PART II
The Impact of Climate Change on Cities

Cities are particularly vulnerable in that they are immobile. Such infrastructure as bridges, subway systems, buildings, and roads, the historic sense of place, and rootedness of residents are critical attributes of cites. These strengths of place can, however, become liabilities if the local ecosystems that they are based on are unable to adapt to the climate-induced changes. Climate change poses serious threats to urban infrastructure, quality of life, and entire urban systems. Not only poor countries, but also rich ones will increasingly be affected by anomalous climate events and trends (World Bank 2010b).

In 2003, more than 70,000 people died in Europe from a severe heat wave (World Bank 2009b; Dhainut et al. 2004). These kinds of extreme events will increase in coming years. The deaths were also considered a harbinger as the victims were disproportionately elderly. This acute vulnerability of the elderly, children, and infirm is even more pronounced in the cities of developing countries. The effects of climate change are especially unfair as those most unable to adapt, and those who contributed least to the problem, will be harmed the most.

Cities are highly vulnerable to the disruption of critical supplies. During medieval wars, for example, a primary tactic of armies was to prevent water and food from entering cities under siege. In recent times, the dependency of large cities on food imports has dramatically increased. London imports more than 80 percent of its food from outside the United Kingdom. Food distribution, energy provision, water supply, waste removal, information technology, and susceptibility to pandemics are all the Achilles heels of cities. Social unrest from shortages and price spikes of key commodities, mass migration, high unemployment, terrorism, geophysical and climatic disasters also threaten cities. Climate change exacerbates these current threats.

Climate Change and Coastal Cities

Traditionally, cities were located near rivers and oceans for transportation and connectivity purposes. This natural geographic advantage is now increasing vulnerability of cities as sea levels rise and wind storms increase in severity and frequency. In Europe, 70 percent of the largest cities have areas that are particularly vulnerable to rising sea levels, and most of these cities less than 10 meters above sea level. Port cities in developing countries — such as Kolkata, Shanghai, and Guangzhou — are as vulnerable as such cities in developed countries —Rotterdam, Tokyo, or New York City. China alone has more than 78 million people living in vulnerable low elevation cities; this number is increasing annually at 3 percent (McGranahan et al. 2007).

Approximately 360 million urban residents live in coastal areas less than 10 meters above sea level and are vulnerable to flooding and storm surges (Satterthwaite and Moser 2008). Fifteen of the world's 20 megacities are at risk from rising sea levels and coastal surges (Figure 4). The IPCC predicts a rise in average sea level over the next 100 years ranging between 13 to 28 centimeters in a low scenario and 26 to 59 centimeters for a high scenario (IPCC 2007).

Planning in a regime where up to a 60 centimeter increase in sea level during the next 100 years is possible poses enormous uncertainty. Long-lived infrastructure, such as flood protection works, major transportation systems, large-scale energy plants (which are often located near cooling-water sources), are designed with service-lives in excess of 60 years. For example, subways, sewers, bridges, and other major infrastructures in London, New York, and Paris are more than 100 years old. Building similar infrastructure in Shanghai, Jakarta, Bangkok, Rio de Janeiro, and others to account for likely sea

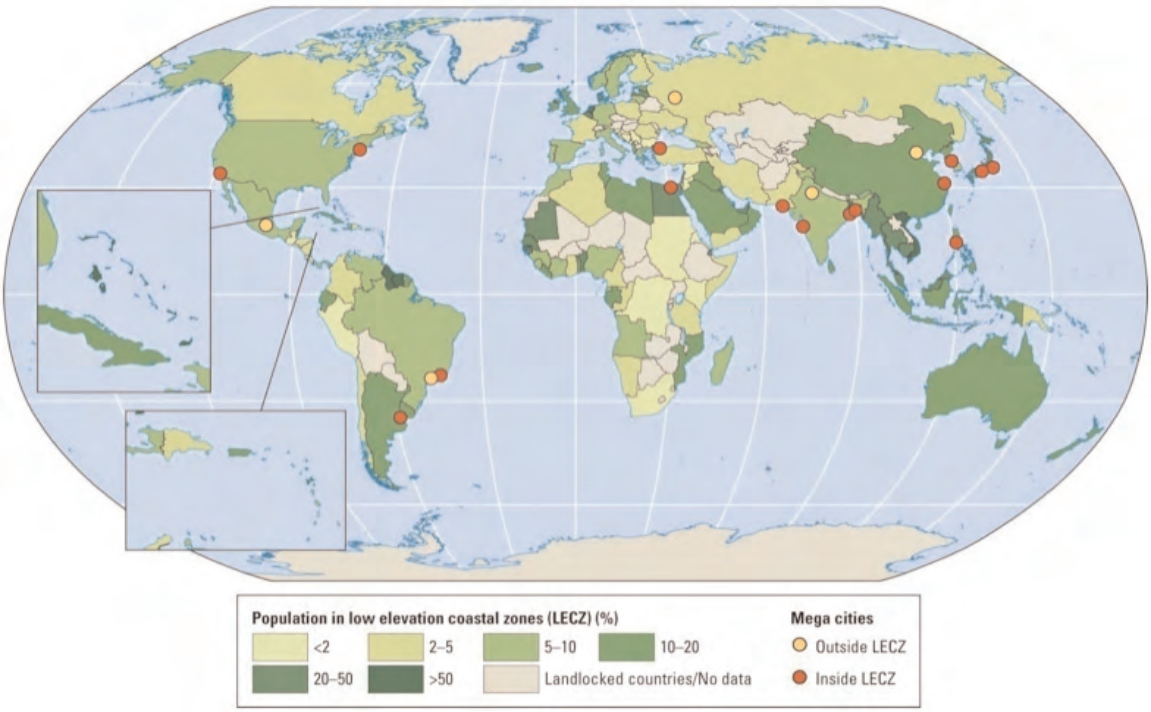


Figure 4a
At Risk: Population and Megacities Concentrated in Low-elevation Coastal Zones (LECZ) Threatened by Sea-level Rise and Storm Surges

Source: World Bank 2009b.

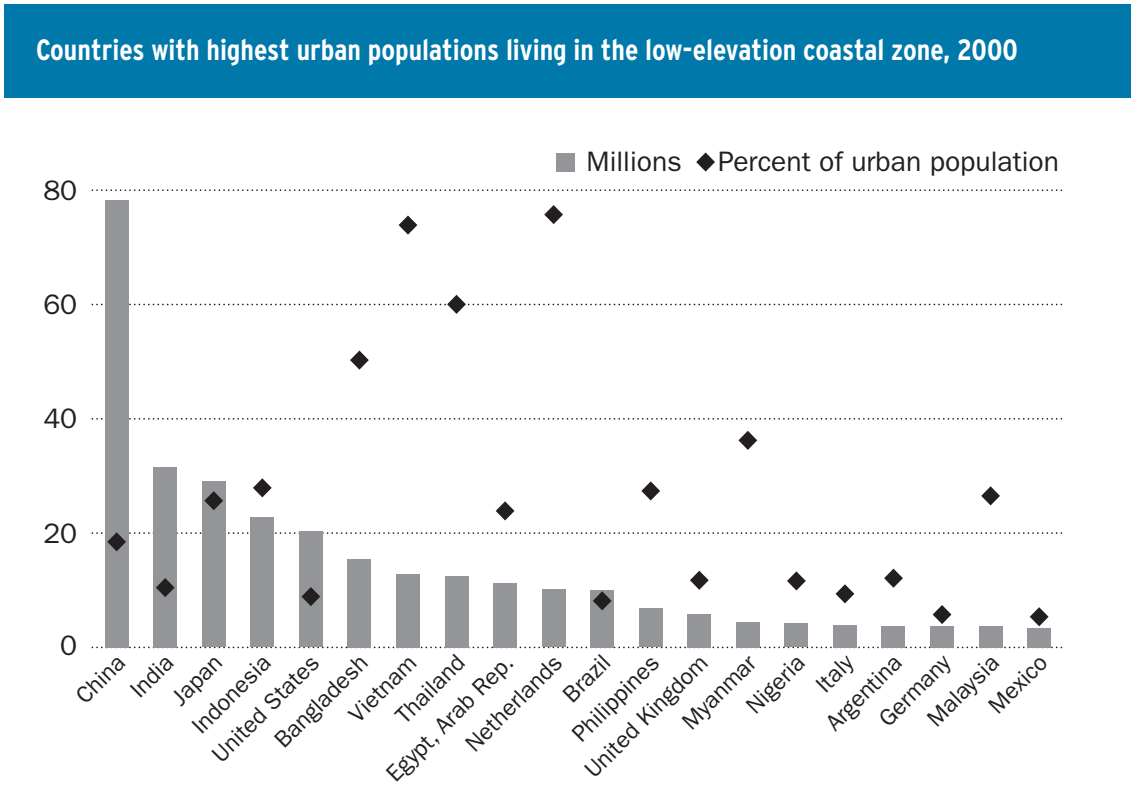


Figure 4b
Urban Populations in LECZ Zone

Source: CIESIN 2007.

level increases adds further complexity to an already challenging environment.

An even more difficult issue, and one that is rarely mentioned in the literature, is the possibility (and potential desirability) that some cities and their national governments will assess the need for relocation and potential abandonment of key infrastructure and areas prone to flooding. This would represent one of the largest losses of value in land and infrastructure and the largest transfer of economic wealth in human history. Tensions will grow as specific land owners and residents demand increasingly costly infrastructure hardening, while others push for less costly shifts in habitation. The complexity of flood protection in New Orleans is an important early window on future city development.

Cities now concentrate large numbers of the poor who are especially vulnerable to climate change. Poor city residents tend to locate in the most vulnerable locations and housing construction materials are not robust. The consequences of surging seas, wind storms, and flooding are much more dramatic in these areas.

How to Deal with Adaptation Issues

Although climate change will bring about gradual change over time in some parameters (for example, mean annual temperatures and mean sea levels), it will also produce changes in extreme events (for example, a greater number and intensity of cyclones, heat waves, and flooding) in many locales. Responses to such extreme events need to build on current experiences in disaster risk reduction. Climate change will place an even higher premium on municipal capacity and management structures. Existing disaster reduction experience has shown that social capital is a critical aspect of all urban communities. Cities with strong social networks often have support systems that can aid in recovery from natural disasters and slower onset challenges, such as high heat, changing weather patterns and lack of water. It is an enormous challenge to grow these networks as they are increasingly stressed.

Cities are complex systems where service delivery mixes with robust infrastructure and social and political factors that determine much of the success or failure of social and economic policies. The best way to deal with city complexity in the face of serious climate change is to improve the city's resilience. Building resilience can, however, be difficult, while reducing it is all too easy.

New Orleans and Hurricane Katrina provide important lessons where resilience was compromised:

- Military personnel were not available as many were posted overseas
- Levees were weak
- Communications and responsibilities were unclear
- Recovery (pumping of water) was delayed, leading to more mold and hardship;
- The rebuilding process was hampered by limited access to credit because of the U. S. housing collapse
- Preparedness was limited in some areas, for example, local buses and vehicles could not be quickly commandeered for the evacuation

Building resilience in a city requires a systems, or integrated, approach. An 'ecosystems approach' can provide a useful context. A few key initiatives can yield large results. For cities, these include (i) robust decision making (incorporating broader-based cost and benefit assessments that include societal values, ecosystem services, risks, and longer time horizons); (ii) buttressing of key infrastructure (e.g. increased robustness of water and power supply systems); (iii) social inclusion (ecosystems abhor extremes, for example, pronounced differences between rich and poor); (iv) urban risk assessments (see Box 2); (v) emergency preparedness (practice, know where the risks are likely, make this information public); (vi) partnerships with other cities, agencies, and governments; (vii) greater adaptive capacity through buildings and critical infrastructure to withstand increased climate variability, for example, metros; (viii) reduced social tensions; (ix) where practicable,

and cost effective, streamlining of key services and infrastructure; and (x) protection and integration of key ecosystem services

There is a significant distinction between climate change mitigation and adaptation. Mitigation efforts aim to prevent further climate change. Adaptation involves readjusting life to the reality that a certain amount of climate change will inevitably occur. An effective climate change policy for cities however needs to include both, and they need to be approached in an integrated manner.

Major difference between mitigation and adaptation is the scale of their effect and the associated costs. Adaptation will have impacts primarily on a local scale: actions are based on specific needs of the affected regions. Costs might be very high, especially in large-scale infrastructure such as flood protection works, roads, ports, and power generation facilities. The cost savings from adaptation efforts mainly accrue through reduced risk impacts (for example, insurance) often at an individual homeowner, business, or community level.

Mitigation is a global effort requiring broad changes of behavior and technological advancements. Mitigation strategies are usually expensive in the short term, because they are capital intensive (change in technology, urban transport, and collective infrastructure) and require fundamental changes to urban systems. Over time, the cost of mitigation is generally self-financed through cost savings (mainly in energy bills).

Cities need an integrated approach that considers mitigation, adaptation and urban development. The improvement of city services is related to the ability of cities to adapt to climate change and reduce their greenhouse gas emissions. Cities with excellent services are generally resilient cities:

- Advanced drainage systems can alleviate flooding during intense storms
- Healthcare services are equipped to respond to emergency situations
- Warning systems and transportation infrastructure allow citizens to evacuate in response to risk

As cities develop, it is essential to evaluate infrastructure and service improvements through a climate change lens so as to promote long-term mitigation, adaptation, and poverty alleviation.
Cities that focus on provision of basic urban services to the poor tend to do so in an integrated manner that follows a simple hierarchy. Adaptation to, and mitigation of, climate change should follow a similar integrated city-wide approach: (i) fully providing basic health and environmental services (and primary education); (ii) encouraging and enhancing the resilience of community organizations; (iii) improving building quality, particularly residential; (iv) avoiding development in hazardous or sensitive areas; (v) protecting buffering capacities of local ecosystems and minimizing degradation (for example, groundwater, mangroves, and wetlands); (vi) ensuring food security (for example, evaluating relevance of local agriculture provision); (vii) ensuring the security and resilience of water supply (and quality) and energy provision; (viii) strengthening city-wide security nets, resilience planning, and effective public information; (ix) providing and regularly updating publicly available land-use or development plans; (x) effectively integrating migrants and other marginalized groups; (xi) increasing energy efficiency of buildings and transportation; (xii) identifying and, where possible, ameliorating local climate impacts such as 'urban heat islands'; (xiii) participating in regional and national programs to increase resilience; (xiv) enhancing local economies; (xv) switching to low consumption lifestyles; and (xvi) participating in global policy dialogues (for example, city-influence on national and international policies, such as agriculture and energy subsidies and UNFCCC negotiations).

The above hierarchy suggests that the most important form of city adaptation to climate change is to push for progress on the Millennium Development Goals, especially providing potable water and sanitation and reducing the number of people living in slums.

Table 1
Benefits of Combining Mitigation, Adaptation, and Development

City	Action	Integrated Value
Mexico City, Mexico[i]	Infrastructure improvements for water supply pipes to reduce water losses and leaks	-Increases water supply -Reduces vulnerability to lack of water -Increases access of basic services to the poor
Dar el Salaam, Tanzania[ii]	Coastal and marine conservation project to plant mangrove trees along the coast	-Sequesters carbon via mangroves -Protects the city from storm surges -Maintains a healthy coastal ecosystem
Bogota, Colombia[iii]	Urban agriculture program	-Reduces transportation costs to deliver produce to cities -Reduces the need for fertilizers, pesticides, and large agro-systems -Provides a supply of food during disasters -Provides employment and is a source of food to poorer sections of society -Prevents settlements in high-risk areas such as slopes and coastal areas
Makati City, The Philippines[iv]	Major citywide tree-planting program, where 3,000 trees are planted each year	-Sequesters approximately 25,000 kg of CO_2e/year in GHG emissions -Reduces atmospheric pollution -Reduces the urban heat island effect -Provides recreational space
Lviv, Ukraine[v]	Energy efficiency program for buildings	-Reduces energy consumption for buildings -Reduces energy costs -Makes buildings, and their occupants, better able to withstand extremes in temperature and precipitation

[i]Summary of Mexico City Climate Action Program: 2008-2012, Secretaria del Medio Ambiente, Gobierno Del Distrito Federal.
[ii]Community Infrastructure Upgrading Programme-Get to know the Programme currently implemented in Dar es Salaam City, Tanzania (2005-2010).
[iii]Resources Centres on Urban Agriculture and Food Security (RUAF).
[iv]Climate Resilient Cities, World Bank: 2008 Primer.
[v]Energy Efficient Cities Initiative Practitioners' Roundtable. Workshop Proceedings Series. World Bank - ESMAP. Nov. 2008.

A growing number of cities are addressing climate change in an integrated approach. Table 1 lists projects in five cities that are addressing mitigation, adaptation, and development.

Cities have always had to respond to the vagaries of their local climate. Climate change as brought about by anthropocentric greenhouse gas emissions will likely be greater in complexity and scale. Cities need to integrate climate change within an already full agenda of basic service provision, usually with insufficient funding.

Climate change forces an even more urgent imperative to move toward sustainable cities. Sustainable cities are the foundation of sustainable development; they drive local and global economies, protect the poor, and build in increasing adaptive capacity. The Melbourne Principles for Sustainable Cities[2] are a practical foundation to highlight how local actions, when magnified globally, lead to substantial results.

[2]The Melbourne Principles were adopted at the Local Government Session of the Earth Summit 2002 in Johannesburg, as part of the final communiqué, known as Local Action 21 or the Johannesburg Call. They consist of 10 statements on how cities can become more sustainable.

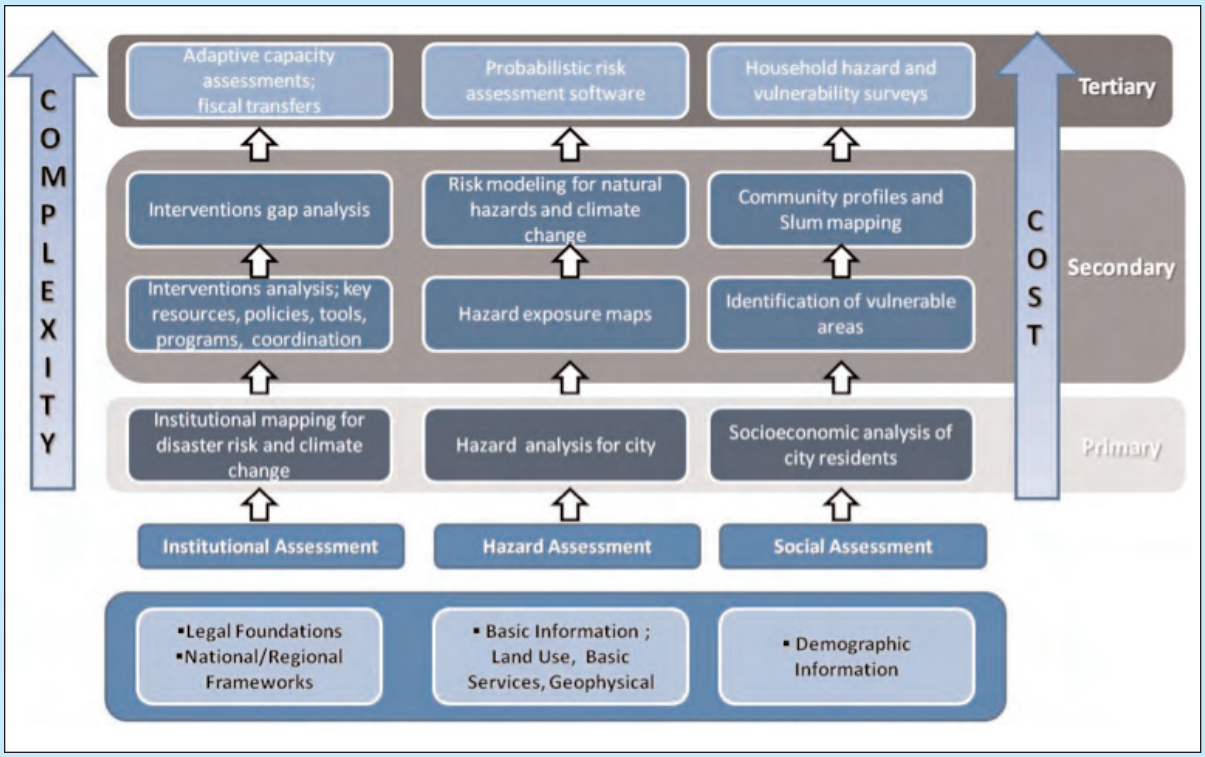
BOX 2

Urban Risk Assessment

The Urban Risk Assessment (URA) as recently proposed* lays the groundwork for the definition of a plan for strategic collaboration across city governments, the private sector, and development agencies to begin benchmarking their own progress towards the reduction of urban vulnerability. The objective is to move toward a common cost effective approach for specifying where and how many people are vulnerable to natural hazards, in addition to identifying susceptible infrastructure that if damaged, would also have detrimental effects on the urban population.

The assessment is based on four principal building blocks to improve the understanding of urban risk: historical incidence of hazards, geospatial data, institutional mapping, and community participation. The URA is structured to allow flexibility in how it is applied based on available resources and institutional capacity of a given city. Through a phased approach linked to complexity and required investment, city managers may select a series of subcomponents from each building block that individually and collectively enhance the understanding of urban risk (see below).

*The development of the Urban Risk Assessment is part of a joint Cities and Climate Change work program among UN-Habitat, UNEP, and the World Bank, supported by Cities Alliance. Through consensus building and collaboration, the URA is being developed and piloted with the support and guidance of various agencies including: ITHACA, ESRI, GTZ, International Development Research Centre, Joint Research Commission, UNEP, Office of Space & Advanced Technology (U.S. Department of State), United Nations University, United Nations Population Fund, Arizona State University, Association of American Geographers, Cisco, UN-HABITAT, International Institute for Environment and Development, Development Seed, and Fortius One.



Primary, Secondary, Tertiary Building Blocks

Source: The World Bank 2010d.