rural areas creates push factors while year round labour demand and better wages in cities creates pull factors leading to excess supplies of labour in the urban areas. With few relevant skills or education, a large section of rural to urban migrants have no option except to work in informal sector. In the face of a high natural growth of population, rural-urban migration aggravates the situation of excess supplies of labour in the urban areas. Within the urban informal sector push migration tends to reduce the level of earnings and get manifested in a high incidence of urban poverty. Thus in the process rural poverty gets transformed into urban poverty – the phenomenon is also described as 'urbanisation of poverty (Mitra & Murayama, 2008). Construction and services (Transport driver, plumbers, domestic help, small stores etc.) in India is mostly informal. India has a large informal economy, with about half of its GDP estimated to be informal, and 84% of non-agricultural workers work informally (Credit Suisse 2013).

The income instability in informal sector increases the vulnerability of the poor to disasters. Also, poor accessibility to lifeline services add additional burden of lost time and money to access water, electricity and other basic services.

Location and differential exposure: Since the poor cannot afford to buy land or houses due to high costs, they settle mostly in uncontested areas like river and gully banks, adjacent to railway lines and other unoccupied government/public lands. These are generally higher risk areas and often unsuitable for permanent housing.

More than 40% the slums are located along Nallahs/ drains, along railway lines, on river banks, river beds, and other areas. An estimated 24% of all slums were located along Nallahs and drains and 12% along railway lines. About 22% of slums were located on the fringe or border area of towns and 78% in other areas (NSSO 2009b).

Table 2.1: Percentage distribution of slums by location of slums (All India)

Location	Notified	Non-notified	All
Along Nallah/drain	22	26	24
Along railway line	10	15	12
River bank	8	5	7
River bed	2	0	1
Other	59	53	56
All	**100**	**100**	**100**

Source: NSSO 2010b

Being located in high risk areas, the slums are naturally more exposed to water logging and flooding. About 48% of the slums were usually affected by waterlogging during monsoon with following variations in waterlogging:

- 32% of slums reporting waterlogging inside of slum as well as approach road,
- 7% reporting only slum getting waterlogged and not the approach road,
- 9% of slums where only the approach road was waterlogged in the monsoon.

It means that nearly 45 million slum dwellers are prone to waterlogging that can affect their livelihoods as well as expose them to vector-borne and water-borne diseases. Any increase in amount or intensity of precipitation can cause more impacts on the houses as well as livelihoods of slum residents.

2.4 CURRENT CHALLENGES OF URBAN INDIA

2.4.1 Housing

As per Census of India, 2001, 52.4 million people lived in slums in 1,743 towns which constitute 23.5% of the population of these towns. The Technical Group on the Estimation of Housing Shortage projected the total shortage of dwelling units in urban areas in 2007 to be 24.71 million units and the shortage during the plan period (2007-12) including the backlog is estimated to be 26.53 million of which 99% pertains to the EWS & LIG segments of the urban population (MoUD, 2010). It indicates unmet demand for poor housing, which is largely due to inadequate/ inappropriate land use and building regulatory regime and lack of inclusion of economically and socially weaker sections in urban planning. On the other hand, there are significant number of middle income and high income residential units lying vacant or unsold in most cities. This in turn creates distorted land markets and very high cost of housing due to high land costs. Uncontrolled land prices and unaffordable housing in cities are some of the most pressing issues that have defied solution so far. With housing costs unaffordable, poor are forced to search for informal solutions resulting in mushrooming of slums and squatter settlements.

Gross densities in Mumbai (29,650 persons/sq. km.) and Kolkata (23,900 persons/sq.km.) with medium rise buildings dominating these cities indicate very low per capita floor area for the residents. The average per capita floor area in urban India during 2008-09 was 9.8 sq.m, while the lowest MPCE quintile having only 4.5 sq.m. About 8 percent of the total households live in Semi-Pucca or Kuchha houses. Only about 24% of the urban households lived in flats, while 58% lived in individual houses, rest in other types of houses (NSSO, 2010).

The FSI limits prevented raising the number of floors under the LRHD paradigm and now the city planners are increasingly debating about compact cities and multi-modal urban regions. As per the debate for compact cities, they are preferred due to lower costs of infrastructure and services (public transport, water supply and sewerage electricity, communication etc.). Poor public transport has resulted people opting for private transport, which has led to overcrowding of road network. High cost of extending infrastructure and services, transport congestion and land scarcity are some of the reasons for compact city debate as of now (Jenks& Dempsey 2005), (Chattopadhyay, 2007).

CHALLENGES AND BENEFITS AND OF HIGHER FSI IN CENTRAL BUSINESS DISTRICTS

"A higher FSI would require a better performing infrastructure. However, coupling impact fees with an increased FSI could generate the revenues needed to upgrade existing city services. This increased in FSI will result in higher land prices in the CBD but it will lower the price to property ratio. It will also tend to slightly lower the sale price of floor space in the area. Land prices in peripheral areas will tend to become lower. The economic gain to the city, in the long run will be extremely large. In addition, raising the FSI from 1 to 4 in the CBD alone will also reduce trip length, improve the efficiency of public transport and decrease air pollution."

- Bertraud (1996)

However, with already high population densities, low per capita floor areas, uncertainties in quality of lifeline services, high rise building based townships are unlikely to be feasible or attractive unless major improvements are done in quality of infrastructure and services. The following Box presents the uncertainties in power and water supply in Mumbai and Chandigarh as well as grid failure affecting nearly 600 million people. These issues can cripple high energy demanding compact cities for days together.

Fire at substation causes outage October 16, 2011

Express News Service: Mumbai, Mon Oct 17 2011, 03:11 hrs: South Mumbai suffered its worst power outage in a decade after a fire at the BEST undertaking's Backbay substation caused disruption in supply to areas including Colaba, Cuffe Parade, Marine Drive and Navy Nagar for most of Sunday (16th Oct 2011). While supply to some areas resumed after a few hours, parts of Colaba and Cuffe Parade went without power for over 16 hour

By evening, with some traffic signals dysfunctional, minor traffic pile-ups ensued. Parts of Colaba lost electricity for the second time and shop fronts were plunged into darkness too. Some establishments did business by candlelight. Streetlights in some parts of the affected areas were intermittently dysfunctional too and a small part of the Queen's necklace at Marine Drive remained unlit — a surreal darkness in an area that never goes to sleep.

Major buildings such as Maker Towers, Jalkiran, Sealord, Palm Spring and Cuffe Castle had no power all day on Sunday, Padmakar, who lives in Jalkiran, added. "We pay the highest taxes, but we are still not getting electricity. I spoke to Mayor Shraddha Jadhav and requested her to start the supply as soon as possible." (City population Website 2011)

Express News Service: Mumbai, Tue Oct 18 2011, 00:01 hrs: Parts of Cuffe Parade and Navy Nagar had to go without electricity for the second day on Monday as the Brihanmumbai Electric Supply & Transport (BEST) undertaking could not completely fix the technical snag that had caused a major power outage in parts of south Mumbai on Sunday.

Express news services, 2011

Power & water cuts worsen winter woes

"Tue Dec 27 2011, 01:58 hrs: UT (Union Territory) facing 20-30% electricity shortage; power department may fix time of rotational cuts for industry; water crisis to continue for some days.

City residents are facing a tough winter this time. The electricity and water supply cuts that are being faced in Chandigarh during the winter season are likely to continue in the coming days. The rotational cuts in electricity supply are being faced as due to outage of central generation plants, the entitlement of power to the city has decreased. While rotational power cuts are faced in summers, the winter months used to be generally free from these"

Express News Service- Chandigarh

Peak power scarcity and two grid failures- July 2012

"To leave one in 20 people on the globe's surface without electricity, that lifeblood of modern society, in the hairdryer heat of an Indian summer is unfortunate. To do it again to one in 12 of the world's population a day later is an unpardonable carelessness" .

"Tuesday, 19 states and more than 600 million people spent hours without electricity in the world's biggest blackout. The power outages are reportedly the result of northern states likes UP, Punjab and Haryana drawing more than their allotted share from supply grids (the states have denied the charge)".

"The Northern power grid has been strained this summer as a weak monsoon meant farmers used pumps extensively to water their fields. But the dual blackouts this week also highlight the growing gap between the demand and supply of power. More than half of India's power is generated using coal. Many plants are not able to deliver the sort of power they're capable of generating because of a shortage of coal"

NDTV 2012

"It (Grid failure) occurred twice over period of two days and took more than 6 hours and affected railways, hospitals, water supply and other essential services across whole of North and East India. The urban areas are prone to such blackouts that can cripple life on a mass scale and would take several days to recover, if there are insufficient backup systems."

The Guardian 2012

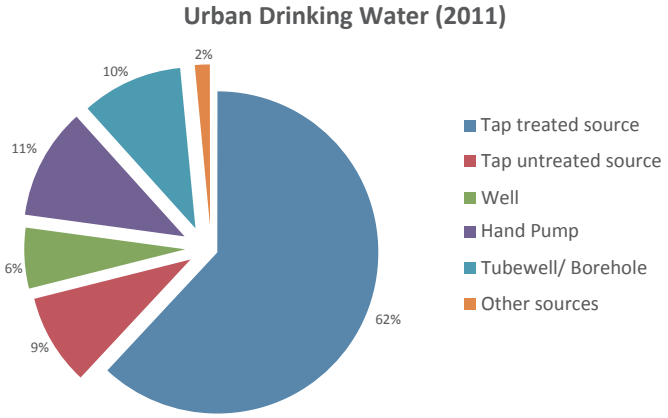
Multi-storeyed buildings dependent on electricity for lifts, water supply and other services can face major problems for aged and physically challenged persons. The compact growth paradigm should be seen in the light of such vulnerabilities in lifeline services in energy and water hungry/deficit environments with uncertain quality of services.

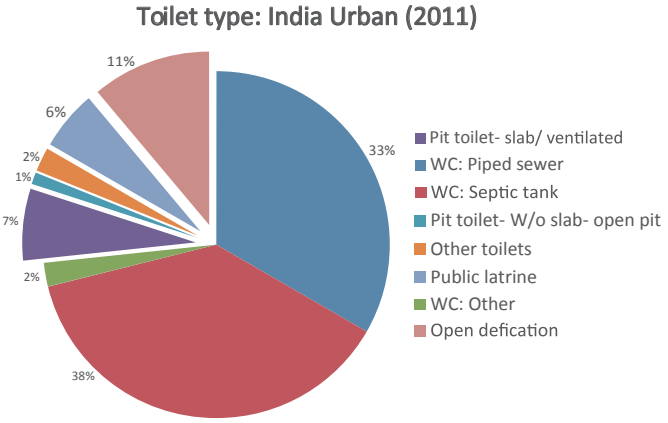
2.4.2 Lack of infrastructure

The efficiency of any urban system depends on the availability of infrastructure and services to support its population. But almost all the Indian cities today are facing serious deficiencies in infrastructure and lifeline services today. None of the cities have been able provide universal access to lifeline services.

In 2011, only 70.6 percent urban households had access to tap water and only 60.6 percent had access to tap water from treated sources. About 27 percent of urban households depended on ground water sources including wells, hand pumps and borewells (Census 2011). Considering poor sewerage conditions, the ground water sources in urban areas are mostly contaminated. Only about 81.4 percent of urban households had toilet facility within their premises and only 72.4 percent had water closets. Only about 32.7 percent of urban household toilets were connected to sewerage system (Census 2011). These figures indicate nearly two third of the households dispose the untreated sewage in to ground or to surface water bodies. Except for metros and some large cities, the sewage treatment is either non-existent or insufficient. Lack of recycling water and contamination of local and downstream resources are two major opportunities lost in the water scarce Indian urban environment. The water supply and sanitation statistics of 2011 is presented in the following Figure 2.5.

Figure 2.5: Drinking water and sanitation arrangements: Urban India 2011





Source: Census of India, 2011

Poor infrastructure-especially storm water drainage and sewerage, has resulted in increased risk of water logging and floods during rainy seasons while high leakage losses are exacerbating water scarcity conditions in most cities. These services are de-jure managed by the ULBs, but is often modified by the residents through illegal connections as well as using sewerage system to drain waterlogged areas. Poorly managed sewerage systems also result in increased breeding of pests and disease vectors and occasional epidemics like malaria and Dengue, which have become more common in the recent years. With the sewerage systems not fully maintained, they become breeding areas for vectors like cockroaches and rats and support a growing pest control industry.

The urban growth over the current backlog of infrastructure imposes major challenges to urban service delivery. Even though the leakage and unaccounted for water (UFW) is quite high in most cities, the ULBs are not exploring for soft options like leakage reduction and metering. Also, the lack of financial, technical and managerial capacities of the ULBs to fill the growing gap in infrastructure and services further imposes very high burden on the citizens who have to invest on coping measures.

India Infrastructure Report in 2006 noted that "Though there are vast improvements in basic amenities such as access to telecom services, electricity, water supply and sanitation, etc., the quality of basic services except that of telecom, is declining. In other words increasing coverage of infrastructure is not matched by improvement in the service levels. While there are more taps today in sheer number, there is less water once the taps are turned on" (3iNetwork 2006). This observation is still valid with inordinate delays and bottlenecks in building infrastructure and managing the services due to a variety of governance issues.

This current gap in urban infrastructure and services in cities is due to building up of lag due to historic lack of functional and financial autonomy given to urban local bodies by the state governments. Only after the 74th Amendment was enacted, some degree of autonomy was delegated to the urban local bodies. The issue of autonomy and delegation of functions, funds and functionaries is still being addressed by enforcing reforms through conditionality to access the urban development funds under JNNURM programme. The thrust of the infrastructural development strategy is on generation of larger tax and non-tax revenue through internal sources, external borrowing, private-public partnerships, mobilizing funds through bonds and other innovative financial instruments. The development plans and investments (e.g. JNNURM) over last decade have also focused on limited number of large cities with less focus on investments for small and medium towns.

2.4.3 Water Supply services

Inadequate coverage, intermittent supplies, low pressure and poor quality are some of the most prominent features of water supply in the cities of India. Even those covered by centralized water supply get intermittent supply with attendant problems of low pressures and contamination from sewerage network.

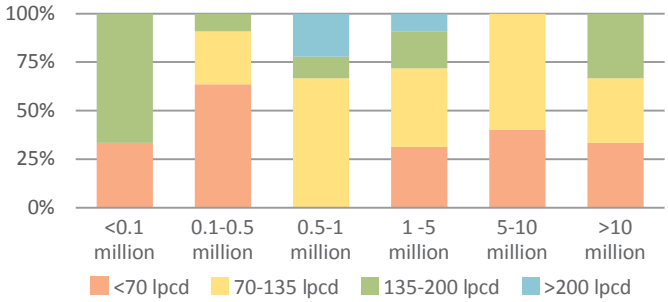
With rapid increase in urban population and continuing expansion of city limits, the challenge of delivering water in Indian cities is growing rapidly (MoUD 2011). Without sufficient coping measures like storage tanks, pumps and water purifiers at household level, the vulnerability to waterborne diseases would remain high. The scarcity has given rise to a growing private sector of borewell drillers, tanker water suppliers and capital goods like PVC storage tanks, booster pumps and various types of water purification systems. The city horizons are dominated by PVC storage tanks.

While the burden of unreliable water supply is felt by all sections of the society, it is more pronounced among the lower-income households and coping costs for water supply is highest for the urban poor. An intermittent water supply or collection of water from tankers/distant sources forces the poor to forgo work or lose part of their earnings. Alternatively, they also have to pay much higher cost for supply (often many times that of formal supply) from illegal or informal networks. Slums are often not taken into consideration for planning purposes and such habitations are typically bypassed at time of service expansion. Even if they are provided water supply, "elite capture" upstream leads to poor supplies to slums. The responsibility of ULBs with respect to slums is often restricted to supply through public stand posts or delivering water through ad-hoc arrangements such as water tankers. Since provision of municipal water connection may be seen as regularizing an illegal slum and leads to subsequent demand for tenure rights, ULBs and state governments have not extended themselves to provide house service connections in slums (Banerjee & Pratap 2011). On the other hand, water is used as a political tool, especially during elections.

Of the 27 Asian cities with populations of over a million, Chennai and Delhi are ranked as the worst performing metropolitan cities in terms of hours of water availability per day, while Mumbai is ranked as second worst performer and Calcutta fourth worst. While the 2001 Census data shows that 90% of urban India has access to "safe drinking water", only about 50% of this population was directly connected to the distribution system, and another 24% was accessing public standpipes. By 2011, the percentage connected to some form of tap water supplies (treated or untreated) went up to 71% only.

The water availability is another major issue. With high leakages, the actual availability is much less than water supplied in to distribution network. The following Figure 2.6 presents the per capita treated water made available. About 77% of the total population of the 63 largest cities of India (also covered under JNNURM. 154 million population in 2011) gets less than 135 lpcd.

Figure 2.6: Per capita water availability in 63 Indian cities after deducting UFW



Source: ADB 2007, Taru analysis, City population Website. City CDPs

With metering system abandoned and flat tariff system introduced over the decades, households and other users now have no incentives to control water use. In addition, lack of access to round the clock water supply has created several perverse incentives like elite capture, created water markets often relying on the existing system itself. The poor maintenance and inadequate replacement lead to technical losses in the distribution network. Errors in metering, unbilled water consumption and plain theft contribute to commercial losses. This leads to high levels of non-revenue water with no monitoring system in place and no incentive to reduce inefficiencies, the urban water scenario in India is one of poor service delivery, poor maintenance of physical systems, poor recovery of costs, and poor generation of revenues (MoUD 2011).

The Central Public Health and Environmental Engineering Organization (CPHEEO) allows for a maximum of 15% unaccounted for water (UFW), but levels in many Indian cities are as high as 40% with some cities surpassing 50%. This arises from both the old and decrepit infrastructure and unauthorized tapping of the supply. In most metros, households spend both on capital investments (bore/tube wells, storage tanks, pumps, purification systems) as well as running expenses on water tankers, bottled drinking water, alongside what they pay to the utility. Also, households spend many hours daily managing water at household level (NIUA 2005).

The cost is not computed or understood when cities map out the current and future water scenario. In most cases (as evident from the city development plans submitted to JNNURM for funding), cities emphasize the need to augment supply, without estimating what it will cost, in physical and financial terms. Data suggests that most cities spend anywhere between 30-50 percent of their water supply accounts for electricity to pump water. As the distance increases, the cost of building and then maintaining the water pipeline and its distribution network also increases.

Since most of the distribution infrastructure is old and decrepit and also not maintained, water losses also increase. The end result is that the cost of water increases and the state may not able to subsidize the water supply. The situation is worse in the case of the poor who often have to spend a great deal of time and money to obtain water since they do not have house connections. Worse, as the city municipal water system collapses under the weight of under-recoveries, the rich move to private water sources like bottled water. The poor suffer the cost of poor health.

Coping measures: The coping measures include, increasing household level storage capacity to overcome water supply uncertainties, use of household filtration equipment and reliance on bottled water for drinking and cooking. Almost all middle and upper class households have invested on these "mini-utilities" to overcome intermittent water supply and water quality issues. Also, since the new housing and other development projects have to internalize these costs, the additional costs have to be borne by the prospective buyers of houses. While the household level coping measures alleviate some of the issues, at city scale they often aggravate the problems due to elite capture.

Improving the quality of services under the urban growth scenarios is the greatest challenge today and will continues over next several decades. If not addressed, these issues can lead to violent protests and law and order problems especially during peak scarcity periods. Such semi-organized protests have become common in cities facing water scarcity. Indore is one of the best examples where the city is facing water scarcities and organized protests leading to violence during every summer.

The public is willing to pay, provided reasonable services are made available to them and confidence building measures to overcome historic poor performance is taken up and reasons for the water charges increases explained to them. For example, many ULBs have been able to simultaneously improve services and increase the water tariffs without protests by the residents. The production costs in cities depending on distant sources are quite high and cross subsidies are given to enable domestic users to pay less than O&M costs. This system leads to commercial and industrial users shifting to other sources like groundwater, resulting in overall insufficient revenue to pay for the production costs.

Beside these challenges, cities are also facing threat from climate change. Increasing temperature, changing rainfall patterns, reducing natural resources, sea level rise and urban floods are imposing threat to infrastructure and livelihood of the urban citizens in India.

2.4.4 Sewerage and Sanitation services

The challenge of sanitation in Indian cities is acute. With very poor sewerage networks, a large number of the urban poor still depend on public toilets. Many public toilets have no water supply while the outlets of many others with water supply are not connected to the city's sewerage system. Only 13.5 % of the sewage from Indian cities was treated the rest being let out untreated leading to pollution of land and water-bodies, while the treatment capacity installed was only 30%. The actual treatment was estimated at 72.2 % of the sewage collected which implies that only about 20% sewage generated was treated before disposal in Class I cities and Class II towns (CPCB, 2009).

Over 50 million people in urban India were estimated to be defecating in the open every day in 2008. None of the 423 cities studied by MoUD in 2008 were found to be 'healthy' and 'clean'. The scoring done for these cities indicated that the Municipal Corporations of Chandigarh, Mysore, and Surat and the New Delhi Municipal Council were the only four ULBs that fared relatively better. Close to 190 cities in the study were rated to be in a state of emergency with respect to sanitation and public health (MoUD, 2008). Eradicating practices of manual scavenging, and mobilizing states and cities to accord sustained priority to urban sanitation (MoUD &MoRD, 2011)

Diseases linked to poor sanitation and hygiene lead

to substantial loss of life and potential. It is estimated that one in every ten deaths in India is linked to poor sanitation and hygiene. Diarrhoea, a preventable disease, is the largest killer and accounts for every twentieth death. Around 450,000 deaths were linked to Diarrhoea alone in 2006, of which 88% were deaths of children below five. Monetized economic losses linked to poor sanitation in 2006 was of the order of Rs.2.4 Lakh Crore (US$ 53.8 billion), or Rs.2,180 (US$ 48) per person. This works out to 6.4% of Gross Domestic Product (WSP, 2010).

The poor are worst affected by the poor water supply and sanitation services. Water related diseases result in disproportionately high medical expenses as well as infant mortality, which is compounded by the location of slums and poor settlements along the drainage lines, which receive the sewage from the rest of the city. Also, since poor predominantly depend on contaminated groundwater for water supplies without treatment, their vulnerability to water borne diseases are higher. They also suffer disproportionally during water crisis periods due to elite capture of centralised supplies.

2.4.5 Electricity

About 92% of the urban households used electricity for lighting, indicating that they have access to electricity (Census 2011). Also, National sample survey indicated that only about 86% of the lowest quintile of MPCE in urban households had access to electricity (NSSO, 2010). It is not the access, but frequent power cuts that is an issue in poorer sections of urban population. Also, a significant proportion of poor households have illegal connections, which pose revenue loss to the utilities.

In 2008, lighting accounted for approximately 30 percent of total residential electricity use, followed by refrigerators, fans, electric water heaters and TVs. Approximately 4 percent of total residential electricity used is for standby power. In 2009, the urban India had estimated number of 179 million fans, 28.3 million air coolers and 4 million air conditioners. By 2030, the numbers of fans are expected to grow to 527 million fans, 107 million air coolers and about 40 million air conditioners (10 times). This would mean an increase of 4-6 times energy for space cooling alone. Appliance penetration, particularly of refrigerators and air conditioning units, is expected to be the main driver for the growth of residential energy demand by 2020 (World Bank, 2008). Frequent power cuts and low quality of electricity occasional damage to the appliances that constrain the urban households.

2.5 URBAN GOVERNANCE

2.5.1 Urban Governance in India

History of Municipal Governance: Municipal Governance in India exists since 1687 with the formation of Madras Municipal Corporation and then Calcutta and Bombay Municipal Corporation in 1726. In early part of the nineteenth century almost all towns in India had experienced some form of municipal Governance. In 1882 Lord Ripon's resolution of local self-government laid the democratic forms of municipal governance in India. In 1919 Government of India act incorporated the need of the resolution and the powers of democratically elected government were formulated. In 1935 Government of India act brought local government under the purview of the state or provincial government and specific powers were given. (City managers Orissa, website 2012).

However, decentralization through the Constitution Seventy- fourth Amendment Act, 1992 (CAA) is considered to be a watershed development in urban policy initiatives in India. This is due to the fact that for the first time in the history of urban governance, the municipal bodies were provided the Constitutional Status of the third tier of government. It is however, well known that the local governments in India are confronted with poor finances, state control over local governance and multiplicity of agencies- often with overlapping functional and geographical jurisdictions. With the increase in responsibilities as a result of the devolution of eighteen functions mentioned in the 12th Schedule of the 74th CAA, empowerment of the ULBs became inevitable. Moreover, the decline in the budgetary support from the higher tiers of Government, as a result of the second generation of reforms that aimed at reducing state fiscal deficits, made devolution of powers to ULBs imperative. It took nearly two decades for decentralisation initiative after the second generation of reforms triggered during the early nineties (Bagchi & Chattopadhyay 2004). Still, some of the states have not devolved all the functions to the ULBs.

The institutional arrangement for municipal governance

and urban service delivery mainly comprises the Constitutional provisions, State Municipal Laws, role of State Finance Commission (SFC) and Central Finance Commission (CFC), and status of ULBs and parastatals (DEA, 2009). Under the Seventh Schedule of the Constitution, the state government has the exclusive domain of the Local government, including the constitution and powers of municipal corporations, improvement trusts, district boards, mining settlement authorities and other local authorities for the purpose of local self-government or village administration. The statutory urban areas have one of the following administrative bodies:

- Nagar Panchayats for areas in transition from a rural area to urban area;
- Municipal Councils for smaller urban areas;
- Municipal Corporations for larger urban areas.

The Census towns are administered by respective Panchayats, pending declaration as the statutory towns and formation of Municipalities. The 74th Constitutional Amendment Act (CAA) came into force in June, 1993, which sought to strengthen decentralization. The CAA devolved most of the urban management and planning functions to the ULBs (funds, functions and functionaries), but actual devolution across states show very high diversity. The CAA did not lay down revenue base for ULBs and the power to determine the revenue base continues to remain with state governments (DEA, 2009).

With the long history of state government's control over ULBs, the ULBs are typically weak in terms of finances, technical capacity and functional autonomy is only slowly taking root. The fragmentation and duplication of roles between many agencies exists resulting often unmanageable situations. Despite the devolution of the functions, the problem continues and is often aggravates due to lack of capacity of ULBs and expansion of the cities. In most states, the infrastructure development is still being managed by the parastatal (Urban development Authorities) and state departments.

FRAGMENTED AND OVERLAPPING ROLES IN MANAGEMENT OF URBAN SERVICES

In Bengaluru city, the water supply and sewerage is managed by the Bangalore Water Supply and Sewerage Board (a Parastatal Agency), while the storm water drainage is managed by the ULB. With the result, storm water and sewerage gets mixed up and causing the natural drainage carrying the sewerage during normal periods while during rainy seasons, the sewerage system overflows in to the streets with storm water. Also, this results in the sewage treatment plants not getting sufficient load to treat waste water. Similar cases are reported from many other cities across the country.

- TARU analysis 1994

Institutional arrangements for water supply and sanitation in Indian cities vary greatly. Typically, a state-level agency is in-charge of planning and investment, while the local government is in-charge of operation and maintenance. Some of the largest cities have created municipal water and sanitation utilities (parastatal) that are legally and financially separated from the local government. Tariffs are also set by state governments, which often subsidize operating costs. However, due to subsidization of services, the utilities generally remain weak in terms of financial capacity. In spite of decentralization, ULBs remain dependent on capital subsidies and capital investments from the state governments.

Role of Parastatal Agencies

The extent of devolution of powers from the state governments across the country has been quite diverse and a variety of parastatal agencies formed earlier to develop and manage urban infrastructure and services still continue to play major role in infrastructure development and service delivery. They mainly include Urban Development Authorities, Water Supply and Sewerage Boards etc. formed at state or at city levels. Also the State Public Works Departments and Public Health Engineering Departments continue to provide urban services and are in-charge of capital works in many states.

Most of the ULBs have their jurisdiction within the city boundaries with the peripheral areas controlled by the Urban Development Authorities, which develop plans, acquire land and develop housing, urban infrastructure, deliver lifeline services and sell the developed plots and buildings to the public. These bodies are often financially sound, due to the value addition they provide. In most of the cities, the urban development authorities also take up capital works within the city.

As the city grows, urban development authorities hand over the newly developed areas to the ULBs. One of the major complaints of the ULBs is that they are asked to take over new areas with partial infrastructure and services. The parastatal agencies and Town and Country Planning Departments were often responsible for developing master plans for area development, water supply and sewerage. With the result, multiple parastatal agencies often developed separate master plans for sectors/areas under their control.

MASTER PLANS TO CITY DEVELOPMENT PLANS

The pattern of demographic and economic growth, particularly in large cities, in the Post-Independence period was to be determined by master plans, often prepared by parastatal agencies with the support of the state government. This brought in physical planning controls on the location of economic activities and urban land use. In effect, this approach tried to limit the absorptive capacity of different areas. To an extent, it helped in diverting population growth, low-valued activities and squatters towards marginalised areas within large cities or their peripheries, creating select high-quality residential areas. The system of control, nonetheless, resulted in the contraction of land supply in the market, enormous corruption and a large number of court cases that ultimately constrained investments in infrastructure and housing. Master plans have thus come to be seen as deterministic and rigid, inhibiting the dynamics of city growth through land-use controls.

Given the difficult financial situation of the local bodies, it is unlikely that they will be able to strengthen their planning departments by recruiting technical and professional personnel in the immediate future. This assistance is unlikely to come from the state government departments since they too lack adequate professional staff or the resources to employ them. The only choice for the local bodies has, therefore, been to resort to financial intermediaries, credit-rating agencies and private consultants. A large number of such agencies have developed in recent years, a few with assistance from international organisations. The metropolitan cities with a strong economic base, state capitals and a few other globally linked cities have been able to take advantage of the new environment and prepared city development plans (CDPs).

Consequently, several metropolitan cities have prepared quick-fix CDPs or even vision documents, in place of master plans. Many of the vision documents represent a "manufactured consensus", having plenty of rhetoric and stipulations concerning environment, equity, social justice and so on. But they delineate only the broad contours of development strategy and the stakeholders are expected to work out the details within a participatory mode of governance.

Vision documents give no specific detail on, for example, the shifting of slums, access to basic amenities by the poor, or affordability. No definite indicator is worked out by which the fulfilment of the broad objectives or stipulations can be monitored. This undoubtedly opens the way for vested interests that get identified as stakeholder The slum dwellers inducted into the exercise of preparing the vision document often play a decorative role, largely because of their inability to understand the implications of the macro vision.

Extracts from "Trends and processes of urbanisation in India (Kundu, 2009)"

2.5.2 Challenges for urban governance in context of access to services

Urban growth over historical lag in services: The urban growth over the current backlog of infrastructure imposes major challenges to urban service delivery. Over these, the lack of technical, financial and managerial capacities of the ULBs to fill the growing gap in infrastructure and services further imposes very high burden on the citizens who have to invest on household and community level coping measures.

At household/building levels coping measures are resorted to overcome the poor access and quality services. Hoarding water by pumps, sumps and overhead tanks to overcome water supply uncertainties, use of inverters, and increasing reliance on the private transport are some of such measures. When these coping measures are aggregated at city level they become very inefficient use of space, investments and materials. Private sector also plays a coping support role through water tanker supplies and bottled water etc. Also, since the new housing and other development projects have to internalize these costs, the additional costs have to be borne by the prospective buyers of houses. While the household level coping measures alleviate some of the issues, at a city scale they often aggravate the scale of problems as the increasing traffic problems posed by growing private vehicle population or contaminated groundwater by septic tanks.

Improving the quality of services under the rapid urban growth environment over next several decades will pose major challenge in terms of management as well as environmental degradation. If not addressed, these issues can lead to violent protests and law and order problems especially during peak scarcity periods. Semi-organized protests have become common in

cities facing water scarcity. Such protests often lead to violence and further divert utility staff from scarcity management tasks. The public is often willing to pay, provided reasonable services are made available to them (confidence building measures may be required to overcome historic poor performance) and reasons for the water charges increases explained to them. Willingness to pay surveys are incapable of capturing the incipient demand since the potential users are not aware of indirect medium and long benefits of better services.

OPPORTUNITY COSTS OF DOMESTIC HELPER AND WATER SCARCITY

In Rahul Gandhinagar slum of Indore, most women work as maids and domestic workers in neighbouring middle-class colonies. Their working time is mostly mornings and evenings. Due to water scarcity and distribution problems, most of the women and children spend nearly two hours each day to collect water during the morning supply time. These women complained that they lose at least one domestic work job (one hour per day) paying about 100-150 Rs/month due to water scarcity. Even though most of the men initially refused to pay for better water services, the women were ready to pay for improved water supply. With a significant proportion of women pursuing informal sector work, opportunity costs have become higher.

Tariff to meet operational and expansion costs: While many other developing countries are able to provide 24 hour water supply, in most Indian cities, the number of hours of supply has significantly reduced over years. Metering system was abandoned and flat tariff system was introduced over the decades, with no incentives to control water use. In addition to health issues, lack of access to round the clock water supply has created several perverse incentives like elite capture and also created water markets often relying on the existing system itself.

While the users are actually investing on coping mechanisms and pay high costs to access the basic services, ULBs as well as state governments lack the willingness to increase charges since they fear backlash effect from their vote banks. Most of the water supply systems are unmetered and untargeted subsidy of water charges benefits the existing consumers since they have access and storage capacity on the same monthly fixed charge per connection. The poor either do not have any access or do not have sufficient storage to ward against intermittent supply.

Soft paths vs. capital works: The governments and ULBs often resort to building new infrastructure, without managing the existing infrastructure by reduction of system losses or theft in case of services like water supply and electricity. There are huge opportunities for recycling and reuse of resources like water, with demand focused end-use management. In large cities accessing distant sources requiring huge investments, options like reuse and recycling would reduce need for additional capital works to cater the existing and growing needs. Such soft paths for managing the utilities can save huge sums to the ULBs, while taking less time to improve the supply situation without resorting to long gestation period projects.

Even where the state has devolved these functions to ULBs fully, they do not have mandate to take up capital works. This is especially the case of water resources, where the cities have to depend on distant sources-located outside their jurisdictions. Also the financial autonomy of the ULBs to raise funds for capital works is limited due to their poor financial health.

Staff capacities and institutional memory: The poor financial health of the ULBs limit their ability to access higher quality staff, invest on technologies (IT, Water supply, sewerage, transport etc.) to manage more efficiently or to rehabilitate the poorly performing lifeline infrastructure. Most of the ULBs are unable to hire new staff, and the older generation, which was managing the essential services, is retiring. The locations of underground infrastructure, maps and other information about the infrastructure often don't exist, and the retirement of the old staff is leading loss of institutional memory to manage the services. One of the JNNURM mandatory reform conditions is implementation of city level GIS for infrastructure anon line taxation system, which the cities have been trying to implement with mixed results due to capacity constraints.

Informal and under-served enclaves: The urban growth is increasingly being driven by private sector, with diminishing role of ULBs to plan and manage spatial expansion. Since significant part of the urban expansion is taking place in peripheral areas, ULBs are often unable to control growth. These areas are mostly developed haphazardly without basic infrastructure networks laid out before expansion. Retrofitting

underground networks, laying storm water drainage and widening roads have become a challenge leading to bottlenecks. Also the existing peri-urban villages are allowed to densify without proper planning. These give rise to pockets of haphazard growth amidst of planned cities. These enclaves remain the continued challenges for the city managers as they are enveloped by growing cities. Even when built by large real estate companies, these problems remain and since their plans are not integrated with city level plans with insufficient connectivity with roads and water supply networks. Similarly, redevelopment of core areas with old infrastructure, slums, low income settlements in the core areas also suffer from inadequate and low quality provisions of services.

Technology absorption: The technologies for efficiently managing the resources and service quality are fast emerging and viable at city levels. The ULB's capacity to use them and afford these would determine their ability to provide satisfactory universal access to services. These technologies include recycling and reuse, energy conservation, GIS and IT enabled service management systems for water supply, and traffic etc. hold promises to enable much needed quantum jump in coverage and quality of services.

2.6 LEGACY-CURRENT CONTEXT-FUTURE OPTIONS

Challenges of Indian cities are a combination of legacy issues arising out of their historical growth, which are amplified by current context of urban development. They are unable to deal with them largely due to lag in decision making as well as inability to explore opportunities arising out of technological innovations in planning paradigms, management of services through developments in IT and other tools as well as lessons from other cities facing similar challenges. It is important to learn from legacy issues, since they provide lessons to ensure that current interventions or inaction does not lead to additional legacy issues in the future as the case of climate change shows. This framework helps in unbundling these challenges and explores opportunities to address them by incorporating new paradigms for managing the cities. The following Table presents a brief list of legacy issues, current context and opportunities.

Table 2.2: Legacy-Current Context and future options across sectors

Sector	Legacy	Current context	Future opportunities
DEMOGRAPHY	▪ Marginalised pockets without access to services ▪ Poor-immigrants without skills or education due to neglect of education and skill development in rural areas	▪ Mega polis with large number of emerging million plus cities	▪ A judicious mix of large, medium and small cities based on resources economy environmental carrying capacity
LIVELIHOODS	▪ Artefacts of old livelihoods (tailoring, shoe making etc.) with artisans unable to transform their livelihoods and growing down in socio-economic ladder	▪ Large enterprises depending on export of finished goods, service sector increasingly depending on global demand ▪ Rapid transformation amidst of manpower or investments on skill development	▪ Skill development relevant for urban areas through education and skill building efforts in both rural and urban areas

Sector	Legacy	Current context	Future opportunities
LANDUSE	▪ Extremely dense old traditional buildings without sufficient maintenance, Pockets of enclave villages with increasing density without build regulations. Slums in Urban sprawls created by single use planning and LRHD paradigm. Partly implemented master plans and encroachments. Illegal settlements not integrated with master plans	▪ Dense-core serving as de-facto mixed use/Business districts ▪ Regularisation of illegal settlements ▪ Low/medium rise Urban sprawls, Blockage of drainage by other landuse ▪ Encroachment of high value high risk zones(Flood plains) ▪ Severe land constraint high and skewed real estate prices	▪ Compact mixed use, ▪ Dedicated public spaces ▪ Respect for natural processes based on sustainability and risks
WATER SUPPLY	▪ Aged infrastructure of core areas without sufficient drainage and sewerage resulting in increasing water pollution. Narrow roads buildings over old infrastructure adding to constraints to add new infrastructure. ▪ Ad-hoc infrastructure with no maps ▪ Large distribution networks of various vintages/types ▪ Deeply rooted subsidy culture benefiting only served population constraining the decision makers from making water supply system economically viable	▪ Limited supply amidst of high UFW with little or no investments on reducing UFW ▪ Continued subsidies due to lack of political will resulting in high opportunity losses even to poor. ▪ Increasing per capita demand without incentives for reuse/saving ▪ Neglect of soft paths with continued focus on hard infrastructure ▪ Wastage of high quality water for low end uses ▪ Loss of trust leading to internalisation of risks/hoarding by large House/Building level storages/pumps/ground water ▪ Ineffective ground water control	▪ Universal access ▪ Minimising per capita consumption based on end use quality demand ▪ Dual water Systems ▪ Increased use of recycled water ▪ Matching local resources with demand/population
SEWERAGE AND SANITATION	▪ Decrepit infrastructure that cannot be upgraded due to space constraints ▪ Pollution from decentralised septic tank systems from un-served old peripheries enclave villages ▪ Direct discharge to water bodies	▪ Centralised system serving mostly core, with poorly maintained partial treatment of sewage, Individual septic tanks in periphery ▪ No/limited reuse of waste water and lack of incentives ▪ Lack of rules to prevent pollution from houses and lack of rules for peripheral development	▪ A mix of treatment at source for local reuse ▪ New technologies with energy generation & minimum sludge generation ▪ Use of treated lower water for gardening/construction/ Space cooling ▪ Dual water systems using low quality water

Sector	Legacy	Current context	Future opportunities
TRANSPORT	▪ Narrow roads in the core area unable to meet growing densities and economic activities ▪ Challenges of retrofitting of public transport corridors due to narrow roads	▪ Limited investments on public transport resulting in continued preference of private vehicles and traffic jams resulting in loss of opportunity costs ▪ Slow land acquisition processes for public transport corridors and lack of policies to enforce public transport corridors ▪ Lack of incentives/mechanisms for integrating para-transit with public transport ▪ Continued Single land use planning resulting in longer travel distances and travel times ▪ Knee jerk reaction investments on over bridges without scope for improving approach and exit roads ▪ Increasing travel time for significant proportion of working population ▪ Limited use of IT in enabling faster movement	▪ Mixed landuse based on access rather than mobility ▪ Dedicated public transport networks ▪ Origin to destination multimode systems through seamless public and Para transit solutions ▪ Intelligent transport systems
HOUSING	▪ Dense cores of unsafe and decrepit buildings with limited scope for retrofitting essential services ▪ Urban sprawls without sufficient services	▪ On-going process of building of gated communities and High rise buildings in periphery ▪ In house amenities built for high per capita resource consumption juxtaposed with growing number and density of slums ▪ Insufficient investments for providing universal access of lifeline services resulting in continued exclusion of poor ▪ No forward looking policies to improve housing in enclave villages	▪ Skyscraper dominated compact cities ▪ Intelligent building systems to optimise resource use ▪ Zero discharge townships built on lifecycle resource use minimisation
WATER RESOURCES	▪ Local resources	▪ Increasing reliance on distant resources amidst of growing conflicts in water deficit environment ▪ Inadequate of monitoring water quality and enforcement pollution control resulting in downstream pollution	▪ Optimal systems based on zero discharge minimising need for tapping of additional resources ▪ Extensive reuse and management of water quality of water bodies
SOCIETY	▪ Traditional rural communities dependant on primary activities. Coexistence of primary and livelihood based communities in urban environment often resulting in conflicts	▪ Inadequate investments on lifeline services and education/skill development resulting in exclusion of poor and urbanisation of poverty ▪ No conscious effort or incentives/ policies to transform primary activities dependent communities resulting in stress on transport, sewage and other sectors	▪ Inclusive society with global culture

Sector	Legacy	Current context	Future opportunities
INSTITUTIONS	▪ Patronage based/oligarchic systems, especially enclave villages and slums	▪ A mix of Democratic, oligarchy based system increasingly becoming soft state with loosening control ▪ Fragmented and overlapping roles of urban services departments creating ▪ Dominance of private sector with public institutions/planning process losing control	▪ Democratic society with e-governance and new institutions focusing on efficacy competitiveness and sustainability
ENVIRONMENT	▪ High pollution of water land and soils, especially core areas and drainage systems	▪ Large and increasing footprints impacting at global scale ▪ Inadequate mechanisms/rules to maintain public spaces green resulting in increasing urban heat islands ▪ Increasing imperviousness amplifying peak discharges without effective enforcement of rainwater conservation/ ground water recharge. ▪ Increasing ground and surface water pollution due to inadequate enforcement of pollution control ▪ Increasing risks of natural disasters, resource scarcity	▪ Reducing footprints by optimal use of resources, long term planning
ENERGY	▪ Legacy wiring systems old buildings that can increase fire risk	▪ Energy hungry systems increasingly dependent on Imported resources ▪ Mix of fossil fuel and electricity ▪ Local and regional air pollution ▪ Extensive replacement of human energy by household gadgets ▪ Increasing penetration of indoor environmental control	▪ Minimised energy use through efficient devices ▪ Recycling and combined use systems (waste recycling to energy) ▪ intelligent energy use optimisation combining local(waste heat, solar, wind) and distant energy sources
HEALTH	▪ Polluted ground water and continued use of unsafe water sources impacting health	▪ Increasing incidence of lifestyle diseases due to sedentary lifestyle and stress ▪ Inadequate focus on access to public health services, especially poor ▪ Inadequate sewerage resulting in continued pollution and public health issues ▪ Water/air quality related diseases	▪ Public health research for reducing disease outbreaks and strengthening of linkage between urban services and health ▪ Focus on pre-emptive control through extensive use of real-time-monitoring ▪ Early diagnosis/control ▪ Environmental control to reduce disease incidence

Table 2.2 offers opportunities for the cities to address the challenges through better governance and use of technologies. Considering the current institutional capacities and constraints, it may be necessary to involve civil society as well as private sector in facing these growing challenges across sectors. The framework enables unbundling these issues to understand the impacts of delayed decisions so that the city administrators can understand the consequences of lack of timely action in future by looking back at legacy issues being faced today.

2.7 URBAN GROWTH AND INCREASING RISK PROFILE

Most of the cities of the country have evolved from historic small towns formed along river banks, trade centres, administrative centres or army cantonments. At the time of their formation, pumping and long distance water conveyance technologies did not exist; local access to year round water was one of the main considerations for the formation and survival of these towns.

The technological as well socio-economic context of the cities have changed over time, resulting in discordance between the geo-physical, hydrological and landuse context. As these towns expanded, the new infrastructure like bridges and water supply systems based on distant sources were developed so that these cities could expand to sizes beyond their local resource base. Also, the cities expanded to both banks of the river, constricting the flood plains. To overcome occasional flooding, embankments were built which further constrained the natural flow and resulted in siltation of river beds. For improvement of water supply, barrages were built. The flood risks increased due to these anthropogenic changes in river hydrology. This has increased the flood risk of many river-bank cites like Delhi, Ahmedabad, Vadodara, Pune, Surat, Cuttack, Kolkata etc. Also the problems of inadequate storm water drainage and filling of traditional water storage reservoirs (which acted as buffers) within the city have increased the pluvial flood risks. The Restriction imposed by master planning process (e.g. low FSI limits) has led to increased house prices and has indirectly forced the poor to settle in peripheries marginalized areas like drainage lines and differentially higher flood prone areas with little or no protection.

Most of the cities are likely to expand over the next few decades and the risk profile is likely to change towards worse, unless the land use planning is informed by the changes in hydrology and climate variability issues. As mentioned earlier, the private sector and individual household led expansion of peripheral areas without developing regional infrastructure networks are likely to increase the risk profiles. It may be noted that this increase in risk profile is unrelated with the climate change.

2.8 URBAN CLIMATE CHANGE RISK

As reported in the earlier sections, Indian cities face challenges of scarcity of resources, inadequate and infrastructure and poor quality of lifeline services. A significant proportion of urban infrastructure is old and decrepit in the core city areas. These old infrastructure is still being used, since refurbishing or installing new infrastructure is nearly impossible due to very high densities and lack of space. Major changes in density and decongestion of the core to improve the services are politically unpopular and administratively challenging. Only in rare cases, the ULBs are able to decongest the old core and improve the services in the core areas

Climate change is likely to add additional stress on urban infrastructure and lifeline services, which will impact the residents in many direct and indirect ways. The urban climate change impacts can be classified in to following major classes:

1. Slow onset and unidirectional phenomenon e.g. sea-level rise or saline water intrusion in to coastal aquifers
2. Slow onset periodic phenomenon e.g. droughts, heat waves
3. Fast onset high intensity phenomenon affecting large number of people e.g. floods, cyclones etc.

The three main direct impacts of climate change on urban India would be disruption of life from floods, water scarcity and morbidity and mortality due to hot and cold waves. The coastal cities are also likely to face additional stress due to sea level rise and possible increase in frequency of cyclonic storms. These direct impacts can cause disruptions in urban

economy for days to weeks or months at a time. Some of the issues like water scarcity already exist due to rapid urbanisation and the climate change will only amplify these issues. The urban storm water drainage modifications have been causing water logging in areas earlier not known to be prone as in case of Powai area of Mumbai.

The main indirect impacts would include changes in vector borne diseases, seasonal stresses on energy systems due to temperature increase. Climate change impact water supply systems by unpredictable precipitation patterns and increased competition over limited resources by upstream use. Also, floods and other rapid events disrupt other infrastructure like electricity and transport, which can result in huge losses and take weeks to months to recover.

Even during normal times, due to access constraints, poor end up paying higher for the lifeline services, which reduce their capacity to invest on coping mechanisms. Climate change can impact the poor in many ways, including differentially higher risk exposure, limited accessibility to scarce resources like water, lack of coping systems like water storage/ cash, loss of wages due to disruptions, lack of community safety nets. Due to low financial buffers, duration for recovery is differentially higher than other SECs.

Vulnerability of households to climate change would depend on endowment of five capitals for different socio-economic categories under livelihood framework. For urban households, human financial, physical and social capitals are most important from the capacity perspective, while the role of natural capital is more indirect. It is desirable to look at these capitals through the lens of accessibility-equity-quality-diversity. This is essential as the mere existence of these capitals does not imply their actual availability for use. For instance, piped water connections may be physically inaccessible to the residents of a slum; transport infrastructure may be unevenly distributed; electricity services may be irregular or of poor quality; and there may be little diversity of food and other goods. Moreover, rising temperature or delayed rainfall are expected to exacerbate scarcities of water, food, or energy bringing issues of distribution, equity, and purchasing power to centre stage (Kelkar et.al 2011).

2.8.1 Water Scarcity

One of the most important impacts of climate change would be the accessibility of water to residents. Urban systems have their water footprints much larger than the city limits. Many cities have their water sources located far way and water supply. With the result, the residents have no control over the water sources, except for local sources, like ground water, which is often polluted due to poor sewerage systems or leaking septic tanks.

Climate change is expected to change the availability of water to the cities and especially to the poor. Beyond water's functions in the hydrological cycle, it has social, economic and environmental values, and is essential for sustainable development. Unprecedented population growth, a changing climate, rapid urbanization, expansion of infrastructure, migration, land conversion and pollution translate into changes in the fluxes, pathways and stores of water – from rapidly melting glaciers, saline water intrusion in to rivers and aquifers and decline of groundwater due to overexploitation.

Population density and per capita resource use have increased dramatically over the past century, and watersheds, aquifers and the associated ecosystems have undergone significant modifications that affect the vitality, quality and availability of the resource. The United Nations predictions estimate that the world population will reach 9 billion people in 2050. This exponential growth in population – a major driver of energy consumption and anthropogenic climate change – is also the key driver behind hydrologic change and its impacts (UNESCO 2011).

Water scarcity is increasingly being posed as a development challenge for many countries, particularly in urban areas (Saleth and Dinar, 2004). It is forecast that by 2050, the urban population of India will constitute 50 percent of the country's entire population and will be confronted with serious water problems exacerbated by the effects of climate change (Singh, 2000). Consequently, planners and policy-makers are increasingly coming under pressure to optimize the current use of water and to develop innovative solutions for sustainable water augmentation and management in the long term (Sarangi, 2010).

The effect of climate change on stream flow and groundwater recharge varies regionally and between climate scenarios, largely following projected

changes in precipitation. Water resource management techniques, particularly those of integrated water resource management, can be applied to adapt to hydrologic effects of climate change, and to tackle additional uncertainty. Currently, supply-side approaches (e.g., increasing flood defences, building weirs, utilizing water storage areas, including natural systems, improving infrastructure for water collection and distribution) are more widely used than demand-side approaches (which alter the exposure to stress); the latter is the focus of increasing attention. However, the capacity to implement effective management responses is unevenly distributed around the world (IPCC Working Group II, 2001).

Climate change risk is expected to increase the frequency and intensity of current hazards, an increased probability of extreme events, spur the emergence of new hazards and vulnerabilities with differential spatial and socio-economic impacts. This is expected to further degrade the resilience and coping capacities of poor and vulnerable communities, who make up from a quarter to half of the population of most Indian cities (Satterthwaite, 2006). Hundreds of millions of urban dwellers in the Indian cities are at risk from the direct and indirect impacts of climate change. In July 2005, Mumbai, India, was struck by cyclone that dumped 94 centimetres of rain in 24 hours, and leaving more than 1,000 dead, mostly in slum settlements (Sherbinin et al, 2007). This event underscores the vulnerability to climate hazards faced by urban poor in Indian cities.

Climate change will bring changes in the pattern and trend of temperature, precipitation, climate hazards in the urban areas. An important challenge for India is to reduce the risks of climate change and enhance the resilience of cities. The increasing population in the urban areas of India will further complicate and make the task of reducing vulnerabilities to climate change more challenging. Over the early 21st century, estimate is that an almost equal number of people will live in about 0.6 million villages as in 12-15,000 towns and cities 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 (50 million), the National Capital Region of Delhi (over 30 million) and Kolkata (20 million) will be among the largest urban concentrations in the world (Revi, 2006, Census, 2006). Without effective adaptation to climate change there will be very serious consequences for the most people residing in the cities in India.

All the population in the urban areas will not be equally vulnerable to the impacts of climate change. People with high adaptive capacity will be less vulnerable but people who are most vulnerable are the urban poor, slum dwellers and low income category population. These populations have less adaptive capacity to deal with the impacts of climate change because of poor governance; the lack of investment in infrastructure and in the commons; and strong connections between the political class, real estate developers and public agencies (Revi, 2008). Recent research highlights an urgent need to improve our understanding and action on climate variability and adaptation in urban areas as an urgent priority, particularly where poverty levels and population growth rates are highest (Huq et al, 2007b)

Source: Panda, 2011

Climate exigencies such as droughts can lead to increased groundwater pumping or investment in new surface storage, which have long-term hydrologic effects. Increased uncertainty in climatic outcomes-and hence to the renewable freshwater supply-can change the investments and use of regional water resources. Increased flood magnitude and frequency can translate into changes in sediment fluxes and the mobility of biological and chemical pollutants, as well as in investment in flood control works which, in turn, impact future sediment and residence times (UNESCO 2011).

3

FUTURE SCENARIOS OF URBAN INDIA

The economic growth of last two decades had an immediate consequence on urbanisation; there has also been great pressure on infrastructure and resources like water supply, energy, public transportation, land, etc. The ULBs and other para-statal agencies responsible for delivery of basic services are facing stiff challenges in catering to this demand. It is projected that Indian urban population will reach a figure of 600 million in 2030 (HPEC 2011), an increase of 223 million of population over next 20 years. Most metropolitan boundaries are expanding; it is difficult for the increases in geographical area to keep pace with population growth.

Already the number of metropolitan cities/UAs with population of 1 million and above has increased from 35 in 2001 to 53 in 2011(45 cities: 1-5 million; 5 cities: 5-10 million, 3 cities: 10 m+). The MGI report projects that by 2030, 68 cities with more than 1 million population out of which 13 cities with more than 4 million and 6 mega cities (10 m+). Mumbai and Delhi will be among the 5 largest cities in the world. This trend exerts enormous resource pressure in the neighborhood of those 68 cities, unless water and other resource conservation through better infrastructure and services are commissioned.

India, with its relatively young population, is expected to derive the demographic dividend, during this period. Despite reduction in decadal population growth (17.64% in 2001-2011), the India has large share of below 20 years age group, which is going to shift towards 20-30 age group in 2030 and India is expected to reach a higher working-age ratio than ever seen in East Asia (Bloom 2011). The 20 to 60 age population will increase from about 649 million to 848 million persons (increase of nearly 200 million) in 2030.

The urban areas are already suffering from inadequacy and inequity in access to basic services. For example, water supply today is beset with problems relating to coverage, quality, poor operation and maintenance and sustainability. To provide 135 lpcd of water, cities like Delhi, Bangalore Hyderabad, Chennai, Indore etc. are already exploiting sources more than 70 kms. away. The on-going tussle between Uttar Pradesh, Haryana and Delhi on sharing Ganga and Yamuna waters, interstate disputes over Kaveri waters and the violent conflicts over sharing water from the Bisalpur dam between villagers and the city of Jaipur may be precursors to more such disputes in the future (Google sites-waterexcreta website, 2012).

> The current paradigm requires cities to source water from further and further away. Delhi for instance, is presently sourcing part of its water supply from a distance of 500 kilometres from Tehri dam. This undeniably adds up to the cost of treatment and delivery of water. It also leads to increased inefficiencies in supply, which further cripples water supply in our cities. Firstly, as the cost of supply and delivery is high, the state can afford to supply water to only a few and not all in cities. This makes problems of inequitable access acute within cities. Secondly, the political imperative results in cities not charging its users for water supply. This in turn, leads to increased wastage and inefficiency. The burden on public utilities, in this manner, keeps mounting. But it is important to understand that even if public agencies were to do full cost pricing – charge users the cost of water supply and waste disposal – most cities would be incapable to meet up the incremental costs. This is because the current capital-intensive technological model adopted by cities of the South requires huge investment in supply and treatment of water and waste. But the answers and alternative paradigms for sustainable urban cities are more difficult to find.
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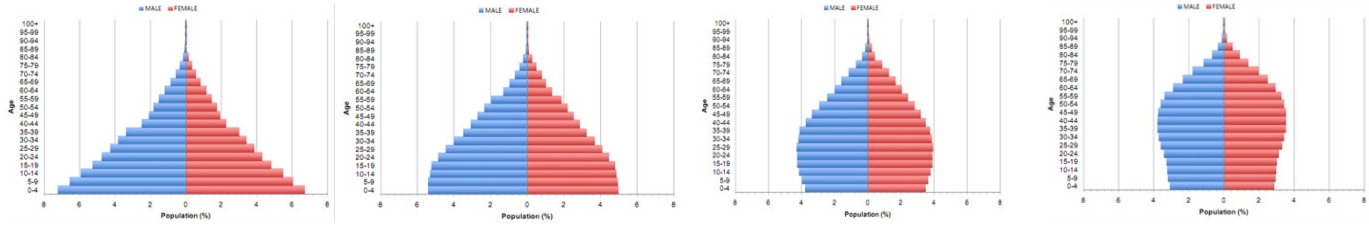
> *Google sites-waterexcreta website, 2012*

Figure 3.1: Age structure in the Indian Demography (1990 to 2050)



Source: Bloom 2011, UN population projection (2009)

With agriculture and other primary activities unable to absorb any new labour, urbanization will be led significantly by push migration of rural people in search of better work / earning. The skill set of these migrants vs. demand would determine the urban poverty situation of the future. With increasing mechanization and automation of most urban activities, the skill poor migrants may not be able to earn enough. Depending upon the urban reforms, financial prudence and targeting subsidies, investments on infrastructure, regulation of private transport and scenarios of urban India can be visualized as:

1. Improved housing vs. Housing problems
2. Compact cities vs. Urban sprawls
3. Public transport led growth vs. Traffic jams and pollution
4. Water conservation and reuse vs. Perpetual water scarcities and rural-urban water conflicts
5. Unending demands for civic amenities like roads, transport, markets, etc.

URBANISATION AND ECONOMIC DEVELOPMENT

Despite equivocation, it is clear that urbanization and economic development are intimately related, and the concentration of resources—labour and capital—in cities is a part of this process. To the extent that these movements are the sensible response to market signals about scarcity, there is no reason for concern about the size of any city or the size distribution of cities in general. To the extent that external effects—pollution and congestion, for example—are unpriced in cities, conurbations will be too large, but not by a lot. Public concerns about pricing congested roadways and about water supplies and public health investments to decrease the chances of epidemic are well-placed; from this perspective the concern with urban slums per se is less important.

Urban poverty is not an excuse for policies limiting the extent of urbanization in low-income countries. Increased urbanization certainly facilitates the development process, and explicit policies to discourage urbanization are surely misguided.

Source: IBRD (2008)

3.1 POPULATION GROWTH AN URBANIZATION

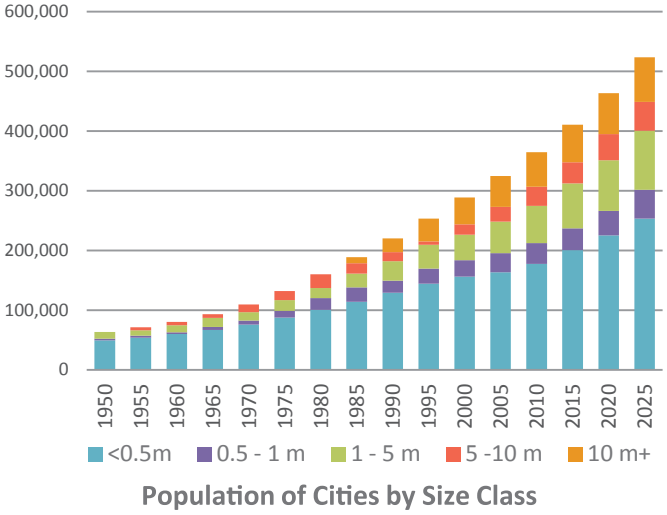
3.1.1 UN projections

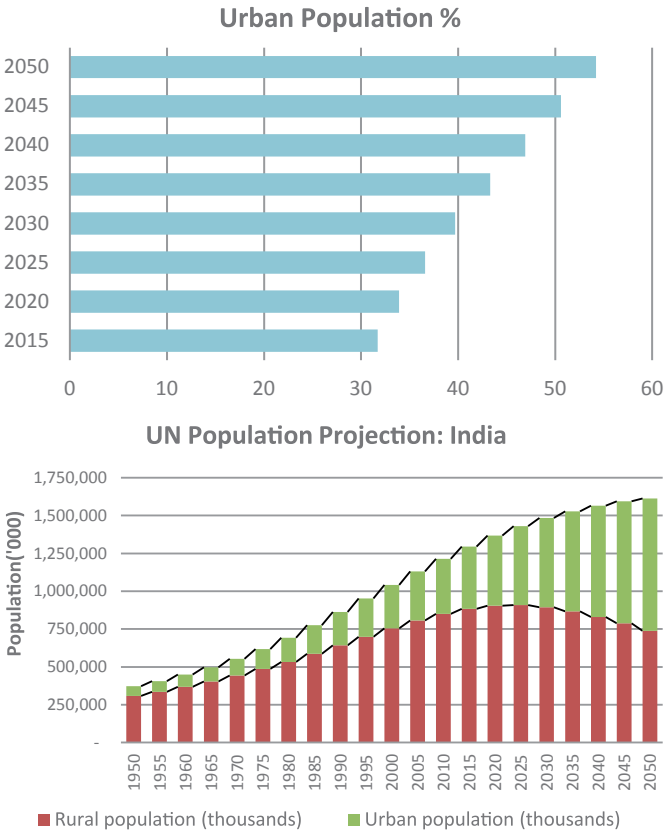
India's projected population in 2050 is estimated to be 1.6 billion with urban population projected to be about 875 million in 2050. While the annual urban growth rate is likely to remain above 2% up to 2040, the rural population is expected to peak at about 900 million 2025 and then start shrinking. The share of urban population is projected to reach 54% in 2050. By 2016, the population of India (1.22 billion) is expected to be larger than the population of all the more developed countries combined (that is, all the countries of Europe (including Russia), Australia, New Zealand, Japan, Canada and the United States)

The working age population (15-64 age groups) will increase from 0.8 billion to 1.04 billion by 2030 and finding employment for this population is going to be a major issue that is further discussed in MGI report.

In 2025, Tokyo is projected to remain the world's most populous urban agglomeration, with 37 million inhabitants, although its population will scarcely increase. It will be followed by the two major megacities in India: Delhi with 29 million (21 million as UA including Gurgaon, Faridabad etc. in 2009) inhabitants and Mumbai with 26 million (19.7 million in 2009), both expecting important population gains. China and India together projected to account for about a third of the increase in the urban population in the coming decades. (United Nations 2009)

Figure 3.2: UN Population highlights





Source: UN Population data

Implications on Livelihoods: The arable land available for rural households is likely to shrink to about 0.86 ha per rural household by 2025. With limited landholdings, sustaining rural population with primary activities would become unviable. This means that the current rural employment guarantee schemes aimed at creating and sustaining rural livelihoods may need to be refocused. Also education relates schemes also need to refocus on ensuring employable skills suitable for urban areas. It also has to be noted that, the secondary activities are also going to shrink with mechanization and automation as seen in production as well as construction sector Human labour component per unit value addition from secondary sector is already shrinking and the trend is likely to continue and accelerate. The composition of demand for tertiary sector can also be expected to change with increased demand for high skilled persons.

By 2025, nearly half the urban population is expected to reside in cities more than 0.5 million population and 42% in the million plus cities. With the current planning paradigm continuing, water scarcities, traffic jam etc. will be major challenges in urban areas. In semi- arid and arid areas, water scarcity can aggravate by droughts. Droughts can trigger domino effect on electricity and other sectors as exemplified by 2012 regional electricity black-out across Northern and Eastern India.

Inadequate storm water drainage can result in floods and water logging in flat terrains, even in upper catchment areas as the case of Indore and Pune shows. The annual mean rainfall across the 53 million+ cities shows that nearly half (27) cities lie in arid and semi-arid areas.

Figure 3.3: Annual rainfall across million plus cities

Annual rainfall Across Million plus cities				
Rainfall	Population size class (2011)			All
	1-5m	5-10m	>10m	
<500 mm	1			1
500-700mm	5			5
700-1000m	16	4	1	21
1000-1500	15	1		16
1500-2000mm			1	1
>2000	8		1	9
All	45	5	3	53

Source: Worldclim website, Census 2011

By 2030, three Mega cities are likely to account for 74 million people, six 5-10 million size cities will account for 48 million people (average 8 million/city) and 54 cities with 1-5 million population will account for nearly 100 million people (avg. 2 million/city). This would mean that there would be concentrated point demands for water and energy from nearly 63 cities (million plus) across India.

3.1.2 MGI Economic and urban projection

Mckinsey Global Institute (MGI) published a report "India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth" based on econometric model. This report does not address the issues of natural resources to meet the growing demands. Unlike other countries of Asia and most of the world, which are grappling with aging population and rising dependency ratios, India has relatively young and rapidly growing

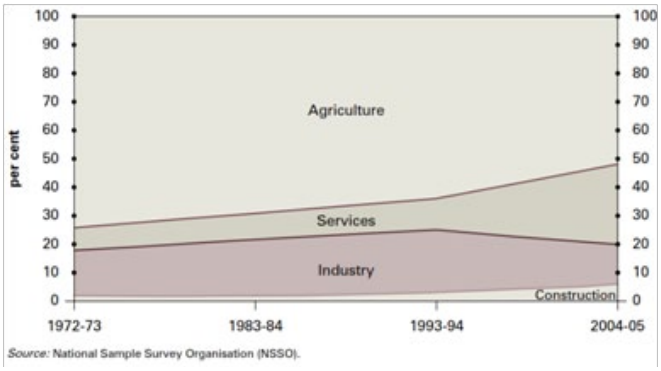
population- a potential demographic dividend. The demographic dividend is conditional on higher literacy and skill levels. India will have largest growing work force for the next 20 years, as about 270 million Indians will join the net working age population between now and 2030.

During 2010-2030, urban India is expected to create 70 per cent of all new jobs in India and these urban jobs is expected to be at least twice as productive as equivalent jobs in the rural sector. If this demand is not met, both urban and rural areas are likely to face serious employment crisis. Such crisis is expected to reduce the affordability of services among people leading to poverty in these areas. Finding jobs for these new workers is the country's great challenge and a major part of the answer probable lies in urban India. Sectoral policies and new investments will be necessary to create jobs for these additional workers. Under a base-case estimate of annual GDP growth of 7.4 %, cities will continue to attract the majority of new investments.

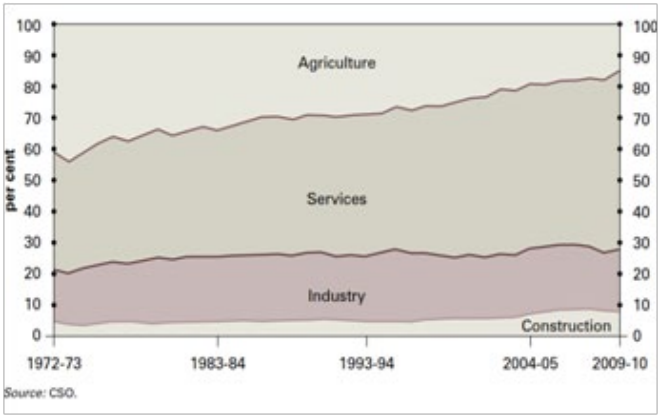
MGI's analysis suggests that rural employment can grow at less than 0.6% annually at best-moving from 330 million to around 380 million, a net addition of less than 50 million jobs. Considering the already low per capita land, any addition in rural employment is difficult to achieve. This is one of the reasons for rural employment guarantee Schemes to reduce rural to urban distress migration. Agriculture was still employing about 50 percent of the labour force, but accounts for only 17% of GDP in 2004-5.

Figure 3.4: Change in Share of employment and GDP by sector over 1972-2004

Share of employment



Share of GDP



Source: HPEC 2011, NSSO, CSO

MGI assumes an 8.0 percent annual GDP growth rate between 2009 and 2018, stabilizing to 7.0 % between 2018 and 2030. From 2008 to 2030, therefore is averaging annual GDP growth of 7.4 %. The report notes that India's needs GDP growth rate close to 10% a year to create enough employment for the nation's young and growing population.

Cities would allow for interactions that promote productivity, one of the underlying drivers of economic growth. Also, scale benefits offered by cities -in India and around the world- offer the opportunities to significantly lower the cost of services delivery. This is particularly relevant for a country like India, which now faces a significant challenge of rapidly ramping up basic services to a very large section of its population when funds are constrained (MGI 2010).

3.1.3 HPEC Report 2011-Urban Infrastructure

The transition to urbanisation places cities and towns at the centre of India's development trajectory. In the coming decades, the urban sector will play a critical role in the structural transformation of the Indian economy and in sustaining the high rates of economic growth. Only 30 percent of India's population lives in urban areas. This is much lower than in China, Indonesia, South Korea, Mexico, and Brazil. Some of this may be due to much lower per capita incomes in India.

Cities and towns of India today are visibly deficient in the quality of services they provide, even to the existing population. Considering that the Indian economy is

now one of the fast growing economies in the world, and demand for higher quality standards are rising, current service levels are too low relative to the needs of urban households. They are also low relative to what will be required to sustain the economic productivity of cities and towns. The scarcity of affordable housing drives the poor and some non-poor to slums. On an average, 25 percent of the population in Indian cities lives in slums; in Greater Mumbai, slum dwellers account for 54 percent of the total population. Not all slum dwellers are poor, and the complexity of these challenges is reviewed in the context of urban planning, infrastructure development and public service delivery for all.

The challenge of urbanization in India is of ensuring basic and lifeline service delivery at the enhanced minimum. This is particularly so in a situation when even the current urban population is inadequately served and total urban population is likely to increase by at least 250 million. The cities of India will have to provide a receptive environment for innovation and productivity enhancement, which can foster faster growth of the Indian economy and make room for larger migration from rural areas to higher-productivity sectors in urban areas. Government policies will have to address the challenges of an abysmal state of public services in Indian cities and towns.

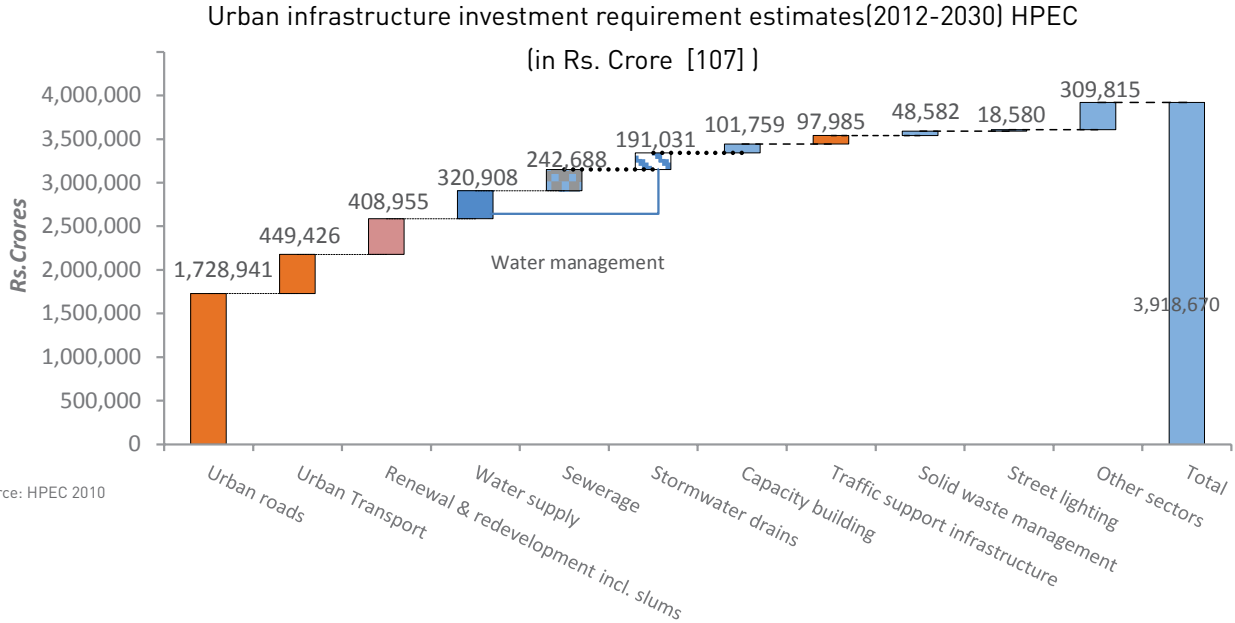
The investment required for urban infrastructure over the 20-year period is estimated at Rs. 39.2 Trillion Rupees (or Rs. 39.2 lakh Crore or 0.78 trillion USD) at 2009-10 prices. Of this, 44% is required for urban road development alone. The backlog for this sector is very large, ranging from 50 percent to 80 percent across the cities of India. It is not clear if these investments can be reduced by paradigm shift towards public transport. Sectors delivering urban services such as water supply, sewerage, solid waste management, and storm water drains will need about 20 percent of total investment. The Committee has made explicit provision about 10% for renewal and redevelopment including slums.

One of the major concerns faced in everyday life is water scarcity. The HPEC estimated investments required to address these basic needs is only 19% of the total investment, which needs to be given top priority.

As per the HPEC estimates, annual investment requirements are of the order of Rs.116,000 Crores in 2011, Rs. 330,000 Crores in 2021 and Rs. 732,000 Crores in 2031-32. Compared with this, the JNNURM investment was only Rs. 12,887 Crores (about 10% of requirement) for 2009-10. These figures indicate that financing from other sources like international finance needs to be explored, if satisfactory urban infrastructure can be provided.

Increasing tax revenues combined with rational user charges will enable cities to leverage their own resources to incur debt and also access new forms of financing through public private partnership (PPP). Also, real cost based pricing would incentivise the users

Figure 3.5: Urban infrastructure investment requirement estimates (2012-2030) HPEC



Source: HPEC 2010

to conserve water and other resources. The ULBs need to be strengthened with their own sources of revenue, formula-based transfers from state governments, and other transfers from the Government of India to help them discharge the larger responsibilities assigned to them by the 74th Constitutional Amendment. Only then, they can augment the urban infrastructure base, provide improved quality of services on a sustainable basis to all citizens, and contribute to the growth momentum of the Indian economy

Hierarchy of needs

The hierarchy of needs paradigm accords first priority to basic services of water supply and sanitation facilities followed by housing, transportation etc. The HPEC's waterfall diagram of investment shows that the most basic services of water supply only require a small fraction of total investments. The hierarchy of needs paradigm may be best suited prioritize investments in the investment scarce environment.

3.2 FUTURE RESOURCE CHALLENGES

Water and energy are two most critical resources for urban metabolism. While energy in its various forms can be transported from larger distances, water sources have to be available within short distances due to capital and recurring costs of conveyance.

MAJOR ISSUES OF WATER URBAN WATER SUPPLY IN ASIAN CITIES

The Asian development Bank highlighted following major challenges in urban water supply sector:

- Partial coverage of the urban population
- Rapid urbanization
- Interrupted supplies
- High nonrevenue water
- Non-potable water
- Lack of asset management
- Low tariffs that hamper connections for the poor

There are many reasons why cities struggle to provide clean and reliable water supplies to their residents, including physical scarcities of water, lack of availability of investment funds, unwillingness of authorities to charge poor consumers for water, and the lack of capacity of service providers in the public sector. All are symptoms of the fundamental reason for these problems, which is inadequate leadership and governance.

The global water crisis is, in fact, a crisis of governance.

Source: ADB

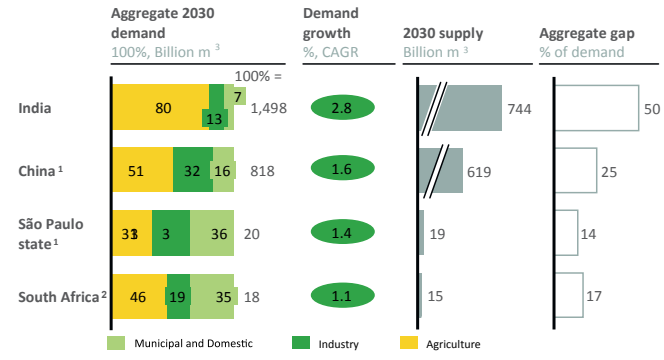
In water scarce country like India, where per capita annual renewable water resources availability had reduced to 1673 cum (WRI Website). It is expected to reduce further, with several areas facing differentially higher scarcity levels.

2030 WATER SCENARIO

By 2030, demand in India will grow to almost 1.5 trillion cum, driven by domestic demand for rice, wheat, and sugar for a growing population, a large proportion of which is moving toward a middle-class diet. Against this demand, India's current water supply is approximately 740 billion cum.

As a result, most of India's river basins could face severe deficit by 2030 unless concerted action is taken, with some of the most populous—including the Ganga, the Krishna, and the Indian portion of the Indus—facing the biggest absolute gap.

Base-case demand, supply, corresponding and gaps for the regional case studies



1 Gap greater than demand-supply difference due to mismatch between supply and demand at basin level
2 South Africa agricultural demand includes a 3% contribution from afforestation
SOURCE: 2030 Water Resources Group

Source: Charting Our Water Future: Economic frameworks to inform decision-making (2030 Water Resources Group)

The Ministry of Water resources and National Commission on Integrated Water Resources Development estimates indicate that drinking water needs of India alone are likely to nearly double by 2050 compared to 2010. With urban population growing from 33% to nearly 50% during that period, most of the demand increase is likely to occur in urban areas in a diverse water scarcity environments.

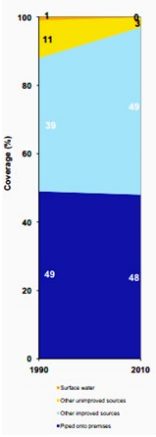
Figure 3.6: Water Requirements for Various Sectors in 2025 and 2050

	Water Demand in Km³ (or BCM)					
	MoWR 2000			NCIWRD 1999 Year		
Year	2010	2025	2050	2010	2025	2050
Irrigation	688	910	1072	557	611	807
Drinking Water	56	73	102	43	62	111
Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	11
Total	813	1093	1447	710	843	1180

Source: Report of the Working Group on Water Resources for XI FYP (2007-2012) Data from Ministry of Water Resources, GoI

Urbanisation is expected to lead to high points demands beyond the resource availability at diverse geophysical environments ranging from arid to per-humid regions. With urbanisation alone significantly increasing demands, climate change is likely to add further pressure on the resources.

> "Modelled results show that currently 150 million people live in cities with perennial water shortage, defined as having less than 100 L per person per day of sustainable surface and groundwater flow within their urban extent. By 2050, demographic growth will increase this figure to almost 1 billion people. Climate change will cause water shortage for an additional 100 million urbanites."
>
> *- McDonald et al, 2011*



In Indian urban areas, the persons having access to tap water was only about 73% as per the 2007 estimates of Planning Commission. Other estimates like Joint Monitoring Programme report of UNICEF and WHO based on District level health Surveys indicate that across urban India only about 67.1 percent of Urban India have access to tap water supply (47.8 percent with household connection & 19.3 percent access to public taps), while and other safe sources (mainly groundwater) accounted for 49% of urban households.

The National sample Survey data (2011) indicates that there is still large gap in safe water supply in urban areas, which is especially important since most of the ground water in urban areas suffer from quality problems due to inadequate sewerage as well as contamination of even tap water due to percolation of sewage from decrepit sewage systems.

Table 3.1: Access to Drinking water from various sources in urban areas

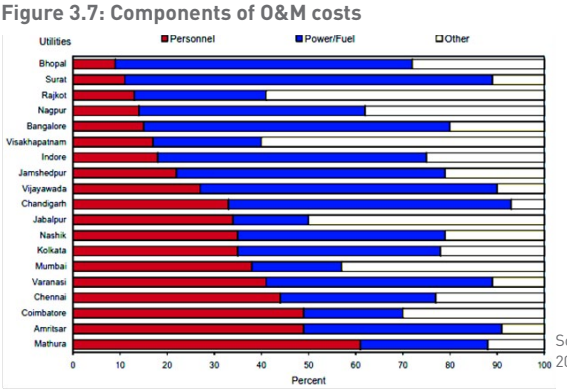
Major source of drinking water	49th Round: 1993 (%)	58th Round: 1998 (%)	65th Round: 2009 (%)
Bottled water			2.7
Tap	70.4	73.6	74.3
Tube well/ Hand pump	18.5	19.6	17.5
Wells	8.6	5.1	3.3

Source: (NSSO 2010)

The above data sets highlight the lack of uniformity in data. Also considering the NSSO 2009 figure, existing gap in tap water supply is about 80 million urban residents. Considering an average of Rs. 3,350 Rs/ capita capital costs for tap water supply, an investment of Rs.267 billion is necessary to overcome the current gap in water supply. However, the National Mission on Sustainable Habitat estimates the safe water supply gap as only 9% of the urban population. These diverse estimates point to need for more stringent definitions of "safe water supply" as well as systematic data collection and corrective measures.

Most of the JNNURM city development Plans have highlighted the need to augment supply, without detailing distance from sources and implications on recurring costs in terms of energy and running costs. As the distance increases, the cost of building and then maintaining the water conveyance and its distribution network increases (Planning Commission 2010). Most of Indian cities spend anywhere between 30-50 percent of their water supply O&M costs for electricity to pump water (ADB 2007).

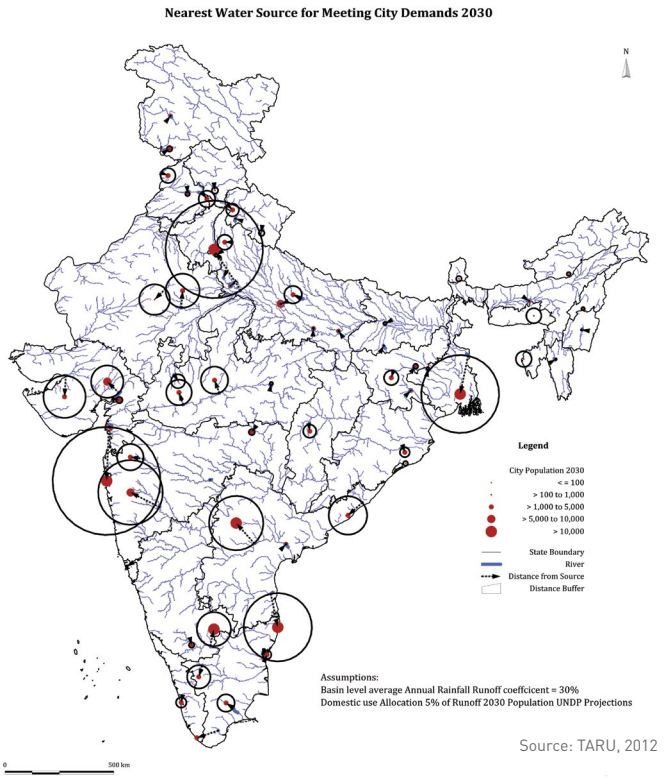
Figure 3.7: Components of O&M costs



Source: ADB, 2007

TARU used a model for estimating the distance from which water need to be transported to meet the water city water demands of projected population (Year 2030). This model assumed 30% of average rainfall as runoff coefficient and 5% of the renewable water resources allocated for domestic consumption from nearest available sources. The demand was calculated with 135 lpcd for 2030 city population. The largest 56 cities of 2030's will have a population of 233 million and would require about 11.496 billion cum of water annually to meet domestic needs. The distances between sources and cities are shown in the following Figure 3.8.

Figure 3.8: Distance from sources



Source: TARU, 2012

Most of these cities have to depend on resources which are already being used by other users and conflicts are bound to result due to growing demands, especially in the semi-arid and arid areas. Also, long distance water conveyance would increase dependency on energy, which is likely to become a bottleneck in already energy and water hungry India. Energy and material needs of these cities will also need allocation additional water resources for thermal or nuclear power stations.

> "Governments should realise the potential of urbanisation to reduce material consumption and environmental impact through efficiency measures. The well planned provision of water supply, waste disposal, power and other services will avoid slum conditions and increase the welfare of inhabitants."
>
> *- Recommendation 5, People and the planet (Royal Society, 2012)*

Cities provide opportunities for more efficient water and energy use due to economy of scale as well as concentrated demand. Possibilities of waste reduction, efficiency improvement, recycling and reuse exists in both water and energy sectors. Investments and long term planning would be necessary to improve overall use efficiency supported by improved governance and use of Information technology for city level management of these scarce resources as well as participation of citizens in water conservation. Also, a mix of decentralized and city level options need to be explored so that local solutions for water supply, sewage treatment and recycling can happen at colony/ neighborhood levels also. This would necessitate strengthening of settlement level organizations like Resident Welfare Associations and ward committees.

3.3 INFRASTRUCTURE CHALLENGES

The cities of India are already facing stress on existing infrastructure as well as lifeline services due to historical lag in investments amidst of growing population. The JNNURM investments were only able to reduce the stress to some extent. Growing pace of urbanisation, redundant land use planning and development control regulations and other policies have only exacerbated the stress as evident by continued expansion of urban sprawls due to low FSI rules (LRHD paradigm) resulting in higher capital costs of infrastructure to serve the expanding cities.

Even though most of the cores of Indian cities were compact and over-crowded, they hardly had sufficient conventional infrastructure and lifeline services. Donut shaped concentric urban sprawl developed due to growing urban population, without pre-built infrastructure, often limited by basic natural resource scarcity. Now a change towards the compact city with sufficient infrastructure would require radical change in land use on already built up spaces, high investments to meet concentrated demand on water, energy and transport.

The infrastructure building as well as expansion of services network could not keep pace with the urbanisation as well as increase in per capita resource use due to changing aspirations of the residents. This

has led to reduction in per capita availability as well as access to services over last several decades. The cities have neither financial resources nor capacity to expand the infrastructure and lifeline services, nor were they able to leverage investments due to the limited autonomy.

The following challenges have to be addressed to retrofit the cities to make them provide lifeline infrastructure to all.

- Bringing together different stakeholders for paradigm shift in
  - Urban planning towards sustainability and resilience building including
    - — Integrating land use and service networks
    - — Matching demand and supply of resources(water, land, energy etc.) under evolving urbanisation and climate change environments
  - Unified management of resources, infrastructure and services at city level
  - Inclusive growth and universal access along with cost recovery at city level
  - Devolving roles to neighbourhoods/ communities as well as partnership models, wherever viable.
  - Shift towards more intensive use of public services, especially in transportation to reduce need for augmentation of infrastructure
- Leveraging investments for infrastructure building, under stressed and subsidised cost recovery environments
- Integrating efficiency improvement (including usage efficiency improvement, loss reduction, reuse etc.) along with augmenting sources of water and energy
- Decongestion and allocation of Space for common infrastructure especially the road network and in core city areas under very high land price situation.

3.4 GOVERNANCE ISSUES

The JNNURM provided an opportunity for implementing some of the important urban reforms envisaged in the 74th Constitutional amendment. However, the pace of actual implementation of reforms is quite diverse across the states. The Urban Local Bodies continue to depend on the central and state funds for not only meeting the capital costs of infrastructure, but also for maintaining the services due to high subsidies. The ULBS are still incapable or not empowered to fix tariffs due to a mix of administrative as well as political challenges.

Performance incentives need to be underlined, especially since the service level benchmarking efforts have been initiated under JNNURM. With very limited data availability, performance metrics are difficult to design and implement under prevailing overstressed and decrepit infrastructure and monitoring systems. Three major options exist for improving the efficiencies in service delivery. They include extensive use of technologies (automation, monitoring, management etc.) to increase efficiency of the staff and resources, private public partnerships for selective management of infrastructure & services and increasing staff strengths to match the growing city population.

Some efforts have been done under JNNURM in organizational restructuring to improve efficiencies, but without radical revamping of the system and extensive use of technologies in all sectors, no major changes are possible. The city administration is constrained by financial and capacity bottlenecks that limit possibilities for major restructuring efforts.

Duplication and fragmentation of roles between different institutions in control of resources, management of infrastructure and services currently constrain the urban system management.

These roles are spread unevenly spread across ULBs, para-statal organizations and the state governments resulting in inability of any agency to manage even simple services autonomously. This especially felt in meeting the energy and water demands, especially in peripheral areas. Coherent action among policy makers, regulators and implementers and other stakeholders is another issue limiting the urban planning and management. Generic policies recommended by the central government are often cannot be contextualized and local policy making mechanisms are weak due to capacity constraints at the city levels. This is especially true in case of master planning process as well as building rules, especially cities located in risk prone and resource scare environments and facing challenges of high growth. Successful models for direct stakeholder involvement starting from settlement levels are yet to emerge, even though it is highlighted in 74th CAA and some of the states have enacted rules for community engagement, but these efforts are in early stage of evolution.

4

CLIMATE CHANGE CHALLENGES

4.1 HISTORIC DATA OF TEMPERATURE CHANGES

Analysing past trends in climate is a difficult task due to gaps in data sets and consistency of past data. Past data sets, wherever available require considerable cleaning up due to vintage instruments used for collection of data as well as data gaps. According to a new Berkeley Earth study, the average temperature of the Earth's land has risen by 1.5°C over the past 250 years. The good match between the new temperature record and historical carbon dioxide records suggests that the most straightforward explanation for this warming is human greenhouse gas emissions (Berkeley Earth Website 2012).

4.1.1 Downscaled Climate variability and change analysis

The climate data (past and future) from Climate Systems Analysis Group (CSAG), Indian Institute of Tropical Meteorology (IITM), Indian Meteorological Department (IMD) and Global Historical Climate Network (GHCN) were analysed and their results discussed within this report. The CSAG data was downloaded from University of Cape Town web site accessed between December 2009 and March 2010. CSAG has taken data from nine large-scale general circulation models (GCMs -listed in Table below) and down-scaled the scenario results to a scale more relevant to the cities. Information regarding data is presented below:

- CSAG data was used for analysing the climate variability and change for two cities namely Surat and Indore.
- The data have not gone through any bias corrections - sometimes they represent the historical climate as being more wet/dry or hot/cold than actually happened. These biases were corrected within this study.
- The data from CSAG which are modelled for only one greenhouse gas emissions scenario, A2 and for only one future time range: 2046-2065. Whereas the data from PRECIS included three emission scenarios A1B (2021-2050), A2 (2071-2100) and B2 (2071-2100).
- The CSAG data are currently available as station point data and PRECIS as gridded data.
- The Indian Meteorology Department's daily station data has many days of missing data, especially for precipitation. Therefore, the information from GHCN was used to compare and correlate with the model's base data to identify the level of bias in the models. Daily rainfall and temperature data, data from GHCN was used for bias correcting.

Table 4.1: Name of Research Institute, Model and Abbreviation

Name of Research Institute	Name of the Model	Abbreviation used within this document
Canadian Centre for Climate Modelling Analysis (CCCMa)	Coupled Global Climate Model	CGCM3
Centre National de Recherches Meteorologiques, Meteo France, France	CNRM-CM3	CNRM-CM3
CSIRO, Australia	CSIRO Mark 3.0	CSIRO
Geophysical Fluid Dynamics Laboratory, NOAA	CM2.0 - AOGCM	GFDL
NASA Goddard Institute for Space Studies (NASA/GISS), USA	AOM 4x3	GISS
Institut Pierre Simon Laplace (IPSL), France	IPSL-CM4	IPSL
Meteorological Institute of the University of Bonn (Germany), Institute of KMA (Korea), and Model and Data Group	ECHO-G = ECHAM4 + HOPE-G	MIUB
Max Planck Institute for Meteorology, Germany	ECHAM5/MPI-OM	MPI
Meteorological Research Institute, Japan Meteorological Agency, Japan	MRI-CGCM2.3.2	MRI
Indian Institute of Tropical Meteorology, Pune and Hadley Research Center UK	Providing Regional Climates for Impacts Studies	PRECIS

- The gridded historical rainfall and temperature data were procured from the Indian Meteorological Department. This data was used for gap filling within GHCN.

There are several models, which attempt to model the future precipitation and temperature scenarios. From these models, two downscaled models were used in this analysis.

1. GCMs as downscaled by CSAG
2. PRECIS, RCM developed for India by Hadley research centre in collaboration with IITM.

The results from the above models are simulations of the future climate with assumptions of certain emission scenarios. The results presented in this study are an indicative/ approximations of the future. Since the models are simple approximations of climate, there are inherent biases and uncertainty in their climate scenarios. The uncertainty includes the models inability to represent all the land-ocean-atmosphere interactions that influences the current and future climate.

Bias: Our confidence in a model's scenarios of future climate is largely determined by how well that model can simulate historical, observed climate - past rainfall, past minimum or maximum temperatures both in time and in measure. The models usually tend to simplify the reality; the models tend to overestimate or underestimate past rain or temperatures. This variation from the observed measure is called the bias within the model. This deviation/variation, in time (e.g. say average monsoon onset and withdrawal) and in measure (e.g. increase or decrease in temperature) determines the confidence in the model. The model's bias in replicating past rainfall and its ability to replicate the monsoon and summer was taken as a measure of uncertainty of the models ability in predicting the future climate scenarios. The models with low bias in both its ability to replicate the seasons and measures were selected for further analysis. In this analysis, multiplicative bias correction was carried out. The equation below describes the bias correction factor which was performed.

Bias Correction Factor = Simulated / Observed

All future simulations for selected models were corrected for their bias by dividing the future simulated measurement by the bias correction factor. This enabled in comparing the results with respect to the observed information.

4.2 EXTREME EVENT ANALYSIS

Based on the results from the above process Extreme event analysis (EEA) was carried out using the daily precipitation and temperature data. The best models which were selected from the bias correction and correlation analysis were considered for the EEA.

The historical data used in this case is from GHCN daily. IMD gridded data was not used because GHCN provides the station data, which is more representative of the city under study rather than the grid, which is more representative of the region. Further, IMD data used for the bias correction and correlation analysis was gridded data of 0.5 degree x 0.5 degree, which is a representative sample of 50 sq. km. Such gridded data may not be able represent the daily precipitation and temperature levels, which are bound to change at a city level. Therefore, IMD data was used but to fill the gaps within the GHCN data (days for which no GHCN data was available). This process ensured data continuity.

The EEA were carried out for three indicators i.e. Rainfall, Minimum Temperature and Maximum. Historical daily weather data used for the EEA analysis were from the following periods:

- Rainfall: GHCN data (1901-2007) and model base line data (1961-2000)
- Minimum Temperature: GHCN data (1969-2007) and model base line data (1961-2000)
- Maximum Temperature: GHCN data (1969-2007) and model base line data (1961-2000)

Following EEA was carried out for the historical, base line and model predicted future scenarios:

1. Percentile variations (5th, 10th, 90th and 95th percentiles) within rainfall, minimum and maximum Temperature
2. Number of days where the rainfall is less than 2 mm, within all given months (especially during rainy season)

3. Number of days within which the 24 hour precipitation has been more than 25 mm.
4. Number of days in a given month where the maximum temperature and minimum temperature exceeds 40°C and 27°C respectively.

4.3 UNCERTAINTIES

The models are simplifications of reality and we are uncertain about the future. This includes the level of greenhouse gases, the change that may occur in the land use or population, etc. While future climate scenarios are likely, we are uncertain as to which future climate scenario will actually come true. Further, we have higher confidence in some model because of their relatively low bias, but these are relative to the observed data as depicted by either IMD (gridded at 0.50 x 0.50) or GHCN (station). Since, we do not know exactly what the future will be, it is essential we estimate the range of possible climate futures. This can be achieved through detailed analysis of each climate scenarios as depicted by the selected models to arrive at the range of possibilities.

4.4 CLIMATE CHANGE PROGNOSIS FOR INDIA

The National sustainable Habitat mission has been entrusted with developing mitigation and adaptation measures for climate change in human habitations. Various climate models developed so far indicate following issue that would impact the cities

- Temperature increase and higher variability leading to
  - Reduced comfort levels over longer periods across seasons
  - Increase in energy use for space cooling and heating
- Precipitation changes leading to
  - Drought, and extreme precipitation events,
  - Changes in river hydrology causing floods, seasonal water scarcity
- Cyclonic storms storm surge and coastal flooding
- Sea level rise leading
  - to loss of developed land in the coastal cities
  - Increase in salinity of coastal aquifers and surface water sources along estuaries

These changes will be diverse across the country depending on the geographical and hydrological context as well as the size, livelihood pattern and distribution of the population across the city and neighboring regions.

4.5 URBANISATION AND CLIMATE CHANGE IMPACTS

As reported earlier, the urbanisation and climate change impacts are likely to acting together, often mutually amplifying the risks. This would be the case especially in cases of:

- Heat island effects along with regional temperature increases
- Increasing water demand due to urbanisation, aspiration changes, food and energy sector demands along with increasing uncertainty in water resources due to droughts
- Flooding due to expansion of the riverine cities in to flood plains along with increasing frequency of extreme precipitation events locally and in upper catchments
- Downstream indirect impacts like push migration from rural hinterlands, cascading effects of regional/global food scarcities etc.
- Expansion of coastal cities towards the sea (high real estate values) along with sea level rise/cyclonic storm frequency changes.

Both the urbanisation and climate change impacts are expected to simultaneously roll out in the coming decades. With high exposure burden as seen by high density informal settlements located along marginal lands (including stream banks, even inside dry river channels) exposed to seasonal flooding almost every rainy season, any climate change impacts are likely to increase severity of the exposures.

4.5.1 Floods and coastal inundation issues

The expansion of the city from comparatively safe old core to possibly higher risk periphery as well as disrupting and constraining natural drainage (by expanding in to both sides of the river flood plain) can only increase the flood and coastal inundation risks. In costly real estate environment, the risks get ignored and haphazard growth by multiple real estate developers only complicates the risk situation. The integrated risk informed master planning process is yet to take root in urban planning debate.

Indian urban land is quite costly due to limited availability of land in the core areas, poor transportation network and archaic land use (single use) and building rules that discourage compact growth. Haphazard growth of the periphery and inability to extend the lifeline services, further distort the land markets. With the Para-statal Urban Development Authorities developing partial infrastructure and handing over these areas to ULBs further stress the finances and technical capacity of the ULBs to integrate resilience in urban planning. The National Disaster management Authority has recognized following reasons for growing urban flood risks (NDMA 2010):

- Increase in impermeable areas and resultant higher runoffs
- Lower design criteria of storm water drains
- Capacity reduction of storm water systems due to lack of maintenance,
- Encroachment of natural drainage areas
- Reservoir management issues
- Poor solid waste management and
- Dumping of construction wastes on drainage lines and filling of natural water bodies.
- Absence of sewerage and dumping of sewage in to drainage system.
- Urban micro climate as well as global climate change aspects of increasing flooding frequency.

The above list captures combined impacts of urbanisation and climate change on urban flooding. The Guidelines suggest various measures to manage urban floods including early warning systems, better designs of drainage systems. It has to be noted that NSHM has accepted the recommendations of International Conference on Urban Drainage in 2008, to 20% increase in calculated discharge suggested for designing for future storm water drains (NSHM undated).

4.5.2 Temperature increase, urban heat island effects and energy use:

India has one of the lowest per capita annual energy consumption in the developing world with only 580 kg oil equivalent (kgoe) and it is expected to grow to about 890 kgoe by 2030 Per capita electricity consumption was only 518 kWh in 2007 and it is expected to grow to about 1895 kWh by 2030 (IEA 2009).

4.5.3 Urban growth and Climate Change Scenarios for master planning

The urban population as well as average incomes are expected to grow rapidly over coming decades. The average income of 112 largest cities across India was estimated to be about 66,252 Rs/capita in 2008-09 (Indicus Analytics, 2011)

Most of the cities face serves capacity constraints to generate city development scenarios under transforming urban economy in the globalized world. This limits more systematic approach to master planning process informed by future growth scenarios. The current master planning process still retains the top down approach of the 20th Century planning dominated by the state government. Concepts like LRHD, single landuse for each area is no longer valid in the current and future urban contexts.

Paradigm shift from the conventional population growth rate calculations and archaic (single use) land use planning based master planning process to integrated infrastructure and landuse planning optimizing water, energy and land resources as well as services like transportation in the resources, demographic and economic context.

Development of such scenarios and exploration of alternate futures would necessitate multi-stakeholder engagement starting from city levels to high administrative levels. Enabling environment for such dialogue is slowly emerging with increased focus on urban rejuvenation efforts and investments.

REFERENCES

3i Network (2006), *India Infrastructure Report 2006*, Urban Infrastructure Development Finance Company, Indian Institute of Management Ahmadabad and Indian Institute of Technology, Kanpur Oxford University Press, New Delhi.

ADB 2010, Every Drop Counts: *Learning From Good Practices In Eight Asian Cities*. Asian Development Bank and Institute of Water Policy, Lee Kuan Yew School of Public Policy Manila

Arghyam (2007),"Urban Waters", Background Paper, Second Annual Conference, Bangalore 2007

Asian Development Bank and Ministry of Urban Development, Government of India (2007), *Benchmarking and data book of water utilities in India* , New Delhi

Bagchi, S and Chattopapdhyay S (2004) Decentralised Urban Governance In India: *Implications for Financing of Urban Infrastructure*: Economic and Political Weekly December 2004

Banerjee Ranen & Padode. V. Pratap (2011), *Bringing water to your door step- Urban Water Reforms for the next decade*, PWC, 2nd Annual India H2O conference, 2011.

Berkeley Earth Website 2012, http://berkeleyearth.org/results-summary/ Accessed on 30 July 2012

Bertaud (1996),http://alain-bertaud.com/images/AB_Ahmed_Report.pdf,Accessed 13/1/2012.

Bertaud Alain (2002), http://alain-bertaud.com/images/AB_%20India_%20Urban_Land_

Reform.doc Accessed 15/1/2012

Bertaud Alain (2004), *The spatial organization of cities: Deliberate outcome or unforeseen consequence?* http://alainbertaud.com/images/AB_The_spatial_organization_of_cities

_Version_3.pdf, Accessed 18/1/2012

Bhagat.R.B, Das.C.K & Mohanty Soumya (2000), *Levels trends and structure of workforce – A Census analysis (1981-2001)*, Available: http://www.iipsindia.org/pdf/IIPS%20

Research%20Brief%20No. %203.pdf, Accessed 11/12/2011

Bloom E David (2011), *Population Dynamics in India and Implications for Economic Growth*, Harvard School of Public Health. The Handbook of the Indian Economy, Oxford University Press

Census of India 2011, *Provisional Population Totals and Urban Agglomerations and Cities.* Census of India, Government of India

Chattopadhyay, Basudha (2007), *Sustainable urban development in India; some issues,* Publication NIUA, Available: http://niua.org/Publications/discussionpaper/ basudha_paper.pdf, Accessed 14/1/2012

City Managers website 2012, *Urban governance in India,* http://www.cmao.nic.in/ugov.html, Accessed 12/2/2012

City Mayor's Statistics (2007), Available: http://www.citymayors.com/statistics/largest-cities-density-125.html, Accessed 17/1/2012

City population Website, http://www.citypopulation.de/India-Agglo.html, Accessed 14/12/2011

DEA, (2009), *Urban Issues, Reforms and Way Forward In India*, by Chetan Vaidya: Working Paper No.4/2009-DEA Department of Economic Affairs Ministry of Finance, Government of India

Desai.N. (2010) *Demographic Dividend or Debt.* Building from bottom: Infrastructure and Poverty Alleviation edited by Kochar, Sameer & Ramachandran, M Academic Foundation New Delhi

Dodman David (2009), *Urban Density and Climate Change,* United Nations Population Fund (UNFPA), Revised Draft – Paper 1 2009

Dzikus, A 2003, *Water Demand Management Strategy and Implementation Plan for Indore* Habitat Debate Vol. 9 No. 3 UN-HABITAT, 2003 http://ww2.unhabitat.org/hd/hdv9n3/15.asp

Express news services, 2011, http://www.indianexpress.com/news/south-mumbai-recovers-from-shock-as-best-tries-to-fix-snag/861201, Accessed 1/11/2011

Express news services, 2011, *Fire at substation causes outage*, http://www.indianexpress.com/news/citys-darkest-hours-of-decade/860818/, Accessed 1/11/2011

Express news services, 2011, *Power & water cuts worsen winter woes*,: http://www.indianexpress.com/news/power-&-water-cuts-worsen-winter-woes/892433, Accessed 1/11/2011

FAO (2010) *Aquastat Database*. Food and Agricultural Organisation, Rome http://www.fao.org¬/nr¬/water¬/aquastat/¬¬data/query/index.html?lang=en Accessed on 20Jul 2012

Google sites-waterexcreta website, 2012. https://sites.google.com/site/waterexcreta/urban-water-source/urban-rural-conflict Accessed on 06 Nov 2012

Gupta .K. Anil & Nair .S. Sreeja, *Urban floods in Bangalore and Chennai: risk management challenges and lessons for sustainable urban ecology.* Current Science, Vol. 100, No. 11, 10 June 2011

IBRD (2008), *"Urbanization, Agglomeration and economic development Quigley"*, John, M.-Working paper 19: The International Bank for Reconstruction and Development and The World Bank on behalf of Commission on Growth and development

IEA 2009: *World Energy Outlook 2009*. International Energy Agency

IIHS (2011), *Urban India 2011: Evidence and Experiences.* India Urban Conference, Mysore, Available: http://www.iihs.co.in/wp-content/themes/education/ resources/IUC _Press-release.pdf, Accessed 9/12/2011

Indiastat (2011); *(Lok Sabha Starred Question No. 270, dated on 15.03.2011)*

International Institute for Population Sciences (IIPS) and Macro International (2007), *National Family Health Survey (NFHS-3), 2005–06*, India: Volume I, Mumbai

IPCC (2001), *Climate Change 2001: Impacts, Adaptation, and Vulnerability,* Sixth Session of IPCC Working Group II, Geneva

Jenks (2000), *The Appropriateness of Compact City Concepts to Developing Countries* in Compact cities: Sustainable urban forms for developing countries. Edited By Mike Jenks and Rod Burgess, Spon Press London

Jenks, M. & N. Dempsey, (2005) *The language and meaning of density* In Future Forms and Design for Sustainable Cities, in M. Jenks and N. Dempsey (eds.) Elsevier, Oxford

Kelkar Ulka, Balachandra. P & Gurtoo Anjula (2011), *Assessing Indian Cities for Vulnerability to Climate Change,* Vol.4, 2011, 2nd International Conference on Environmental Science and Development IPCBEE, IACSIT Press, Singapore

Kundu A. 2009, *Trends and processes of urbanisation in India.* Urbanisation and Emerging Population Issues -6, International Institute for Environment and Development (IIED) and United Nations Population Fund (UNFPA)

Kundu A, undated:http://www.networkideas.org/ideasact/jun07/Beijing_Conference_07/Amitabh_¬Kundu.pdf Accessed on 25/02/2012

Kundu, A (2011), *Politics and Economics of Urban Growth, Economic & Political Weekly,* May 14, Vol. XLVI, No. 20

McDonald R.I, Green P, Balk Deborah, Fekete, B M, Revenga C, Montgomery M, Todd M 2011: *Urban growth, climate change, and freshwater availability* : PNAS Early Edition. Proceedings of the National Academy of Sciences of the USA

MGI (2010), *India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth.* The McKinsey Global Institute

MoHUPA (2011a), *Annual report 2010-2011*, 2011: Ministry of Housing & Urban Poverty Alleviation, Government of India, New Delhi

MoHUPA (2011b): Report of the Committee on Slum statistics/Census, Ministry of Housing and Poverty Alleviation, Government of India http://mhupa.gov.in/W_new/Slum_Report_¬NBO.pdf

Mitra Arup & Murayama Mayumi (2008), *"Rural to Urban Migration: A District Level Analysis for India"*, IDE Discussion Paper No. 137, Available: http://ir.ide.go.jp/dspace/bitstream/2344/729/3/ARRIDE_Discussion_No.137_mitra.pdf, Accessed 11/12/2011

Moneylife website. http://www.moneylife.in/article/about-10-of-rural-india-lives-on-less-than-rs17-a-day-nsso-survey/27437.html

MoRD & MoUD (2011), *Enhanced Quality of Life through Sustained Sanitation India Country Paper,* SACOSAN – IV South Asia Conference on Sanitation, Colombo

MoUD (2011), *"Report on Indian Urban Infrastructure and Services"*, Report of the High powered Expert Committee, Ministry of Urban development, New Delhi

MoUD, Government of India (2008), *National Urban Sanitation Policy,* Available: http://www.urbanindia.nic.in/programme/uwss/csr_faq.pdf, Accessed 18/1/2012

MoUD, Government of India (2010), Strategic Plan (2011-2016), Second Draft, New Delhi.

MoWR 1999: *Report of National Commission for Integrated Water Resource and Development,* Ministry of Water Resources, Government of India

MoWR 2000, *Report of the Working Group on Water Resources for XI Five year Plan (2007-2012)* from "Standing Sub-Committee for Assessment of Availability & Requirement of Water"(Year 2000)

Mundu Bahalen Grace & Bhagat B.R. 2008. *Slum Conditions in Mumbai with Reference to the Access of Civic Amenities,* Volume 5.No. 1, Publisher ENVIS, IIPS Mumbai, 2008, Available: http://www.iipsenvis.nic.in/Newsletters/vol5no1/page_3.htm, Accessed 9/12/2011

NCC (2006), *Trends in Precipitation Extremes over India,* by Joshi .R. U. & Rajeevan M Research Report No: 3/2006, Indian Meteorological Department, Pune

NDMA 2010: *National Disaster Management Guidelines: Management of Urban Flooding.* National Disaster Management Authority, Government of India. September 2010, New Delhi

NICCA (2010), *Climate Change and India: A 4x4 Assessment-A Sectoral and Regional Analysis for 2030s,* Ministry of Environment & Forests, Government of India

NIDM (2009), *Special Issue: Urban Floods-II, Journal of Disaster & Development,* Volume 3, Number 2 2009 New Delhi

NIUA (2005), *Status of Water Supply, Sanitation and Solid Waste Management in Urban Areas,* Ministry of Urban Development and CPHEEO, Government of India, New Delhi

NREGA 2011, Available: http://nrega.nic.in/circular/WageRate_1jan2011.pdf, Accessed 14/12/2011

NSHM (undated): *Report of Sub-committee for Development of National Sustainable Habitat Parameters on Urban Stormwater Management,* National Sustainable Habitat Mission GoI

NSSO, 2010, *Housing condition and amenities in India:* 2008-09, NSS 65th round Report number 534(65/1.2/1), Ministry of Statistics and Program Implementation, Government of India, 2010

NSSO, 2010b, *Some characteristics of Urban Slums,* 2008-2009, NSS 65th Round, July 2008-June 2009, National Sample Survey office, GOI, November 2010

Panda, Architesh, *Unleashing Urbanization, Climate Change Risks & Adaptation: Indian Mega Cities,* Institute for social and Economic Change Bangalore, India, The Indian economy review, Available: http://theindiaeconomyreview.org/Article.aspx?aid=30&mid=3, Accessed 8/12/2011.

Planning Commission (2002), *India-Vision 2020,* Government of India,

Planning Commission (2010), *Report of the Working Group on Urban and Industrial Water Supply and Sanitation,* Twelfth Five-Year Plan (2012-2017), New Delhi

Planning Commission, Government of India (2007), *Eleventh Five Year Plan 2007-2012:Urban Infrastructure: Housing, Basic Services and Poverty Alleviation,* New Delhi

Royal society 2012: *People and the planet.* The Royal Society Science Policy Centre report 01/12 DES2470. Issued: April 2012

Saleth, M. R. & Dinar, A. (2004): *The Institutional Economics of Water: A Cross Country Analysis of Institutions and Performance,* Edward Elgar, A co-publication with World Bank, Cheltenham, UK

Sarangi K. Gopal, *Towards a Public-Private Partnership Regime: An Analysis of Water-supply Systems in Urban India.* Published at ASIEN 117, 2011, S. 45-57, http://www.asienkunde.de/content/zeitschrift_asien/archiv/pdf/117_Sarangi.pdf, Accessed on 14/12/2011

Satterthwaithe, D. (2006). Climate Change and Cities, London, IIED

Sharma Sudhirendar, (2005) *India's water future: Dry days ahead.* Info change agenda, http://infochangeindia.org/agenda/the-politics-of-water/india-s-water-future-dry-days-ahead.html, Accessed on 18/1/2012

Singh, N. (2000). *Tapping Traditional Systems of Resource Management.* Habitat Debate, http://www.twnside.org.sg/title/2139.htm , Accessed 10/2/2012

Sridhar Seethara Kala (2010), *Carbon Emissions, Climate Change, and Impacts in India's Cities,* Available: http://www.idfc.com/pdf/report/Chapter-21.pdf, Accessed 14/12/2011

Sud Hari (2006), *Poverty and slums in India-Impact of changing economic Landscape* http://www.southasiaanalysis.org/%5Cpapers18%5Cpaper1769.html, Accessed 12/12/2011

Swami S, Vyas A, and Narang S. 2012. *Transformation of Surat: From Plague to Second cleanest city in India.* Urban Innovations, Published for the urban management programme for Asia and the Pacific by All India Institute of Local Self Government. http://www.-indiawaterportal.org/sites/indiawaterportal.org/files/UI_1-Surat.pdf

The Guardian (2012). http://www.guardian.co.uk/world/2012/jul/31/india-blackouts democracy-power-people , Accessed on 2nd August 2012

ToI 2009, http://timesofindia.indiatimes.com/city/surat/SMC-to-earn-additional-income-from-registration-of-new-buildings/articleshow/5204273.cms Accessed on 25th January 2010

University of Cape Town Website: http:// data.csag.uct.ac.za/ Accessed on 2nd August 2012

UN 2011, World Population Prospects: World Urbanization Prospects: The 2011 Revision. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, Available: http://esa.un.org/unpd/wup/CD-ROM/Urban-Agglomerations.htm , Accessed 18/1/2012

UN Habitat (2009), *Global report on Human Settlements 2009.* Planning sustainable cities United Nations Human Settlement Programme, Earth Scan Publishers London

UNDP (2009), *India Urban Poverty Report,* Ministry of Housing and Urban Poverty Alleviation, Oxford University Press (New Delhi)

UNDP Population, http://www.un.org/esa/population/pubsarchive/india/¬ind1bil.htm¬, Accessed 10/12/2011

UNESCO (2011), *The impact of global change on water resources*- Response of UNESCO, International hydrological Program, Available: http://unesdoc.unesco.org/images/ 0019/001922/192216e.pdf, Accessed 12/1/2012

Wakeupcall.org, http://www.wakeupcall.org/administration_in_india/¬poverty_line.php, Accessed 8/12/ 2011

World Bank (2008), *Residential consumption of electricity in India (Documentation of data and methodology)-India: Strategies for Low Carbon Growth,* Background Paper, World Bank, Washington

World Bank, (2011), *Social Protection for a Changing India,* World Bank, Washington

World Resource Institute Web site, http://earthtrends.wri.org/searchable_db/index.php?

step=countries&ccID[]=1&cID[]=85&theme=2&variable_ID=694&action=select_years Accessed on 20Jan2012

World Urbanization Prospects (2009), *Highlights Final,* Department of Economic and Social Affairs, Population Division UN 2010, http://esa.un.org/unpd/wup/Documents/WUP2009_Highlights¬¬¬¬_¬Final.pdf, Accessed 3/1/2012

WorldClim website, *Global Climate Data,* http://www.worldclim.org , Accessed 9/12/2011

WSP (2010), *The Economic Impacts of Inadequate Sanitation in India,* Available: www.wsp.org/wsp/sites/wsp.org/files/publications/wsp-esi-india.pdf , Accessed 18/1/ 2012

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A SYNTHESIS REPORT - INDIA

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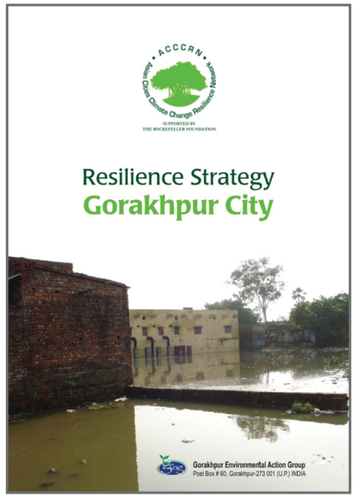
Gorakhpur City Resilience Strategy

SUMMARY



Prepared by:
Gorakhpur Environmental Action Group (GEAG)

Full Version of the Gorakhpur City Resilience Strategy can be downloaded from:
http://www.acccrn.org/sites/default/files/documents/IN_Gorakhpur_Aug10_resilience%20strategy_%20GEAG.pdf

1

1.1 INTRODUCTION

End of twentieth and beginning of twenty first centuries witnessed to two unprecedented changes happening across the globe. First was unrolling of economic reforms that continue to shape economic growth of large number of developing countries. Akin with pace of economic growth is rapid growth of urban centers all over but more particularly in South-East Asian countries[1]. Before it came to be realized such is the pace of economic change that almost 50% of world population has suddenly come to live in cities. India is no different and has observed 53.7% growth in number of towns in last decade[2]. According to recent World Bank report[3], India accounts for one-third of world poor[4]. It is implicit therefore that contrary to prevailing perceptions of poverty being endemic to villages in India, urban areas too are now home to millions of poor people. From where and why do poor people come to settle in urban areas, very often in most appalling subhuman living conditions is key question that needs serious thinking.

Parallel to global economic reforms but not necessarily consequence of it is growing concern of climate change. Climate being over arching phenomenon affecting every other function on earth, any significant change in climate has potential of affecting social, economic and political milieu of nations. Relation between economic growth and climate health is perhaps better understood in recent times than it was thought ever before. Government policies and development initiatives are more interested and inclined in favor of supporting sustainable models of economic growth and development. Climate impacts viz. floods, cyclone, draught and temperature whilst are increasingly becoming more devastating and frequent, beckons serious relooking and mainstreaming of into planning considerations of development projects.

Quest for sustainable development and to button down problems of urbanization, economic growth and climate change is extensively pursued at various levels. All said and done, what is visible more and more is shift in livelihoods of people from farm to non-farm based employment sectors. Development policies need to recognize and address current occupational shifts and make suitable corrections and adjustments, thereof.

City Resilience Strategy (CRS) is premised to address climate impact challenges faced by city systems and services offered to people. Strategy document has been conceived, designed and developed to test notion of resilience of a city made vulnerable to climate change impacts. Strategy document is enriched by first-hand experience of local people who have withstood many disasters by being at the center of it. Lessons drawn from other countries and important policy analyses go into making of present strategy document for its application by city managers. CR attempts to capture complexities of urban systems and suggests short to long-terms interventions to build city resilience. Strategy chooses to empower local people and their institutions who it believes hold keys to process of building resilience of city.

1.2 THE CITY

Gorakhpur is situated on banks of two major river systems, namely Rapti and Rohin. It is spread over 147 sq. km. area and located at height of 75-85 meters above mean sea level. Gorakhpur is unique to have large number of water bodies; biggest among all is Ramgarh Tal in south-east part of city. Proximity of city to Himalayan mountain range and location in tarai region, Gorakhpur has moderate climate with annual average temperature 25.68ºC. Summer and winter temperatures however peaks to 31.95ºC and 19.57ºC respectively. City receives 119.2 cm of annual rainfall with maximum precipitation recorded in months of July to September.

Gorakhpur is one of the fastest growing cities of mid-Gangetic region. City is administered by 70 municipal wards having a total population[5] of 692519 spread unevenly in city. Old wards of city have very high density of population. Population of Gorakhpur has increased rapidly with record growth of 64.1% during 1981-1991 due to expansion of city by incorporating 47 peripheral villages into municipal area[6]. Large number of slums constitute roughly 33% of total population of city resides in 110 different locations with or without tenure rights.

1 Asian Cities Climate Change Resilience Network – Aug 2012
2 Ministry of Urban Development, GoI, January 2012
3 World Bank Report 2013
4 Less than 1.25 US$ (about Rs 65) per day

5 Census 2011
6 Master Plan 2021 of Gorakhpur

1.3 THE CONTEXT

In last couple of decades, Gorakhpur has been experiencing unprecedented problems of water logging in large areas of city causing loss of employment and physical damages to property. Health issues are grave concerns for the city and have been increasing in exponential terms with large number of deaths reported every year due to water and vector-borne diseases. Population growth and vehicular pollution have reached to levels which were never experienced before. There is fast depletion of open areas in city due to large scale unplanned construction all over. Civic services are at the nadir, non-existent or at best exist in unhygienic and unusable state. City becomes virtual hell and unlivable during rains. Gorakhpur is fast turning to become a place where rains are NOT welcomed any more by large number of households.

In backdrop of humungous problem faced by city, crucial determinant for success for city resilience was to develop a method and approach that people and administration equally share and also willing to support. Method need to assess and establish climate risks to city and determine consequent vulnerability of communities. It meant designing participatory tools using which hydrogeology of city, climate variability and allied risks and vulnerability of people is put into perspective of development planning for overcoming challenges faced by people. In following sections, general outline of method and strategy formulation is explained.

1.4 ELEMENTS OF RESILIENCE STRATEGY FORMULATION

Strategy has looked into following essentials into making of resilient city:

1.4.1 Understand historic climate trends and futuristic projection

Over hundred years of precipitation and temperature data is analyzed to understand historic climate events and trends. Similarly, temperature and precipitation projections of Gorakhpur city for years 2046 to 2065 is analyzed by running CGCM3, CNRM, MIUB and CSIRO climate models. Such analysis show maximum and minimum temperatures of Gorakhpur will increase and decrease respectively for maximum and minimum temperatures compared to past hundred years of climate. Projection data shows increasing trend of maximum temperature for all four seasons. There is not enough model agreement over precipitation data. It might decrease in period from December to February and increase from March to May and later during September and October. Historic climate data however show that Gorakhpur is experiencing same amount of rainfall in less number of days, meaning thereby heavy to very heavy rainfall in shorter spells.

1.4.2 Understand fragility of systems and service

It is important to understand people's access to system and service, what are the systems most impacted by climate change, why do systems and services become fragile, are these designed to withstand climate impacts and able to render services even when stressed, have systems been designed after taking climate projections into consideration, what are roles and responsibilities of people who manage/use systems and how is one system linked and dependent on other systems and implications of failure of one over other systems.

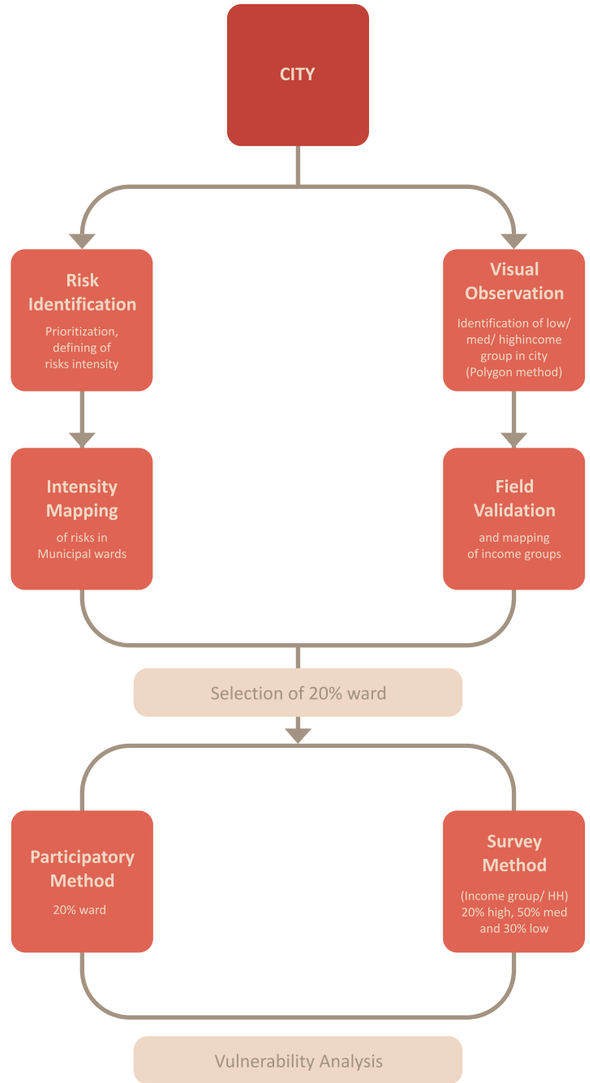
1.4.3 Understand vulnerability and resilience options

How do people cope and manage when denied access or deprived of accessing system and its services, who are most vulnerable and why are they so, what could be done to build resilience of people, systems and thus of city on whole

Inputs from above three steps have been extensively used in designing of city resilience strategy.

1.5 THE METHOD

Knowing well that climate impacts are harsh on vulnerable communities not properly protected or having safe access to infrastructures and services, it was challenge to design method[7] that well and truly represents entire city of Gorakhpur. Through rapid assessments and consultations with large population samples, preliminary survey inputs were collected. The city was divided into 7 police zones. Survey finding were shared and discussed with representatives of 7 zones. Representatives were facilitated to identify and also prioritize severity of climate risks, its impacts and vulnerabilities of communities in their respective areas. Perception mapping done with people were cross-validated with municipal data of services in respective wards. Using Google imagery and GIS techniques, 30% households were identified by stratified sample method for detailed household surveys were carried to ascertain climate impacts at micro-level on municipal services and systems. Sixteen problems related to systems and services were identified in Gorakhpur which was further prioritized into 5 core systems and services and recommendation for initial intervention with the Municipal Corporation of Gorakhpur.



Community perception of problem in Gorakhpur

Water logging
Unregulated traffic
Water quality
Sanitation
Solid waste
Road design
Drainage
Civic amenities
Population increase
Slaughtering of animal
Education
Stray animal
Poor infrastructure
Open space
Green cover
Unplanned construction

Priority problem

Water logging
Sanitation
Drinking water
Drainage
Solid waste

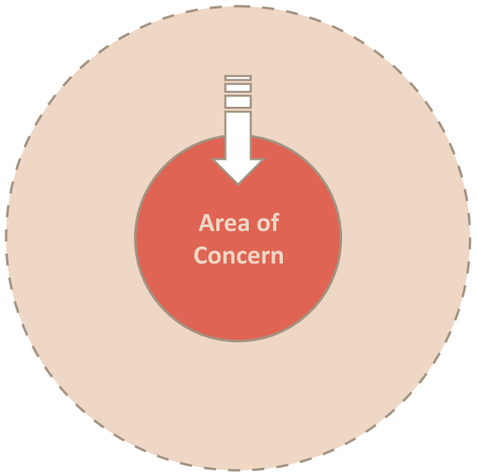
7 City Resilience Strategy Gorakhpur

1.6 RESILIENCE STRATEGY

Having identified and prioritized climate risks to systems and services and related vulnerability of communities, it was important to diagnose causes behind systemic failures and/or malfunctions when put under climate stressed conditions. It was more important to ascertain and establish systemic behavior under projected climate conditions for Gorakhpur city in order for strategy to recommend and influence short and long term investments decisions of Municipal Corporation for infrastructure development.

Climate change impacts in Gorakhpur have been broadly classified and put under three major causes. These are:

1. Natural causes
2. Behavioral causes of people who manage and use systems
3. Policy and political causes



1.7 THE APPROACH

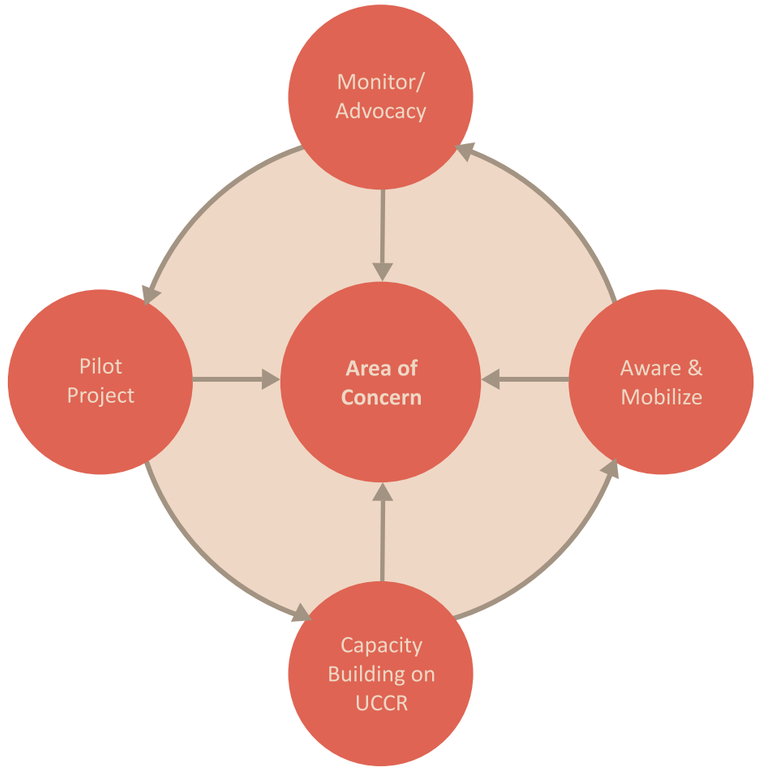
Approach towards city resilience is based on prudence of improving system efficiency through behavior change and performance improvement of people who manage systems and those who use. It works on principle of minimum demand for energy and investments together with high returns through public education and accountability measures. Resilience strategy of city is aligned with approach and to inherent principles therein. It addresses sphere of influence that works more at behavior to influence areas of concerns e.g. natural and infrastructure systems. In regions of high rural-urban ratio, it makes sense to work more at level of sphere of influence than sphere of concern.

In Gorakhpur water logging, drainage, solid waste, drinking water and sanitation services are hampered badly by climate change impacts. It is visualized that resilience could be build by addressing fragility of systems to climate change impacts by rendering improved access of communities to services and by quality implementation of rules and policies.

Major problems faced by residents of Gorakhpur due to climate change impacts have been put under seven groups each representing a sector.

Sector	Climate change, impacts and vulnerability
Basic services	Sanitation, hygiene, drainage and safe drinking water
Housing	Inundation, low cost house design for water logged situation
Industry	Industrial waste and pollution, safety at work place, housing for workers
Health	Seasonal outbreak of epidemic, preventive health, health surveillance
Energy/Electricity	Power failure and breakdowns, production/livelihoods, alternate energy
Transport	Efficient transport mechanism, vehicular emission,
Ecosystem	Conservation of public and open areas, water bodies

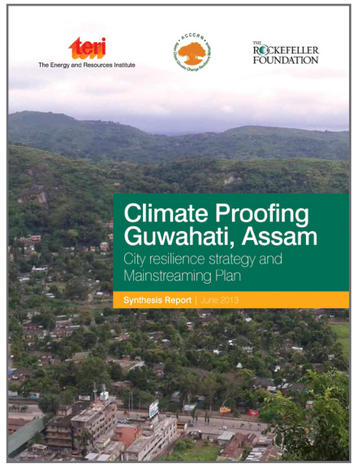
City resilience building is an evolving and continuous process. Therefore, CRS would need periodic reviews by stakeholders for needed adjustments. Proposed resilience strategy is unique in sense that it attempts to build synergy at three different levels i.e. system, users and providers and governing rules and policies. In Gorakhpur, out of seven interlinked sectors, four sectors have been identified for pilot interventions. Sectors like water, sanitation, drainage, housing, health and natural ecosystems are badly hampered under climate stressed conditions also are the most basic ones providing health, shelter and life to local populace. CRS has identified key actionable areas to build resilience of each sector in short and long terms



Climate Proofing Guwahati, Assam

City Resilience Strategy and Mainstreaming Plan

SUMMARY



Prepared by:
The Energy and Resources Institute (TERI)

Full Version of the "Climate Proofing Guwahati, Assam. City resilience strategy and Mainstreaming Plan" can be downloaded from:
https://acccrn.org/sites/default/files/documents/TERI_Guwahati%20Synthesis%20Report.pdf (English)

2

2.1 INTRODUCTION

As part of the Asian Cities Climate Change Resilience Network (ACCCRN), TERI has made an assessment of the risk and vulnerability of the city of Guwahati and has prepared a detailed resilience strategy. The focus of TERI's assessment is to facilitate adaptation initiatives and mainstream them into the city development paradigm to make Guwahati city more resilient and prepared towards the risks. This risk assessment largely extracted local information in the form of secondary data along with consultations with the government departments and relevant stakeholders. Besides this a climate scenario assessment was also carried out by TERI to understand the future implications of climate change on the city. Review of existing policies and governance framework of the city was an integral part of the assessment to identify channels for integrating adaptation and disaster risk reduction measures in planning and development.

2.2 ABOUT GUWAHATI AND ASSAM

The population of Assam according to the 2011 census stands at about 31 million, making it the 14th most populated state in India. The state is spread over an area of about 78000 sq. km. making it the 16th largest state in the country in terms of area. The density of population per sq. km. is about 397 against the national average of 382. It comprises of 27 districts, 219 development blocks and 26,395 villages[1].

Guwahati is the capital city of Assam and the largest city in the North East Region. The total population of Guwahati UA/Metropolitan Region is 968,549. Guwahati is located towards the south-eastern side of Kamrup district, surrounded by Nalbari district in the North, Darrang and Marigaon districts in the East, Meghalaya State in the south and Goalpara and Barpeta districts in the West. Located on the banks of the Brahmaputra River, it is the largest commercial, industrial and educational centre of the N-E Region. The city also surrounds one of the Ramsar Notified wetlands, the Deepor Beel which is under threat due to the encroachment and unplanned urban development of the city. The city is prone to floods and landslides and is located on the earthquake prone belt. The preparedness to deal with disasters and combat its impacts is low which has made the city and its residents quite vulnerable.

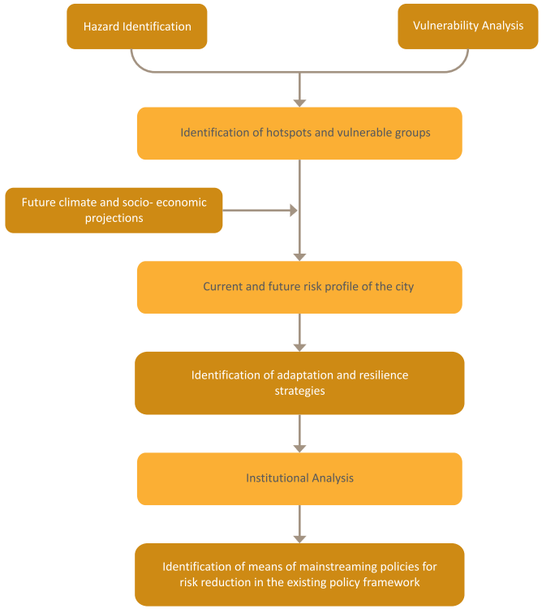
1 http://www.agriassam.in/agriHorti_profile/Profile_ofAgri-HortiSector_ofAssam-June2012.pdf

2.3 METHODOLOGY AND APPROACH

A detailed step by step description of the methodology adopted for risk and vulnerability assessment in Guwahati is given below:

1. **Hazard identification:** The initial step in risk assessment was the identification of natural, human-made and human induced hazards and stressors (climatic and non-climatic) which have been affecting the city of Guwahati. This was done on the basis of literature review, city level stakeholder consultation, and an analysis of the relevant secondary data.
2. **Vulnerability analysis:** An analysis of the characteristics of the city was conducted to determine the level of exposure to the identified hazards and stressors. Variables such as topography, population dynamics, socio-economic condition and land use pattern were studied to understand the sensitivity of the city to the hazards. The quantitative assessment was supported by an analysis of the spatial information retrieved from satellite imageries and inputs from the stakeholder consultations.

Figure 1: Study Framework



3. **Identification of hotspots**: Outcomes of the vulnerability analysis were used to identify and map the climate sensitive hotspots using GIS. The analysis also highlighted vulnerable communities and sectors as well as urban functions which are more vulnerable to risks and hazards.

4. **Climate projections:** Climate projections for 2030s at a resolution of 25 km X 25 km were conducted for the region to understand the change in temperature (mean, min and max) and precipitation from the baseline. For this purpose, daily outputs from PRECIS model were used at 25 km x 25 km resolution. Projections for A1B scenario for the time slice 1961-1990 referred to as 'baseline', and 2021-2050 referred to as '2030s' were utilized.

5. **Current and future risk profile of the city:** The information generated on vulnerable hotspots, communities and urban functions was used to generate the current risk profile of the city.

6. **Identification of adaptation and resilience options to address the risks:** In the next step, adaptation and resilience options to address these risks were identified. The strategy aimed at having a holistic set of sector specific adaptation options to address their vulnerability and building climate resilience in the city.

7. **Review of existing policies and legislations to identify gaps in addressing to risks:** A review of existing policies, legislations and by-laws was conducted to prepare a mainstreaming action plan.

2.4 KEY FINDINGS

Change in land use pattern of Guwahati city due to uncontrolled development activities is said to have done a lot of harm to the ecology and environment of the city. A trend analysis of the change in land use land cover shows an increase in the built up area. It is also evident that there has been more sprawl and infill development in certain pockets in the past 5 years. The city consultations and literature review about the city revealed three major components to hazards in the city:

1. Unplanned, unregulated urbanization and its consequences
2. Past climate variability and associated impacts
3. Disasters including floods, earthquakes and land slides

The individual consultations revealed that water supply is greatly hampered in the city during the flood events. Besides this, the overall lack of drainage, absence of solid waste management system and pollution of surface water bodies and ground water sources has created a vicious cycle that leads to flooding and water logging in the city every year. Cutting of hills for encroachment, constructing buildings and large scale deforestation in the city has led to blockage of drainage channels, destruction of top soil and high rate of soils erosion on the exposed hill slopes.

2.5 CLIMATE PROJECTIONS

2.5.1 Temperature trends

Data for both maximum and minimum temperature shows an increasing trend over the city of Guwahati. For minimum temperatures barring 1997 and 2011, all the years show a clear increasing trend in the values. Similarly, except for 2003-2005, values for the maximum temperature also show an increasing trend.

2.5.2 Rainfall trends

The daily rainfall data from Indian Meteorological Department Regional Meteorological Office (RMC), Guwahati from 1982-2011 was averaged to get monthly values. A decreasing trend of seasonal as well as annual rainfall over the city was observed. It was also observed that there has been an increase in extreme rainfall events resulting in more rainfall in short duration. This can be one of the attributing factors for urban flooding.

2.6 OUTPUTS OF TERI'S STUDY

2.6.1 City Resilience Strategy

As an output of this study, a city resilience strategy document was prepared which captured the key findings of the various assessment stages (climate projections, vulnerability, hazard and risk assessment exercise) and comprised of a set of sector specific adaptation options to address the vulnerability of the city. The following sectors were identified as the key sectors to address the present and future vulnerability of the city in the context of climate change impacts:

- Housing and urban planning
- Urban infrastructure and services (water supply; sewerage; natural and storm water drainage; solid waste management; electricity; health)
- Informal settlements and slums
- Ecosystems and land-use
- Emergency response capacity

2.6.2 Mainstreaming strategy

In order to ensure implementation of the recommended resilience measures, a mainstreaming strategy was also prepared with the aim of understanding the current institutional mechanisms to address the risks and disasters faced by the city. An integral step for this stage was review of existing policies, legislations and by-laws which helped in identifying the gaps in the existing policy regime to address the current and future risks. The strategy aims to communicate the means of integrating and mainstreaming policies for risk reduction in the existing policy and institutional framework of the city.

2.7 SUMMARY OF RECOMMENDATIONS

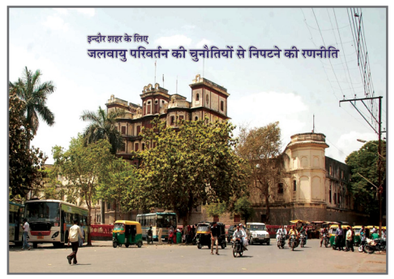
As a result of this assessment exercise, TERI has proposed several recommendations, some of which are highlighted in the table below. For instance, it was found that the ground water is inflicted by high fluoride and arsenic content and that the lack of sewage system is impacting the ground water quality. TERI therefore recommends that the city should take up the sewerage and storm water plan of the city with immediate priority. In addition, TERI also recommends the enactment and adoption of the 74th Constitution Amendment Act which devolves many functions to local bodies. This will empower the ULBs to make decisions and plan for their development and will also enable ULBs to initiate climate action.

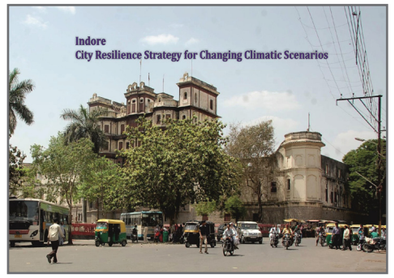
Table 1: Sector Wise Recommendations

Sector	Recommendation/Strategy	Vehicle
Housing	Guidelines for construction of buildings on slope Structural stability of buildings in hills and for the entire GMA Soil erosion and sedimentation control for construction in non-hill GMA areas Precautions and technical details for use of Septic tanks and Soak-pits Rain water harvesting for storage	Section 61 on 'Special regulations for construction in hilly areas' in the Building Bye laws for Guwahati Metropolitan Area need to integrate these points. Intensive micro-zonation studies to be conducted to identify vulnerable areas as per the sub soil conditions of GMA. Norms to be introduced in the Building Bye Laws of GMA 2006 Enforcement of Section 56 of 'Building Bye-laws for GMA 1998' and 'Revised Building Bye-laws-2006 for GMC' which states the necessary provisions and precautions to be followed for septic tank/seepage pits/dispersion trenches Section 65 (i)(b) in the New Revised Building Byelaws for GMC- 2006 provides for terrace water collection and connected to a recharge point in all group housing schemes/apartment and commercial complexes/institutional buildings. This provision should be mandated for such buildings
Urban planning	Demarcate eco-sensitive areas in the city as low/no built up areas Planning of 3 new satellite towns to be on the principles of sustainability	Change in land use zoning and development regulations Use of Urban Development and Plan formulation Guidelines (UDP FI) for norms for optimum densities, land use zoning in hilly areas while Master Plan formulation Use of National Habitat Standards as proposed under the National Mission on Sustainable habitat-One of the 8 Missions of The Prime Minister's National Mission On Climate Change.
Urban ecosystem management and conservation	Conservation of green areas/wetlands/beels-Inside the jurisdiction of GMDA	Preparation of Conservation and management plan for wetlands Preparation of inventory and demarcation of natural water bodies and green areas
Water	Augmenting the water supply system in the city Regulating withdrawal of ground water and rain water harvesting Water quality monitoring and control	Geo-hydrological studies for new projects Conduct exploratory studies for establishing new withdrawal points Centralized monitoring system through a quality monitor team
Drainage	Protecting and managing natural drainage systems of the city Restricting waste disposal in Bharalu and Bashishtha rivulets	Improvement of drainage in the Brahmaputra Valley and Barak Valley, including project planning and construction of dams, flood control and bank erosion measures. Identify points of drainage blockage/ encroachment in the rivulets
Electricity/ Power	Promoting energy efficiency urban land uses Promoting use of renewable energy sources	Employ fiscal measures like a progressive and use based tariff structure to promote energy efficiency Enforcement of energy efficient building code (ECBC) or GRIHA guidelines for energy efficiency in HVAC systems in buildings, particularly under institutional and commercial uses Implementation of Solar City Plan under the Jawaharlal Nehru National Solar Mission (as part of NAPCC).

Indore City Resilience Strategy for Changing Climatic Scenarios

SUMMARY





Prepared by:
TARU Leading Edge

Full Version of the "Indore City Resilience Strategy for Changing Climatic Scenarios" can be downloaded from:
http://indiaurbanportal.in/BestPracticesResult.aspx?type=3&SearchID=182
http://indiaurbanportal.in/Publications/Publications182/Publications182760.PDF (Hindi)
http://indiaurbanportal.in/Publications/Publications182/Publications182756.PDF (English)

3

3.1 HISTORY AND BACKGROUND

Indore is the most prominent city and commercial capital of Madhya Pradesh. It is also the headquarters' of Indore district. Indore agglomeration's population increased from 1.51 million persons in 2001 to 2.17 million persons in 2011(decadal growth rate of 42%). It was 17th largest city in India during 2001 and is now to 15th largest city.

Situated on the western part of the Malwa (Deccan Plateau) at an altitude of 550 m above mean sea level (MSL), it links Central India with the coast. The city lies in black cotton soil region in a relatively flat plateau having a gentle slope towards the north. The Khan River and its tributaries traverse through the densely populated areas of the city. The city of Indore had its first municipality in 1870. In the year 1956, it was declared as a Municipal Corporation and is currently governed by the Madhya Pradesh Municipal Corporation Act, 1956. The Indore Municipal Corporation is divided into 14 Zones administered by two functional bodies namely Political Wing (deliberative) and Executive Wing. The city has a municipal area of 134 sq.km and the total planning area (including IMC and Indore Development Authority area) is 524 sq.km.

3.2 URBANISATION ISSUES

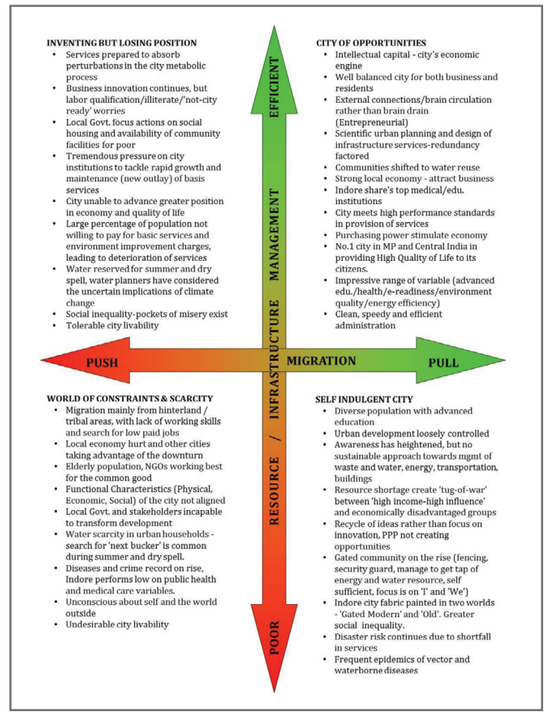
Indore is one of the fastest growing cities and is called Mumbai of Madhya Pradesh. It is also the largest industrial hub of Madhya Pradesh. The decadal population growth of 42% during the last decade indicates that it is growing faster than many other cities across India.

Since the city is located in plateau environment, there are no land constraints. Indore is the largest city in the neighborhood and is likely to be the destination of push migrants from rural hinterlands. The city scenario exercise conducted with the city stakeholders indicated that migration as well as infrastructure and service quality would be most important critical uncertainties that would determine the future growth.

3.2.1 Migration Pattern

The city is located in the semi-arid zone, by complex, diverse risk-prone agricultural region lying in rain-shadow zone of Western Ghats. In the hilly parts neighboring the city, land quality is poor and per capita cultivable land is low and agricultural yields are low and uncertain due to rain-fed agriculture. It is inhabited by a mix of tribal and caste population who are predominantly poor. Any climate change can further increase the risk to subsistence agriculture and rural population is forced to migrate to the nearby cities, with economically stronger Indore becoming the preferred destination for the migrants. These rural migrants are skill poor and the city economy may be affected by the push migration. In such a case, the proportion of low skilled workers will increase and they need to be supported by subsidized lifeline services. If Indore continues to attract secondary and tertiary sectors of economy, Indore may become preferred destination for skilled workers. Its current potential to attract educational and medical institutions will be an added advantage. Such pull migration is likely to result in demand for better services and ability to pay for better services. Therefore, the migration pattern will be most important critical uncertainty for the future

Figure 3.2: Indore Urban Future Scenarios (Risk to Resilience Workshop, Indore 2010, ACCCRN)



3.2.2 City Level Resource/Infrastructure Management

Since the Indore city depends on distant water resource of Narmada River to meet its growing water demands, the cost recovery will be critical for managing water infrastructure of the city. Also, with the increasing energy costs can add additional burden on the IMC. The maintenance as well as capital investments required will depend on the city's ability to recover the costs. Considering the huge gap in municipal finances, the ability to charge the consumers and to maintain the infrastructure will be another major critical uncertainty.

The quality of services would improve only if there is expressed demand for services. So far, the citizens have not been proactively demanding for better services even though water supply is provided only once in two days. Only in case of non-supply, the people protest, but even they are unorganized.

The city stakeholders built four scenarios based on the two critical uncertainties. These scenarios are presented in the previous figure. While "City of Opportunities" scenario is most desired, it would require several enabling conditions to be met and the living environment needs to be kept above the minimum threshold much above the current status. Political will, continued investments and willingness of community to demand and pay for the services would be essential preconditions for this scenario to emerge. For each one of the scenarios, early signs were identified, so that realignment of the goals of the ULB to provide basic services.

3.3 CLIMATE AND HYDRO-METEOROLOGICAL RISKS

In the past, Indore was known for pleasant evenings even during peak summers, known as Shabe' Malwa. Indore is already facing increased temperatures in summers. Combined effect of regional climate change as well as urban heat island effects have reportedly led to continued temperature lag well in to the nights during the summers. The peak temperatures reach upper 40's and also dust storms from western desert region often reach the city. Indore was also known for gentle rains throughout the season, while now it faces dry days with few very heavy showers. This has led to increased water logging as well as occasional floods. Water logging has reportedly increased the incidence of vector-borne diseases. Impervious soils, increasing proportion of paved areas, blockage of drainage by construction of roads as well as blockage of drainage by solid wastes are believed to be increasing the incidences and duration of waterlogging.

The indirect impacts of climate change include increased incidence of water and vector-borne diseases, exacerbated by the water scarcity routinely experienced by the citizens. The major growth in peak demand for electricity can be expected to occur due to higher summer temperatures as well as affordability of air conditioners among majority of the households as well as offices/ commercial/industrial work spaces. With the continued high temperatures lasting through evening and early part of the night, the energy demand for space cooling is likely to stress the electricity network. Occasional droughts can reduce the hydel power generation as is being experienced by the state this year. Grid failures can increase the vulnerability of the energy was well as water supply sector significantly.

For analysis on Rainfall, temperatre, future rainfall and temperature analysis (2021-2100), extreme event analysis, refer to the city resilience strategy document.

3.4 EXPECTED IMPACTS FROM CLIMATE CHANGE

The water will remain the critical resource that can cause large scale impacts on Indore. Models indicate that in this century there is a possibility of only a marginal increase (+200 mm) in annual rainfall. The climate projections indicate dominance of extreme events that would mean either long dry spells or few very heavy rainfall events dominating the monsoon. In case of droughts, the city's reliance on Narmada would increase, which may be accompanied by unreliable power supplies. With heavy rainfall events dominating the monsoon, rainwater storages of higher capacity would be needed at various levels starting from individual buildings to city level. The city should have sufficient sewerage as well as solid waste management system, which would prevent mixing of rainwater with the contaminants from sewage. The Indore water security study has indicated about 5% increase in evapo-transpiration, which will offset much of the increase in precipitation, if the water is stored in surface reservoirs.

Ground water recharging offers an option, but it would require decentralized efforts at household and colony levels. Strengthening of ward committees as well as Rehwasi Sangh (Residents welfare associations) would be critical in ensuring these along with active cooperation from sewerage and solid-waste management utilities.

With high costs of water imported distant source and increased water scarcity, it is important to conserve and recycle water. Current paradigm of centralized sewage treatment outside the city may not be suitable for recycling water. Decentralized options can create opportunities to reuse water from irrigation of gardens and ground water recharge. Such paradigm shift can reduce costs of sewerage network as well as integrate water supply systems with recycling and reuse at colony levels. It would necessitate policy and legal interventions like rainwater harvesting bill enacted few years back.

3.4.1 Storm water drainage and floods

Increase in intensity of precipitation can result in increased frequency as well as intensity of floods. Since the city has black cotton soils, in the events of floods very low coverage of storm water drainage and limited sewerage will prolong the duration of water logging/ flooding. Without integrated storm water drainage and flood control plan, the city may be subjected to more frequent and intense floods under climate change scenarios. Haphazard growth and blockage of natural drainage may further worsen these issues.

3.4.2 Energy

The energy dependency for water pumping will increase with population growth and the impacts of climate change. The PRECIS model indicates reduction of rainfall in the upper catchment of Narmada, while increase in the middle and lower reaches.

The increase of 2ºC of maximum temperature across the year is likely to increase the energy demand for space cooling significantly-especially during the summers,-adding to increase due to life style changes. The human thermal comfort levels are likely to shrink further by combined effect of climate change and urban heat island effects. The urban heat island effects may further increase the temperature in the inner city area by about 3-4ºC.

The current per capita consumption of 250 kwh/year is very low, and is expected to increase by about 10% over next decade while the consumption may increase by about 61% under BAU calculations of the Utility(with 50% decadal population growth). The additional increase due to climate change would depend on the affordability of the households. The practice of using individual owned space cooling systems is likely to concentrate heat in semi-closed spaces in multi-storied buildings.

The extreme heat days can create peak loads and black outs similar to ones faced during last summer. Cascading effects of power supply breakdowns can impact distant source based water supply system and impacts of water supply can only be prevented with continued conservation of local surface and ground water resources, managed by the communities. Recycling of water, recharge and conservation of ground water and conservation of local sources like lakes are important to deal with such cascading impacts.

3.4.3 Land

Land is not a major constraint in Indore, except for the core area of the city. Two main growth axes are seen in the development pattern of the city. They include South-west (towards Mhow) north (towards Ujjain). The population growth across wards indicates that the core area is getting depopulated and converted in to commercial areas, while there is high growth in outer core and periphery. Except for the core and lower income group colonies, Indore has significant open areas. The population growth is likely to put pressure on these open areas.

While there is growing trend of building multi-story buildings as well as increasing use of glass cladding in the city, the urban heat island effect and increased energy use density(for space cooling) can worsen with haphazard taller buildings blocking free flow of winds. A significant number of low height buildings (up to 3 story) currently seen in the outer core may change to high rise buildings, especially along the main roads.

3.4.4 Health

Vector borne disease outbreaks have become more common over last decade due to combined effects of urban development without sufficient drainage and poldering effects of road construction resulting in prolonged water logging of some of the areas. Integrated drainage development has not been done so far. Only about 20% of roads have drainage. Poor solid waste management has further blocked the natural drainage. Along with water logging, increase in humidity, increase in minimum temperatures are likely to extend the disease vector viability periods and may worsen the disease incidences.

3.4.5 Infrastructure Impacts

With Sufficient storage along the upstream stretch of the river basin, water resource at Narmada River is not a major issue in the coming decades, but this source needs significant energy for pumping. The combined effect of increasing electricity demand without concurrent increase in generation capacity and competing uses can impact the Narmada water supply system, which is dependent totally on electricity. The city water supply can be impacted severely if the electrical system is over loaded, especially during summers when the local sources dry up.

To overcome the road maintenance problems in black cotton soil terrain, the IMC has been laying concrete roads in important stretches as well as in slum areas prone to water logging. Unless large funds are available, these measures are unlikely to cover most of the road network. The existing roads may be affected by rains and increased temperatures, causing increased expenditures. Increasing intensity of rains without sufficient storm water drainage and sewerage network is likely to contribute to the deterioration of road infrastructure in expanding black cotton soils as well as increase waterlogging.

3.4.6 Differential impacts on poor

Significant proportions of slums in Indore are located along the streams and are prone to flash floods. Slums are also most vulnerable to waterlogging and vector-borne diseases due to their location. Under various donor funded programmes, improvement of drainage and road network are being attempted. But the outcomes of such measures often do not last beyond the project periods. The recent donor funded programme, MPUSP, has overcome many of these issues, but the issue of solid waste management still needs attention to provide sustainable solutions. Sustainability of community based organizations created by the project would necessitate continued engagement by the ULB.

The temperature increase is also likely to cause differentially higher impacts on poor due to overcrowded settlements, low ventilation and poor vegetation cover. Since most poor cannot afford space cooling devices beyond fans, nor the increasing costs of electricity, they are likely to be impacted differentially. During the monsoons, high humidity conditions, combined with increased monsoon temperatures can increase discomfort in under-ventilated houses.

3.5 ISSUES AND IMPACTS SUMMARY

Indore already faces major issues of water scarcity, sewerage and solid waste management. While resource scarcity exists in case of water, low expressed demand from users and poor management is largely responsible for the current status. The city population is expected to double if the current trends continue. That would mean building to fill the gap in infrastructure and services and additional investment equivalent to cumulative investments done so far in housing, water supply, sewerage, solid waste management. Considering current challenges, Transport and urban health management would be other two major areas of concern. The main issues and impacts that Indore city has to address over coming decades is presented in the following table.

Table 1: Issues Matrix

Scenario Sectors	Current Status	Future Trends (BAU) Without CC	CC Issues
POPULATION	Medium demographic growth (43%)	Growth rates increases unless economic growth slows down/push migration stops	Increased Push migration periods from impacts on hinterlands, dominance of low skilled population
DISASTERS	Droughts common, occasional short term flooding and water logging	Trend likely to continue, Impacts due to city expansion and other anthropogenic changes likely to worsen the flood intensity, vector borne diseases may increase due to water logging	More intense and frequent floods amplified by urban development. Poor residing along drainage lines, even in the upper parts of minor catchments impacted by flash floods. Droughts trigger increased push migration. High temperatures and dist storms in summer
HEALTH	Malaria and dengue common, strong seasonality, Heat strokes unknown	Trend likely to continue	Seasonality of the vector-borne diseases likely to change, expansion of disease transmission period likely to increase due to increased temperature and changes in humid seasons. Morbidity from heat strokes expected
RESOURCES (WATER, LAND, ENERGY)	Water scarcity despite about 85% dependence on distant sources, high UFW. Growing clout of informal water markets. Focus on capital works, without exploring soft paths	Short-lived water sufficiency followed by water scarcity driven by increase in energy prices and unreliable power, Major challenges to recover cost of water. Competing demands. IMC continues to stress on capital investment route without opting for soft paths	Re-emergence of water scarcity due to increasing unreliability of local sources due to uncertain rainfall, Competition over Narmada water from other sectors and thefts/water conflicts along the route with local user Increasing peak energy demand from increased temperature
ENVIRONMENT	Very dense core, vehicular pollution high in core area	Traffic issues, pollution may increase, rapid transport can reduce some load Downstream impacts of disposal of sewage in to streams	Higher impacts of pollution due to higher temperatures, especially during summer Increased algal growth in water reservoirs due to pollution and temperature increase leading to eutrophication and fish kills
ECONOMY	High growth	Medium to high growth expected with increase in efficiencies. Quality of life may not improve if current trends continue.	Minor change in energy consumption for processes, but significant impact on energy demands for space cooling, vector borne diseases may impact the labour productivity.

Scenario Sectors	Current Status	Future Trends (BAU) Without CC	CC Issues
TECHNOLOGY	Fast up gradation to overcome labour scarcity	Shift to more efficient water and energy technologies, especially by those who can afford.	Water reuse technologies can alleviate scarcity. Efficient lighting, mass rapid transport can reduce energy use and pollution impacts
SOCIAL/ EQUITY	Iniquitous growth being addressed by improving Service access to poor, sustainability issues exist	Gated communities and slums coexist. Poverty may increase due to push migration from large underdeveloped drought prone hinterlands with skill poor population	Push migration can lead to conflicts and distress

With near doubling of population, impacts of urbanisation would be much higher than climate change impacts in case of Indore. Extreme precipitation patterns are likely to catalyse large scale push migration from complex diverse risk prone environments with large pool of skill poor labour in to Indore and neighboring cities, which have high costs of water and other basic needs. Poverty is likely to grow, unless conscious efforts are done in skill building of the push migrants and providing opportunities to for them to be absorbed in to the formal economy.

3.6 CITY RESILIENCE STRATEGY HIGHLIGHTS

Being located in the underdeveloped state, Indore faces resource and policy constraints from the state level. The city also faces challenges in terms of lack of demands for better services, capacity of the city administration to address rapid urbanisation, amidst of finance and natural resource base constraints.

On the positive side, Indore has been the focus of donor attention over last two decades and has implemented several donor funded projects aimed at improving the access to urban services to poor. Valuable lessons have been learnt from these projects which has informed this resilience strategy. Indore is expected to continue to attract donor funds for pro-poor inclusive urban development and also expected to guide the inclusive development programmes and debate at state and national levels.

Indore city ULB faces challenges of administrative, municipal financial autonomy and health, political will and lack of consensus. The following approach has been used to build leadership about resilience building by the local and state stakeholders:

- Building on addressing current risks and vulnerabilities with CC context
- Create awareness about climate risks and generate demand: Bottom up approach
- Demonstrate resilience projects to generate interest among the ULBs and other decision makers
- Generate Multi-Sectoral Information & Shelf of Project Proposals
- Building synergy with state and national institutions

It has to be noted that the local stakeholders linked the climate change with water scarcity, changing precipitation pattern as well as increasing temperatures during summer evenings. Series of "Risk to Resilience" and scenario building workshops helped in their raising awareness about a variety of issues like migration, possible resource scarcities and urban health. These workshops built consensus over the linkages between urban growth, poverty and climate change. These exercises traced the recent history of Indore and changes being felt by the citizens and possible impacts of such changes continuing along with rapid urbanisation and migration.

These workshops led to identification of interventions to address the issues raised from analysis of secondary data ranging from climatic, demographic and economic model outputs, local knowledge of stakeholders and facilitation by us. The main sets of interventions across the sectors are presented in the following tables.

Significant changes are expected in economic, urban governance and social situations over this period and more information would be available from emerging higher resolution climate models, economy and demographic trends. It is suggested that a reassessment of these proposed interventions is done by 2015 and suitable modifications may be done in the strategies and interventions.

Table 2: Suggested Short Term Interventions

Sectors	Needs	Interventions	Potential Partners/ Stakeholders
RESOURCES (WATER, ENERGY)	**Water Availability:** Build redundancy for meeting CC impacts Augment alternate supplies/ source, reuse options **Energy:** Improve efficiency, reduce space cooling costs Build redundancies Meet demands and control price, meet shift in energy demands	**Water** A. Comprehensive water management of local and Narmada resources • Assessment of resources • Developing options for different spatial scales/ SECs • Rainwater harvesting/Water reuse options at various scales B. Demand side management • Leak detection and retrofitting • Water literacy modules • Citizen engagement & reporting system **Energy** A. Energy efficiency • Promotion of energy efficiency products • Codes for passive cooling and energy efficiency residential, commercial and industrial buildings, and incorporation of these codes in weaker section housing projects • Develop guidelines and regulations for environmental sustainable building design, construction and operation (Water/Energy/SWM) B. Study on renewable energy options at various scales and end uses	IMC, Water Dept., Narmada and water resources Dept., MPEB, Centre of Energy Studies and Research - D.A.V.V, National Institute Industry Forum for Energy, Industry Associations

Sectors	Needs	Interventions	Potential Partners/ Stakeholders
NATURAL DISASTERS/ HEALTH ISSUES	Reduce risk exposure, especially for poor Warning and forecasting products for severe weather events strengthen city disaster management plan Vector borne disease surveillance and health monitoring system	A. Flood plain zoning and advance warning system B. City level storm water drainage master plan including rainwater harvesting options C. Improving disaster response plans including evacuation of citizens from high flood risk zones D. Disease monitoring system with epidemiological research support & health GIS	IMC, Public Health Deptt. Emergency officials, Hospitals, Irrigation Deptt. NGOs
URBAN SERVICES	Meet global standards, high rating in service level benchmarks Access to affordable, appropriate and health services and information	A. Benchmarking vulnerability of critical lifelines and infrastructure to CVCC risks B. Develop framework for online/continuous monitoring of gaps/ deficiencies in urban services	IMC, Service Deptts, IDA, NGOs, Community Volunteers
POPULATION	Income Vulnerability reduction through Informal education, skill upgradation	A. Increasing livelihood options through informal skill building courses on technologies, improved services and management with close linkages with industry B. Industry approved certification process C. Climate leadership training programmes introduced	Educational institutions, Vocational Training Institutes, NGOs, Chamber of Commerce and Industry

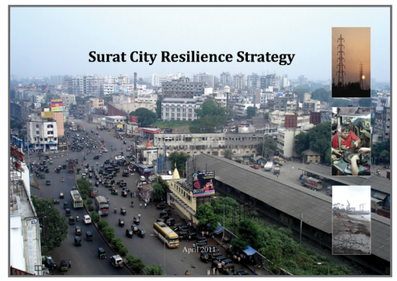
Sectors	Needs	Interventions	Potential Partners/ Stakeholders
ENVIRONMENT	Reducing vehicle pollution, traffic issues, park cool island (PCI) effect, better environmental services	A. Plan for increasing share of public transport, IT enabled Transport system B. Increase in green cover, especially along road network C. City's environment management plan (monitoring of key parameters, maintain within specified standards) D. City level group for monitoring and advisory to the ULB	IMC, IDA, Educational & Research Institutions, Industry/Automobile Associations, MP Pollution Control Board, Civil society
ECONOMY	Reducing economic losses	A. Establishment level disaster management plans, B. Water/energy efficiency improvement conservation plans	Industry associations, Industry Leaders
TECHNOLOGY	Use of state of art water and energy saving technologies. City level water, energy, transport management system Energy audits, awareness about energy saving	A. Technology plan for water and energy sector B. Support agency for energy efficiency improvement C. Demonstrate effectives of technology in select units (residential/ commercial/ industrial)	IMC, IDA, MPEB, Industry Associations, Educational and Research Institutions
SOCIAL EQUITY	Build, strengthen and empower citizen's local groups in managing their local areas Empowering and devolving resource /service management to ward levels	A. Ward level planning program focusing it's on the ground level issues B. Form and facilitate issue based groups for community action and managing of local assets C. Empowering poor communities	IMC, NGOs, CBO, TCP Office

Table 3: Medium Term Interventions Incorporating CC Risks

Sectors	Issues	Projects	Potential Partners/ Stakeholders
RESOURCES (WATER, ENERGY)	Water scarcity issues can become more acute with increase in variability, increased energy demand due to temperature increase and humidity level	A. Improving redundancy of the water supply system B. Near real time water system monitoring C. Interlinking water supply projects D. Urban user groups for conjunctive water management E. Hotline maintenance in monitoring of lines and transformers F. Setting up of cogeneration plant G. Technology upgradation for electricity distribution at city level	IMC, Water department, Water resources department, MPEB, Education and research institutions, Industry & Trade Associations, CEPRD
NATURAL DISASTERS/ HEALTH	Disaster preparedness and adaptation	A. Community based flood preparedness programme in high risk prone areas B. GIS based Disease Surveillance System	IMC, Public Health Dept, Emergency officials, Hospitals, Irrigation Dept, NGOs
POPULATION	Push migration periods from impacts on rural areas, dominance of low skilled population	A. Monitoring programme on push migration and launch of suitable programmes and safety nets B. Initiate programmes that focus on skill development	IMC, NGOs, Educational Institutions, Industry Associations
URBAN SERVICEs	Deterioration of urban services	Harden the city infrastructure to withstand climate risks (Water/Energy/Transport/ Drainage/Sewerage)	IMC, Service departments, IDA, Technical/Educational/ Engineering Institutions
SOCIAL/EQUITY	Push migration, higher inequity due to skill constraints of new immigrants, pressures on infrastructure & services	A. Community planning program focusing on providing services through a revenue model B. Training and Learning Centres to impart skill development	IMC, NGOs, CBO, TCP Office
ENVIRONMENT	Higher impacts of pollution due to higher temperatures, severe loss of green cover, poor quality of urban environment	A. Comprehensive Transport Master Plan based on forecasting latest technologies B. Revive old water tanks across the city and increase green cover C. Development of integrated municipal waste processing facility D. Implementation of environmental building guidelines/energy code in the construction of new buildings and retrofit of existing buildings	IMC, Horticulture Department, Transport Department, Educational and Research Institutions, Industry/ Automobile Associations, NGOs, Environmental consultancy firms
ECONOMY	City loses opportunity due to CC impacts and risks	A. Reassess economic growth and global demand pattern to bring in greater efficiency in services and business B. Develop and implement forward looking policies action plans that proves best for business and residents (infrastructure landscape, health, safety and security, liveability) C. Create environment (branding, marketing) for encouraging pull migration of high quality human resources	IMC, IDA, Planning Institutions, Industry & trade Associations, Resident Associations, Transport Department, Police and Emergency Services
TECHNOLOGY	Indore becoming a centre for CC technologies, resilience approaches	A. Expansion focused on clean and sunrise industry/ service sector B. Establishment of Theme Park to create public awareness and provide solutions	IMC, Educational and Research Institutions,

Surat City Resilience Strategy

SUMMARY



Prepared by:
TARU Leading Edge

Full Version of the "Surat City Resilience Strategy" can be downloaded from:
http://indiaurbanportal.in/frmDocAlbum.aspx?Srno=181&Type=3
http://indiaurbanportal.in/Publications/Publications181/Publications181755.PDF (English)

4

4.1 BACKGROUND OF THE CITY

The city of Surat, located on the western part of India in the state of Gujarat on the River Tapti, is an important historical trade centre and trade link between India and Gulf countries. Surat was a gateway to the Deccan plateau and was an important port and trading centre during the Mughal period. The city has one of the highest proposed investments and almost zero percent unemployment. It is one of the fastest growing cities in India.

Surat has a Tropical Monsoon Climate. Summer temperatures in Surat range from 37 to 44ºC with winter temperatures dropping to 22ºC. Monsoon begins in June and last till end of September, with the average temperature being around 28ºC during those months. Average annual rainfall is approximately 1,143 mm. The city faces the risks of both sea level rise and flooding. The Ukai multipurpose dam built upstream, 94 km from Surat, was meant for flood control management and for irrigation, power generation. During the last two decades the city of Surat and the surrounding metropolitan region has witnessed major floods.

Surat city has seen an unprecedented growth in last four decades recording one of the highest city population growth rates in the country. The City now ranks as the 9th largest city in the country. Coupled with this, the spillover of population into periphery has also been observed. From time to time jurisdictional limits of SMC have also been extended to include the outgrowth.

4.2 URBANISATION ISSUES

Surat is 70th largest City in the world and is expected to become 41st largest city in the World by 2020 (City Mayors.com Website 2010). It is also ranked as the fourth fastest growing city in the world with population of more than 1 million. It is ranked as the 131st richest cities of the world with a GDP of 22 billion USD in 2006, which is expected to rise to 119th rank by 2020 with a GDP of about 57 Billion USD and a growth rate of 6.5 percent annually.

The city population is expected to grow to nearly 7.53 million by 2025, without considering the city area expansion (UN population data 2010) with average decadal population growth rate of about 50% percent over the 2011-25 period as against all India decadal urban growth rates of 27% only. This would mean that the city has to provide housing and lifeline services for another 3 million people or nearly 67% additional capacity in lifeline services. The expansion of basic urban services for the additional population would need investments of at least Rs.1,436 Crore for water supply, sewerage, storm water drainage, solid waste disposal, roads and streetlights as per Planning commissions' per capita investment estimates at 2004-2005 prices. This is over and above the costs towards hardening the existing infrastructure.

The Surat city, being located on the flood plain of Tapi River, is already facing high tide inundation issues during rainy seasons. It is likely to face challenges of increasing vulnerability to floods and sea level rise. Also, further expansion of Hazira industrial area in the lower flood plain, is expected to worsen the flood risks.

One of the major characters of the Surat city is the strong social fabric. The future scenarios developed by the city stakeholders have raised the issue of community cohesion arising out of the growing immigrant population.

Considering the current industrial, infrastructure and investment growth (both in Surat and Hazira) as well as the demand for the labour for Surat's textile and diamond industries combined with push migration from rural/agricultural hinterlands can give rise to 50% + population growth during the next decade. The UN population projections estimate 48% decadal growth in population during 2010-2020 period. (UN 2010)

4.3 POVERTY

Similar to other rapidly growing cities in India, Surat has its own share of slums. The slums have mostly migrant population who are unable to afford formal housing. As per 2001 Census, about 20% of the Surat's population (0.49 million) lived in 307 slums. With the recent expansion of the city in 2006, this number has increased to 420 slums. Many of these slums are located along the tidal creeks, between the river embankments and other drainage lines. These slums face higher risk of flooding (pluvial, fluvial and tidal). In addition to slums, the low income settlements exist throughout the city. Some of them are upgraded slums. The slum and low income population of the city is

estimated to be about 34% of the total population (TARU 2010).

The Urban community development department (SMC) is active and monitors delivery of essential services in slums. In comparison other Indian cities, slums in Surat have better access to water supply, drainage and sewerage facilities. But, very high in-migration of semi-skilled workers from across the country is challenging the efforts of SMC. Having recognized the flood risks, efforts to relocate the slums were initiated by the government under various schemes (mainly during the last decade under various national projects including JNNURM) and more than 30,000 permanent houses at safer location were provided to the slum dweller.

4.4 CLIMATE AND HYDRO-METEOROLOGICAL RISKS

Surat is lies in the flood plain of Tapti river near it's confluence with Arabian Sea. Tapti basin is about 587 km long from east to West and about 201 km wide (N to S) and is elongated in shape passing through Madhya Pradesh and Maharashtra. Tapi is one of the large perennial rivers in Western India. It is 724 km long originating from Multai in Betul district of Madhya Pradesh and cutting across the Western Ghats and joining Arabian Sea near Surat. Total catchment area of the Tapti river basin is 65,145 km2 including about 79%, 15%, and 6% in Maharashtra, MP, and Gujarat respectively. Its upper catchment lies in semi-arid region with high coefficient of variability in rainfall.

In the catchment area of Tapti River, the monsoon generally starts during the third week of June and there are occasional heavy rainstorms from the beginning of August to the end of September. The mean annual rainfall in the basin is estimated to be about 758 mm. and the average monsoon rainfall from 1988 to 1998 was 897 mm. The maximum annual rainfall (1,168 mm) and the minimum of (257 mm) were recorded in 1944 and 1899. Most of the floods in Tapti occurred during August.

4.4.1 Flood History

Throughout the history of more than seven centuries, the city of Surat has experienced floods, fires and plague epidemics. The city earlier had a flood protection ring wall built with bricks and several gates, which were closed during floods. Westerly moving depressions arising out of Bay of Bengal moving from upper Tapi catchment to the Arabian Sea cause heavy rainy spells lasting 3-5 days. The runoff often gets concentrated due to this process, causing heavy river discharges by the time the flood water reaches Surat. During the period 1876 to 2009, the Tapti crossed the danger level at Hope Bridge in Surat 27 times, i.e., on an average every five years.

For current and past climate data analysis, Rainfall, Future Precipitation Analysis: 2021 – 2100. Extreme Event Analysis, Temperature, Future Temperature Analysis: 2011-2100, refer to the Surat City Resilience Strategy document.

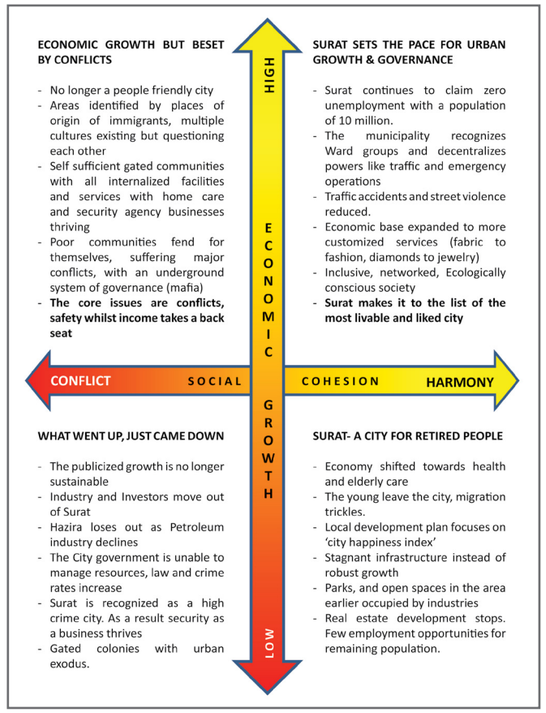
4.5 CITY FUTURE SCENARIOS

Based on two critical uncertainties identified by the City Advisory Committee, four future socio-economic scenarios were developed. These provide a combination of improvement or decay of Social cohesion (X axis) and economy (Y axis). These scenarios reflect 2030-2040 periods and are based on the set of certainties and uncertainties identified by CAC. The diagram highlighting the four scenarios is presented in the Figure 4.5: Surat Urban future Scenarios.

Considering the major global and national level economic changes, Surat may face any one of the above scenarios. The population projections may not represent the reality if the economic growth slows down or the social cohesion breaks down, thereby reducing the resilience of the society.

The climate change is likely to roll out impacting various sectors and sections of population differentially over coming decades. Issues of extreme temperatures, floods and water scarcity may impact the city, even though currently the city only faces the flood risk. With the increasing competition over water resources from Ukai dam, the conflicts over water across sectors can be expected in the coming decades, especially from growing industry and energy sector.

Figure 4.5: Surat Urban Future Scenarios (Risk to Resilience Workshop, Surat 2010, ACCCRN)



4.6 CLIMATE CHANGE IMPACTS

4.6.1 Severe rainfall events

The rainfall increase in the Tapi catchment and Surat city is a matter of concern. This situation may be further aggravated with the possibility of high variation in the distribution of rainfall (longer dry spells and increased intensity of and frequency of severe events). Even though the flood event lasts for two to three days, the city and its economy takes several months to recover. The floods are also expected to impact the Hazira industrial area, despite land filling and other protective measures taken by the Hazira industrial area.

The Maharashtra state (neighboring state) is planning to build dams upstream, which may buffer peak discharges to certain extent. However, the maximum storage that can be added is small given the forest and hilly areas upstream. Conversely, with the increase of siltation in Ukai dam, the carrying capacity and the flood control capacity is likely to be reduced. The situation of flooding due to peak discharges in to Ukai dam is highly likely. This calls for an Flood early warning system for Surat.

The flood damages also should be explored from the perspective of the changing economy and social cohesion. While the city may be able to recover within months in case the city's economy is strong, conversely during economic downturns, the city may take much longer time to recover. Surat's economy is still largely labour dependent and any disasters would lead to mass exodus, which would take many months to reverse as evidenced during the 1994 plague and 2006 floods. In such cases, the city may not be able to recover for long periods. Considering mobility of labour and growing alternate centres of opportunities for workers, the city has no option except reducing the flood risks with improved flood forecasting systems and more effective management of Ukai reservoir.

4.6.2 Sea level rise

Surat has been experiencing some of the highest tides on record during past few years and SMC had to evacuate huts located at the edge of the creeks in 2008 and 2009. Since the high tide level is increasing, some of the already built up areas near the tidal creeks may also face the impacts of submergence as well as weakening foundations of multi-storied buildings due to ingress of corrosive sea water. Sea level rise is also likely to cause further erosion of the coastal area near Dumas included in the city area in 2006.

The coast is potentially high value property due to beach access, which may be developed as the city grows. There are already demands by various interest groups to build coastal erosion control structures, which if implemented can catalyse further real estate development in these high sea level rise risk areas.

4.6.3 Temperature increase

Surat lies in high humidity coastal environment and summer maximum temperatures crosses 40ºC and night temperatures cross 25ºC. The traditional buildings were designed with sufficient ventilation to reduce thermal discomfort. Along with high humidity, these ranges cause discomfort for people. The increase in thermal discomfort due to urban heat island effect

and higher affordability has led to people preferring air conditioning system instead of natural ventilation.

Such change in lifestyle combined with changes in temperature would eventually lead to increased energy consumption. Further, any increase in summer maximum temperature (April May period) is also a matter of concern with respect to health. Since, the humidity levels are quite high in this coastal city, an additional increase in temperature may lead to health problems. The increase in minimum temperature, especially during the winter months, will also lead to increased survivability of disease causing insect vectors and pathogens.

4.6.4 Water demand and resources

Surat city depends on Tapi for meeting most of its water demand. Surat Municipal Corporation prepared a long-term Master Plan in the year 1995 for Water Supply Scheme of Surat city for an area of 112 sq.km before expansion.

The new master plan including the expanded area under the SMC is being prepared. The SMC has only 700 MLD of allocation from Ukai reservoir. Droughts and late onset of monsoon are already creating stress on Surat's water supply system during peak summers. Under both the high economic growth scenario, the population growth is expected to grow significantly. For meeting the demand of future population of 7.5 million plus in 2025 as well as meeting industrial and energy generation needs, the current allocation from Ukai dam is insufficient. This situation may increase the competition over limited resources currently allocated for irrigation and power generation. Water scarcity will become an issue, unless major changes in cross sector allocation Ukai dam water resources takes place.

The climate models have indicated minor increase in annual precipitation along with reduction of rainy days as well as increase in extreme events including droughts and heavy rainfall in the catchment. Considering already increasing conflicting and competing demands for Ukai water storage, the water scarcity can become a reality in this city. With the sea level rise, the aquifers are likely to face increase in salinity, especially in the western parts of the city. Blessed with more than 1000 mm of annual rainfall, rain water recharge systems and storage of emergency release water, reuse of treated sewage water and desalination options need to be explored to meet growing stress on water resources.

4.6.5 Health

Urban health is a major issue in the tropical coastal city of Surat. Located in a nearly flat coastal terrain, Surat was infamous for Filaria and Malaria. Even now, Surat doctors are well known for their knowledge about managing Malaria cases. The health sector study highlighted near-extinction of Filaria due to extension of underground sewage across the city. Similarly, the Malaria is under control due to a strong citywide monitoring system including over 300 doctors and municipal health centres. Mosquito vector control measures including door to door monitoring of breeding and monetary fine system as well as fogging reduces the incidences.

The health sector study also raised concerns regarding changing climate that can cause changes in vector propagation and recommended conducting continued action research on climate and vector-borne diseases. This is especially important since this region is a Malaria endemic area and also faces recurrent outbreaks of Leptospirosis.

4.6.6 Land & buildings

The 2006 floods inundated 75% of the city area. With Arabian Sea on the west, only three directions of growth are possible. The coastal erosion and sea level rise is expected to reduce the area available for city expansion towards west, thereby reducing the area of the current municipal limits over coming years, as evidenced by coastal erosion along the Dumas beach and increasing level of tides entering the creek areas within the city. At least five percent of the total municipal area of 326 sq.km would be prone to sea level rise related risks.

Building of bridges, weirs and embankments have reduced the safe carrying capacity of the river channel. Earlier, more than 1 million cusec of flood waters could be safely discharged without causing any major damage, which now the channel is unable to handle even 0.4 million cusec, mainly due to growing number of bridges, weirs, embankments covering both river banks. The ground floor of any building in the most parts of the city is prone to direct flood risk, with some areas facing risks to first floor also. Any climate change induced precipitation increase can only increase risk to the areas close to the river, especially on the immediate leeward side of the embankments.

In both high economic growth scenarios, the real-estate demand is expected to increase. With some of the coastal and tidal creek areas affected by sea level rise, remaining areas will be subjected to real estate development pressures. Expansion of the city towards south (twin city of Navsari and Surat) as well as towards east (National highway) and towards north can reduce the population density significantly. Given the flood risks, vertical and compact growth may be a good option that needs to be explored in the old city area, but issues of narrow roads and traffic congestion needs to be resolved before increasing the FSI limits in the core area. Major shift to public transportation as well as maintaining/improving energy security would be necessary before any changes in density can be attempted in the core areas.

4.7 ISSUES/IMPACT MATRIX

Urbanisation, poverty and climate change are expected to raise several challenges to the citizens, communities and ULBs. It has to be noted here that the scale of changes catalysed by rapid urbanisation would be of much larger scale demanding major investments in infrastructure and lifeline infrastructure, as highlighted by various analyses (MGI, 2010; MoUD, 2011). With near doubling of the population (with 60+% decadal growth), and existing gap in lifeline infrastructure and services, Surat may have to invest more than cumulative investments done so far for housing, water supply, sewerage and solid waste management. Large investments on infrastructure and efforts in management of services done over last two decades would benefit on short term, but high growth would demand continued large investments and innovative management practices. The main issues that the city has to address are presented in the following table.

Table 1: Surat: Issues/Impact Matrix

Scenario / Sectors	Current Status	Future Trends (BAU) Without CC	Climate Change Issues
POPULATION	High demographic growth	Trend potentially continues, unless economy slows down significantly due to externalities	Push migration periods from impacts on rural areas, dominance of low skilled population
NATURAL DISASTERS	Floods, high tides frequent, the increase in flood levels for similar discharges due to embankments and land filling. Cyclones rare	Trend likely to continue, Impacts due to city expansion and other anthropogenic changes likely to worsen the flood intensity, Disease profiles may change	More intense floods, water scarcity periods, local floods, Tides, Cyclones frequency may change, and the storm surge may impact more areas due to sea level rise
HEALTH	Malaria and Dengue common, strong seasonality, Heat strokes unknown	Trend likely to continue	Seasonality of the vector-borne diseases likely to change, expansion of disease transmission period likely to increase due to increased temperature and changes in humid seasons
Scenario / Sectors	**Current Status**	**Future Trends (BAU) Without CC**	**Climate Change Issues**
RESOURCES (WATER, LAND, ENERGY)	Sufficient, for meeting current demands	Water scarcity issues likely to crop up with high population growth, reuse options can reduce impacts	Water scarcity issues can become more acute with increase in variability

ENVIRONMENT	Very dense core, vehicular pollution, lack of open spaces	Traffic issues, pollution may increase, but with stringent norms expected	Higher impacts of pollution due to higher temperatures
ECONOMY	High growth	Medium to high growth expected with increase in efficiencies, can be affected by external shocks	Minor change in energy consumption for processes, but significant impact on energy demands for space cooling, vector borne diseases may impact the labour productivity
TECHNOLOGY	Fast up gradation to overcome labour scarcity	Shift to better technologies, focus on energy conservation	Surat becoming a centre for CC technologies, resilience approaches possible
SOCIAL/EQUITY	Iniquitous growth being addressed by housing, Rare conflicts	Migration can change world views, social cohesion, would need interventions	Push migration can lead to more diversity in worldviews, Higher inequity due to skill constraints of new in-migrants, pressures on resources

4.8 CITY RESILIENCE STRATEGY

HIGHLIGHTS

The city resilience strategy has been developed based on a set of principles starting from anticipating and forecasting of risks across various time scales giving priority to avoidance, risk reduction and management of residual risks in the same order. This approach is undertaken mainly due to large uncertainties in population growth and economy as well in climate change. Considering these limitation, resilience strategy is based on adaptive management, considering current risks from models and observations and provide scope for improvement over time.

Surat city stakeholders are already aware of current risks, and have taken several measures to reduce risks and improve resilience. Also the city has been implementing several infrastructure development programmes like JNNURM as well as basic services for urban poor. The current strategy will build upon the on-going efforts, existing infrastructure and established institutions. The resilience building process will be spearheaded by SMC and other city stakeholders by providing key knowledge inputs and pilot projects to leverage processes and increase resilience of the system at community/household level.

Surat has the advantage of efficient city administration, strong political consensus and fairly healthy municipal finances. Surat is one of the few cities with AA credit rating, which enables it to raise funds for infrastructure development. The city has also demonstrated its capacity to build resilience by improving the quality of the lifeline services like water supply, sewerage, solid waste disposal and health. The future target is to harden the existing infrastructure to withstand flood risk, to build redundancies and improve resilience.

The ULB has proved its capacity to deal emergencies and take up proactive initiatives in urban development, community health and disaster management working closely with industry and citizens. Surat is considered as a model for good governance as well as for verity effective service delivery in comparison with many Indian cities. Therefore, any progress in this city will be keenly observed and can set models for urban resilience across other Indian cities. A multi-stakeholder Surat Climate change Trust led by the SMC would address issues not only at city level but would also attempt to influence policy at state/central levels.

The city Resilience strategy is designed on following objectives:

- Build on existing and proposed interventions by the SMC
- Demonstrate resilience building projects to leverage further action
- Multi-sectoral information generation and shelf of projects
- Build synergy with state and national level institutions to incorporate the lessons into national urban development policies

The sector studies conducted during Phase I and II indicate that hydro-meteorological risks, coastal inundation risks, health risks and their interlinkages are the most critical issues facing Surat. High population growth and physical expansion of the city would modify these risks significantly. Anthropogenic impacts on river hydrology and climate would be added risks as the city is already experiencing reduced carrying capacity of the river. Climate variability and change will further modify these existing risks. These factors are likely to influence the safety as well as quality of life of the citizens.

The poor would be differentially impacted due to higher exposure and inherent vulnerability. Based on the findings of sector studies and engagement with multiple stakeholders, the resilience strategy outlines short and medium term interventions.

Short term interventions are projects that may span for 3-5 years and medium term interventions are project that may span for 5-20 years. Over next five years, technology innovations may be able to provide better climate forecasts thereby reducing uncertainty about cause-effect relationships. New set of climate information may reduce uncertainty leading to select choice among a set of alternatives. Till this more accurate climate model results are made available and understood by the stakeholders of the social system, it is suggested to intervene with the followings set of activities (short/medium).

Table 2: Short Term Interventions-Surat

Sectors	Needs	Projects	Potential Partners/ Stakeholders
NATURAL DISASTERS	Early warning system, Strengthen response plans, use of ICT in emergency management	Formation of a Climate Watch group to collect and manage data on various fast and slow changing parameters, provide support to decision makers Modeling and sharing of real time weather information to increase respite time (Flood MIS). Developing multi-scalar and multi-sectoral disaster response plans including support to citizens even during emergencies. Flood, surge and tidal area zonation and appropriate building zonation rules	GSDMA, Irrigation department, SMC

Sectors	Needs	Projects	Potential Partners/ Stakeholders
URBAN HEALTH	Vector borne and water borne diseases	Improving disease surveillance and epidemiological research support to track diseases Health GIS	SMC, Health department, SGCCI, Private doctors, Hospitals
RESOURCES (WATER LAND, ENERGY)	Plan for alternate supplies, reuse options, plans for redundancies for meeting future needs	Water resources and supply management plan, Future demand growth under various urban scenarios, CC informed Resource assessment, Technology options including Reuse and desalination, Demand side management, Water conservation options Hardening infrastructure to withstand sea level rise, floods; Emergency supply management	SMC water department, Narmada and Water Resources, Water Supply and Kalpasar Department
POPULATION	Reducing livelihood vulnerability by skill up gradation, informal education	Informal skill building courses on technologies, improved services, management. Certification accepted by industry	Educational institutions, SGCCI
ENVIRONMENT	Reducing vehicle pollution impacts through CC, improve quality of life	Plan for increasing share of public transport, create no-vehicle areas and time zones in over-crowded core	SMC, Police department
NATURAL DISASTERS	Increasing respite time, decreasing response time	Basin level real time flood warning systems to provide 5 day warning, Continued improvement in response time to less than 1 day Improvements in disaster response plans, training and involvement of citizen groups in response action	GSDMA, Irrigation department, SMC

Sectors	Needs	Projects	Potential Partners/ Stakeholders
ECONOMY	Reducing economic losses	Minimize losses by preventive measures (asset banks, vehicle parks outside flood zones, Emergency and Business continuity management plans for natural disasters)	SGCCI, Industry leaders
SOCIAL/EQUITY	Housing for poor. Build, strengthen and empower citizens local level groups in managing their areas and services, Federation of these local level agencies	Affordable, thermally comfortable, flood resistant houses for poor Awareness generation, forming issue based groups for community action on managing local assets, address issues	Community Development (CD), NGOs, SMC, CSS
TECHNOLOGY	Energy audits, awareness about energy saving, demonstration	Support agency for energy efficiency improvement	SGCCI, Torrent Power, DGVCL

Table 3: Medium Term Interventions-Surat

Sectors	Needs	Projects	Potential Partners/ Stakeholders
URBAN HEALTH	Vector and water borne diseases, Heat strokes, flood related health risks to vulnerable	Networking and access with state of art disease surveillance and epidemiological research Improved vector control system Health GIS with data on vulnerable and their needs IEC on heat related diseases	SMC, Health and Family Welfare, SGCCI, Private doctors, Hospitals
RESOURCES (WATER LAND, ENERGY)	Water scarcity issues, temperature, humidity induced increased energy demand	Improving redundancy of the water supply system based on climate change informed water management plan Water monitoring system with zero tolerance	SMC water department, Narmada and Water Resources, Water Supply and Kalpasar Department

Sectors	Needs	Projects	Potential Partners/ Stakeholders
POPULATION	Push migration from impacts on rural areas, dominance of low skilled population	Monitoring programme on migration and demand focused skill building Skill building programmes	SMC, State government
ENVIRONMENT	Higher impacts of pollution due to increasing temperatures	Decongestion of road system, public transport, parking fee rationalization (disincentives) to reduce congestion and avoidable short journey, pedestrian friendly roads without encroachment	Police department, SMC with Civil society support
ECONOMY	Labour days lost due to due to higher temperatures, diseases Risks due to location	Health support systems for Industrial workers Managed retreat of industries to low risk zones	Industry, SGCCI, Industry department
SOCIAL/EQUITY	Social cohesion issues	Managing the Surti social image through local groups and positive action. Preventive action on conflicts.	Citizens groups and SMC
TECHNOLOGY	Surat becoming a centre for CC technologies, resilience approaches	Expansion focused on clean and sunrise industry/service sector	Industry, SGCCI, Industry department

These activities are being advocated through the Surat Municipal Corporation, Industry and academic institutions. City advisory committee was formed in 2009, which now has registered Surat Climate Change trust, with SMC, Irrigation department, GSDMA, SGCCI and academic institutions as members.

4.9 LESSONS LEARNT

The ULBs across the country are facing major issues of functional and financial autonomy, which constrains their capacity to invest on infrastructure and services. Surat, despite being financially more independent compared to many other cites, still has to depend on the state and central finances for infrastructure development. It is able to meet most of the O&M costs of services, but changes in tax regime has impacted it like other cities across the state.

The city had floated municipal bonds to overcome the financial constraints in the past, but innovative financial instruments and attracting private sector would be necessary to expand the infrastructure and services in this fast growing city requiring major expansion of infrastructure.

The city has been unable to expand the staff strength to meet the rapid urbanisation and nearly three times growth in municipal area. SMC has partially addressed this issue by private partnerships in solid waste management and introduction of technologies to improve efficiency of the staff. In the coming decades, strategic partnerships along with private sector participation with increased focus on governance and regulation would be necessary.

The rapid strides in technologies have opened many possibilities for effective management of infrastructure and services. While ICT can support smart management of transport, electricity, water supply etc., the new water and sewage treatment technologies have made household/colony level treatment of water and wastes possible. Unless the city is able to take advantage of these developments, the city's competitiveness and efficiency may go down while creating issues of traffic, waste management and health.

The current master planning process is essentially restricted to landuse planning. Increased focus will be necessary to integrate the transport, communication, water supply and sewerage system in the ambit of master planning. A paradigm shift from landuse based planning to network based planning would significantly improve traffic and essential services delivery.

Hydro-meteorological risks are very high in this city as evidenced by repeated floods and increasing scale of losses. The ULB has so far tried to address flood risks by increasing focus on embankments and crisis management. The embankments have given the false sense of security, as evidenced by 2006 floods. Unfortunately, the ULB has no control over the decisions on emergency releases from the Ukai dam. With growing competition over limited water resources, and increasing frequency of extreme events predicted, the dilemma over flood buffers and summer water storage needs are bound to grow. Integrated water resource management methods with multi-stakeholder engagement would be necessary to manage water resources and floods under changing precipitation patterns and growing population living in the flood plain city.

Stakeholder engagement can be initiated with current issues facing the city. The past emergencies have built and strengthened the resilience of the city and there is increasing willingness of city stakeholders to engage with these issues. Awareness generation and advocacy is to be initiated and followed up by generating options, technical support and demonstration of pilot projects. The Surat climate Change Trust can spearhead such process, as exemplified by the City advisory committee formed earlier in the city.

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