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**CLIMATE CHANGE AND URBANIZATION: EFFECTS AND IMPLICATIONS
FOR URBAN GOVERNANCE***

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*The views expressed in the paper do not imply the expression of any opinion on the part of the United Nations Secretariat.

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The text of this paper draws on a collaborative work programme on possibilities and constraints in regard to adaptation to climate change in urban areas in low- and middle-income nations that involves many individuals and institutions. In particular, it draws on the author's work with Saleemul Huq and Hannah Reid (IIED's Climate Change Group), Mark Pelling (Kings College, University of London), Aromar Revi (TARU) and Patricia Lankao Romero (National Center for Atmospheric Research, USA). It also draws on material prepared by Debra Roberts (case study on Durban's adaptation strategy), Jorgelina Hardoy and Gustavo Pandiella (background paper on Argentina), Karina Martínez, E. Claro and Hernando Blanco (background paper on Chile), Cynthia B. Awuor, Victor A. Orindi and Andrew Adwerah (background paper on Mombasa), Mozaharul Alam (background paper on Bangladesh/Dhaka), Sheridan Bartlett (background paper on the impacts of climate change on children) and Sari Kovats. As such, it also draws heavily on two previous papers: Satterthwaite, David (2007), *Integrating Adaptation to Climate Change in Decision-making at the Urban/Municipal Level in Low- and Middle-income Nations* (first draft), prepared for the OECD Development Assistance Committee, Paris and Satterthwaite, David, Saleemul Huq, Mark Pelling, Hannah Reid and Patricia Lankao Romero (2007), *Adapting to Climate Change in Urban Areas; The possibilities and constraints in low- and middle-income nations*, IIED Working Paper, IIED, London, 107 pages.

A. INTRODUCTION

Urban governments have critical roles in adaptation to climate change in all nations as well as in mitigation (reducing greenhouse gas emissions). It can be argued that they have the central role in adaptation within their jurisdictions – although it is obvious that they need a supportive institutional, regulatory and financial framework from higher levels of government and, for most low- and middle-income nations, also from international agencies. This paper will focus on the effects of climate change on urban areas in low- and middle-income nations and the implications for urban governance. It will emphasize how most adaptation to the likely climate change-related dangers over the next few decades fit well within a local development agenda.

However, unlike most environmental hazards, local governments in low- and middle-income nations have no capacity to reduce the climate change-generated hazards that those within their jurisdiction will face. For many environmental hazards, local governments can reduce the hazard – e.g., treat water before it is distributed, reduce breeding possibilities for disease vectors, reduce physical risks through better quality buildings and infrastructure, traffic management and reduce exposure to dangerous chemicals through pollution control and occupational health and safety. But hazard reduction from climate change in low- and middle income nations depends on major changes in lifestyles and consumption patterns among middle and upper income groups, most of whom live in high-income nations. There is a pressing need to address adaptation in urban areas in low- and middle-income nations as these nations have most of the world's urban population, most of the high-risk urban sites and the largest deficiencies in adaptive capacity. Urban areas in low- and middle-income nations are also projected to house almost all of the world's population increase in the next two decades (United Nations, 2006).

Low- and middle-income nations now have three-quarters of the world's urban population (ibid). They also have most of the urban population at greatest risk from the increased intensity and/or frequency of storms, flooding, landslides and heat waves that climate change is bringing or will bring. The very high concentration of global deaths from extreme weather-related disasters in low- and middle-income nations is well known; if more precise data were available, it is likely to show that a large and growing proportion of these deaths are in these nations' urban areas (UN Habitat, 2007). Most of the nations that are likely to face serious constraints on climate change-related fresh water availability are also low- and middle-income nations. In regard to sea level rise, China and India alone have more than a quarter of the world's urban population and the world's largest urban populations within low-elevation coastal zones. Africa, long considered a predominantly rural continent, has a larger urban population than Northern America – and close to two-fifths of its population in urban areas (United Nations, 2006). It also has a high concentration of its largest cities in coastal areas. Without adaptation, climate change is likely to bring ever-increasing numbers of accidental deaths and serious injuries and increasingly serious damages to people's livelihoods, property, environmental quality and future prosperity.

The adaptive capacity of urban governments obviously has national importance too, given urban centres' economic and political importance – including their role as markets and service centres for agriculture and rural development. Even predominantly rural nations generally have more than half their GDP derived from industry and service enterprises, most of which are in urban areas.

The need for action by city/municipal governments on climate-change adaptation is also urgent – and probably more urgent than that suggested by the IPCC's Fourth Assessment. This is because of new analyses of the vulnerability of urban populations to the increased risks or new risks that climate change is likely to bring in most low- and middle-income nations that were not available to the authors of IPCC's Working Group II. These have begun to make clear the scale of this vulnerability – for instance in the analysis of the number and proportion of nations' urban populations within the low-elevation coastal zone (McGranahan, Balk and Anderson, 2007) and in a range of detailed local, city and regional studies (de Sherbinin, Schiller and Pulsipher, 2007; Dossou and Glehouenou-Dossou, 2007; Alam and Golam Rabbani, 2007; Revi, 2008; Awuor, Orindi and Adwerah 2008 and Levina, Jacob and Ortiz, 2007).

B. CLIMATE CHANGE IMPACTS ON URBAN AREAS

1. Introduction

Table 1, drawn from the IPCC's Fourth Assessment, lists the different aspects of climate change, the evidence for current impact, projected future impacts and the zones or groups most affected. It highlights the different kinds of impacts that arise from changes in extremes and changes in means; it also notes the need to consider the impacts of abrupt climate change, while also noting that its significance is less clearly established.

Among urban centres in low- and middle-income nations, perhaps the most obvious increased risk comes from the likely increase in the number and intensity of extreme weather events such as heavy rainstorms, cyclones or hurricanes. Of course, there are large differentials in the scale of such risks between urban centres in each nation. The urban centres most at risk are generally those where these events are already common and cause serious damage and disruption – although there is some evidence of the geographic range of some extreme weather events expanding. Coastal cities that are at risk from storms will be doubly at risk as sea-level rise increases hazards from coastal flooding and erosion.

For any city, the scale of the risk from these extreme weather events is much influenced by the quality of housing and infrastructure in that city, the extent to which urban planning and land-use management have successfully ensured risk reduction within urban construction and expansion, and the level of preparedness among the city's population and key emergency services. For small and large coastal settlements, the integrity of coastal ecosystems and in particular protective mangrove and salt marsh systems will also influence risk.

City dwellers in high-income nations have had risks in relation to injuries and deaths much reduced by decades of investment in housing and infrastructure – and economic/financial losses much reduced by insurance. But the devastation of New Orleans by Hurricane Katrina in 2005 is an example of how there are still exceptions – both in the lack of investment in flood defences coupled with degradation of the coastal environment, and in the inadequate institutional capacity of emergency services. This is also an example of deliberate local political choices to favour new development over risk reduction. New Orleans planned the expansion into the Lower 9th Ward (the lower part of the city that was devastated by Katrina); in 1999 the New Orleans Planning Commission stated that development in this area represented a significant potential employment for the city (Burby, 2006).

Hurricane Katrina also illustrated the higher vulnerabilities of many lower-income groups and this is an issue that is even more pressing in most urban centres in low- and middle-income nations. In addition, cities are also vulnerable to any damage to the larger systems on which they depend – for instance for water supply and treatment, transport and electricity and thus everything that depends on electricity, including lighting, pumping and communications (Wilbanks et al., 2007).

2. Flooding

Urban areas always present some risk of flooding when rainfall occurs. Buildings, roads, infrastructure and other paved areas prevent rainfall from infiltrating into the soil – and so produce more runoff. Heavy and/or prolonged rainfall produces very large volumes of surface water in any city, which can easily overwhelm drainage systems. In well-governed cities, this is rarely a problem because good provision for storm and surface drainage is easily built into the urban fabric, with complementary measures to protect against flooding – for instance the use of parks and other areas of open space to accommodate floodwaters safely from unusually serious storms. In most cities, there is also scope for land-use management and incremental adjustments to increase flood-water management capacity. But in poorly-governed cities, this does not happen. Most residential areas have no drainage system installed

and rely on natural drainage channels - and it is common for buildings or infrastructure to be constructed that actually obstruct these drainage channels. For instance, in Dhaka, buildings often encroach on or fill in drains and many natural drains have been filled up to construct roads (Alam and Golam Rabbani 2007). Mombasa faces comparable problems (Awuor, Orindi and Adwerah 2008). In most urban centres in Africa, Asia and Latin America, a significant proportion of the population is not served by solid-waste collection services. In cities or neighbourhoods with inadequate solid-waste management or drain maintenance, garbage and plant growth can quickly clog drains, leading to localized flooding with even light rainfall. There is also a growing documentation on the inadequacies in drainage and flood protection for urban centres in Africa and Asia and of the trend towards increased numbers of deaths and injuries from flooding in urban areas. There are also many case studies highlighting the vulnerability of certain cities to floods and/or sea level rise including Alexandria (El-Raey, 1997), Cotonou (Dossou and Glehouenou-Dossou 2007), Dhaka (Alam and Golam Rabbani, 2007), Banjul (Jallow et al 1999) and Port Harcourt (Abam et al., 2000). A recent study documents the lack of provision in six African cities for reducing flood risks or for managing floods when they happen (Douglas et al., 2008). Floods are already having very large impacts on cities and smaller urban centres in many African nations – for instance the floods in Mozambique in 2000 which included heavy floods in Maputo, the floods in Algiers in 2001 (with around 900 people killed, and 45,000 affected); heavy rains in East Africa in 2002 that brought floods and mudslides forcing tens of thousands to leave their homes in Rwanda, Kenya, Burundi, Tanzania and Uganda, and the very serious floods in Port Harcourt and in Addis Ababa in 2006 (UN-Habitat 2007, Douglas et al., 2008). Discussions with residents in informal settlements in various cities found that flooding is more frequent and intense and often occurring in locations previously not at risk. They also showed how little local government was doing to address these issues (Douglas et al., 2008).

Climate change has the potential to increase flooding risks in cities in three ways: from the sea (higher sea levels and storm surges); from rainfall – for instance by heavier rainfall or rainfall that is more prolonged than in the past; and from changes that increase river flows – for instance through increased glacial melt. The IPCC Working Group II noted that heavy precipitation events are very likely to increase in frequency and will augment flood risk and the growing evidence of increased runoff and earlier spring-peak discharges in many glacier- and snow-fed rivers (Adger, Aggarwal, Agrawala et al., 2007). In addition to flood hazards, more extreme rainfall events associated with climate change will also generate increased hazard from landslides in many urban centres.

The IPCC also noted the dramatic impacts on water supplies that are likely under extremes of weather that could arise as a result of climate change. Water supply abstraction and treatment works are sited beside rivers and are often the first items of infrastructure to be affected by floods. Electrical switchgear and pump motors are particularly at risk. In severe riverine floods with high flow velocities, pipelines may be damaged (Wilbanks, Romero Lankao et al., 2007). Sanitation can also be affected. Flooding often damages pit latrines (and most of Africa's and Asia's urban population relies on pit latrines) and floodwaters are usually contaminated by the overflow from pit latrines or septic tanks – and often sewers too. Toilets linked to sewers become unusable without a water supply. But most urban centres in sub-Saharan Africa and in Asia have no sewers – or if they do, these serve only a very small proportion of the population (Hardoy, Mitlin and Satterthwaite, 2001). As the IPCC noted, the main significance of sanitation here is that sanitation infrastructures (or the lack of them) are the main determinant of the contamination of urban floodwater with faecal material, presenting a substantial threat of enteric disease (Ahern et al., 2005).

3. Storms, sea-level rise and coastal urban populations

It is difficult to estimate precisely how many people are at risk from the increased frequency and intensity of extreme-weather events and the sea-level rise that climate change will bring. The first detailed analysis on the number and proportion of urban dwellers (and total populations) living in the low-elevation coastal zone was published recently (McGranahan, Balk and Anderson, 2007). This zone – the continuous area along the coast that is less than 10 metres above sea level – represents 2 per cent of the world's land area but contains 10 per cent of its total population (i.e. over 600 million people) and 13

per cent of its urban population (around 360 million people). Almost two-thirds of the world's cities with more than 5 million inhabitants fall in this zone, at least partly. Low-income and lower-middle-income nations have a higher proportion of their urban population in this zone than high-income nations. The least developed nations, on average, have nearly twice the proportion of their urban population in this zone, compared to high-income nations. Figure I gives the ten nations with the largest urban populations and the largest proportion of their urban population in this zone.

Obviously, only a proportion of those within this zone are at risk from the sea-level rises that are likely within the next 30–50 years. Estimates for sea-level rise vary from 18cm to 59cm up to the end of the 21st century; these will certainly multiply the number of people flooded by storm surges. One estimate has suggested that 10 million people are currently affected each year by coastal flooding and that the numbers will increase under all the climate change-scenarios (Nicholls, 2004). The problems with coastal flooding will obviously be much more serious if certain potentially catastrophic events whose probability is uncertain were to happen – for instance the accelerated melting of Greenland's ice sheet or the collapse of the West Antarctic ice sheet (Adger, Aggarwal, Agrawala et al., 2007).

The latest IPCC Working Group II report notes the particular vulnerabilities to sea-level rise and changes in run-off of large sections of the urban and rural population in heavily populated Asian deltas such as the Ganges-Brahmaputra (that includes Dhaka), the Mekong, the Chang jiang (also known as the Yangtze, which includes Shanghai) and the Chao Phraya (with Bangkok). Many other deltas in Asia and Africa also have large urban and rural populations at risk, especially the Nile but also including the Niger (with Port Harcourt) and the Senegal (with Saint Louis - see Diagne, 2007) – and, of course, in the Americas the Mississippi (with New Orleans) (Nicholls et al., 2007).

There also appears to be increasing population concentrations in low-elevation coastal zones in most nations (McGranahan, Balk and Anderson, 2007). China provides the most dramatic example as it is the nation with the largest number of urban and rural dwellers in the low-elevation coastal zone and it still has a very strong trend towards increasing population concentration in this zone. Increasing trade and market-driven movements, often supported by government incentives, are still attracting people to the coast. The coastal provinces of China experienced a net in-migration of about 17 million people between 1995 and 2000, creating pressures in an already crowded coastal zone (ibid).

There is some evidence that hurricane-force winds will become more frequent and intense, and possibly also that the hurricane belt will move southwards. Highly urbanized coasts most at risk therefore include Vietnam in Asia; Gujarat in western India and Orissa in eastern India, the Caribbean, including major urban settlements like Santo Domingo, Kingston, and Havana, and those on Mexico's Caribbean coast and Central America – as we have seen from Hurricane Mitch. A sea-surface temperature rise of 2–4°C, as expected in the Indian Ocean over the century, is expected to induce a 10–20 per cent increase in cyclone intensity (Aggarwal and Lal, 2001). Since cyclone-formation frequency in the Bay of Bengal is about five times that of the Arabian Sea (India Metrological Department, 1966, 1979, TARU 2005) India's east coast is clearly at more risk. The high concentration of population, especially on the eastern coasts of India and Bangladesh, has led to extremely high vulnerability in this region, leading to very large loss of life and property (Revi, 2008).

4. Constraints on water supplies and other key natural resources

IPCC Working Group II noted that, in Africa, “by 2020, between 75 million and 250 million people are projected to be exposed to an increase of water stress due to climate change” (Adger, Aggarwal, Agrawala et al., 2007) (high confidence). In Asia, “Freshwater availability in Central, South, East and Southeast Asia, particularly in large river basins, is projected to decrease due to climate change which, along with population growth and increasing demands arising from higher standards of living, could adversely affect more than a billion people by the 2050s” (ibid) (high confidence). Any reduction in the availability of freshwater resources caused by climate change will be particularly problematic for those who live in areas already suffering water scarcity or water stress – with poorer groups likely to be most affected (Romero Lankao, 2006). During the last century, mean precipitation in all four seasons of

the year has tended to decrease in all the world's main arid and semi-arid regions: Northern Chile, the Brazilian Northeast and Northern Mexico, West Africa and Ethiopia, the drier parts of Southern Africa, and Western China (Folland et al., 2001). If these trends continue, water-resource limitations will become more severe in precisely those parts of the region where they are already most likely to be critical (Rhode, 1999).

Many cities and their water catchments will get less precipitation (and have more constrained fresh water sources) – which is particularly problematic for growing cities and large cities already facing serious problems obtaining sufficient fresh water supplies (Anton, 1993; UN Habitat, 2006). At least 14 African nations are already facing water stress or water scarcity and many more are likely to join this list in the next 10 to 20 years (Muller 2007). There is already a failure to manage water resources well in much of this region, independent of climate change – where around half the urban population already lacks adequate provision for water and sanitation, although this is linked far more to inadequate governance than to water shortages (UN-Habitat, 2003).

5. Higher temperatures and heat waves

Most cities in Africa, Asia and Latin America and the Caribbean will experience more heat waves. Even small increases in average temperature can result in large shifts in the frequency of extremes (Kovats and Akhtar 2008). For larger, higher-density cities, the temperatures in central “heat islands” can be several degrees higher than in surrounding areas; in tropical cities, the temperature difference can reach 10 degrees by the end of the night (ibid). Many cities will face more problems with certain air pollutants as concentrations of air pollutants change in response to climate change because a portion of their formation depends, in part, on temperature and humidity. This has particular importance for Asia and Latin America, which have most of the cities with the highest levels of air pollution. There is less information on the impacts of heat stress in Africa or Latin America but studies undertaken in North America, Asia and Europe found that heat waves are associated with marked short-term increases in mortality (Confalonieri et al., 2007). The European heat wave of 2003 claimed 20,000 lives, mostly among the poor and isolated elderly. In Andhra Pradesh, India, a heat wave killed more than 1,000 people – mostly labourers working outside in high temperatures in smaller urban settlements (Revi, 2008).

In regard to urban heat islands, higher temperatures occur in urban areas than in outlying rural areas because of diurnal cycles of absorption and later re-radiation of solar energy and (to a much lesser extent) heat generation from built/paved physical structures. These increase the frequency and severity of heat-stress events in cities and can affect the health, labour productivity and leisure activities of the urban population. There are also economic effects, such as the additional cost of climate-control within buildings, and environmental effects, such as the formation of smog in cities and the degradation of green spaces – and increased greenhouse gases if additional demand for cooling is met with electricity generated from fossil fuels.

There is some evidence that the combined effects of heat stress (e.g. urban heat-island effects) and air pollution may be greater than the simple additive effects of the two stresses (Patz and Balbus, 2003). There are again different vulnerabilities to the health impacts of climate-related extremes and air pollution within urban areas. Local factors, such as climate, topography, heat-island magnitude, income, access to health services and the proportion of elderly people, are important in determining the underlying temperature–mortality relationship in a population (Curriero et al., 2002).

6. Other health risks related to climate change

Climate change is also likely to bring an increased burden of diarrhoeal disease and altered spatial distribution of some infectious disease vectors – for instance as warmer average temperatures permit an expansion of the area in which many “tropical” diseases can occur. Expansion is likely in the area in which the mosquitoes that spread malaria, dengue fever and filariasis can survive and breed

(Adger, Aggarwal, Agrawala et al., 2007; WHO, 1992). Note in particular the rapid spread of dengue fever in many nations in recent years, as the *aedes* mosquito adapts to urban conditions. In India, malaria is expected to expand its range horizontally and vertically, from its currently endemic range in eastern and northeastern India to western and southern India (Bhattacharya et al., 2006). Given that Indian cities have become major reservoirs of vector-borne diseases such as malaria and dengue fever, it can be expected that the morbidity risks will increase. However, all the above health risks are present for much of the urban population without climate change.

Extreme weather events can generate new health hazards and cause disruption to public health services that lead to increased disease incidence. Hurricane Mitch in Central America in 1998 resulted in increases in cases of malaria, dengue fever, cholera and leptospirosis (Vergara, 2005). Populations with poor sanitation infrastructure and high burdens of infectious disease often experience increased rates of diarrhoeal diseases, cholera and typhoid fever after flood events. The transmission of enteric pathogens is generally higher during the rainy season (Nchito et al 1998; Kang et al., 2001).

Other health risks that need attention are those related to the lack of disaster-preparedness (to limit the impact of the extreme weather event when it occurs) and the inadequacies or poorly-designed and managed responses after the disaster event.

C. WHO IS MOST AT RISK?

Hazards combine with vulnerabilities for extreme weather to produce direct impacts on health, living conditions and incomes/livelihoods/assets. The main impacts of climate change on urban areas, at least in the next few decades, are likely to be increased levels of risk from existing hazards. For poorer groups, some of the impacts are very direct – for instance, more frequent and more hazardous floods. Some are less direct – for instance, reduced availabilities of fresh water supplies for whole cities that reduce supplies available to poorer groups (or that increase prices). Some are indirect – for instance, as the impacts of climate change-related weather events increase food prices or damage poorer households' asset bases or disrupt their incomes.

It is well known and well documented that, in most cities, the urban poor live in the most hazardous urban environments – for instance on floodplains or other areas at high risk of flooding or unstable slopes (Hardoy, Mitlin and Satterthwaite, 2001). These are also usually the sites most at risk from climate change, as discussed above. In addition, in most cities, the urban poor also have problematic relationships with local government yet local government is meant to be the institution that acts to reduce these risks. In part, this is because most of the urban poor live in informal settlements (including many on land occupied illegally) and work within the informal economy (and thus not within official rules and regulations). In part, it is because of the “anti-poor” attitudes among government officials and elites, so often based on misconceptions. For instance, officials and politicians often assume that those living in informal settlements are unemployed when they work long hours within the informal economy, or that they are recent migrants when they have long worked and lived within the urban centre (or, in many cities, may well have been born there), or that migrants would have been better off if they had not moved (when so many migration studies show that migration flows are logical responses to changing patterns of economic opportunity). One added vulnerability faced by large sections of the urban poor is that governments may bulldoze their settlements to clear them off land-sites deemed to be vulnerable to (for instance) floods, with very inadequate or no provision for finding alternative accommodation that meets their needs. Even more responsible and accountable urban governments face difficulties in addressing this issue, because low-income groups need central locations in relation to income-earning opportunities and if they have to be moved from hazardous sites, it is difficult to find appropriate alternative sites.

In general, in any urban area, the people most at risk from climate change are those who are:

- least able to avoid the direct or indirect impacts (e.g. by having good quality homes and drainage systems that prevent flooding, by moving to places with less risk or by changing jobs if climate-change threatens their livelihoods);
- likely to be most affected (for instance infants and older groups who are less able to cope with heat waves);
- least able to cope with the illness, injury, premature death or loss of income, livelihood or assets caused by climate change impacts.

Poorer groups get hit hardest by this combination of greater exposure to hazards (e.g., a high proportion living in makeshift housing on unsafe sites), lack of hazard-removing infrastructure and less capacity to cope (e.g., lack of assets and insurance), less adaptive capacity, less state provision to help them cope, and less legal protection or protection from insurance. Low-income groups also have far less scope to move to less dangerous sites; indeed, the more dangerous sites are often the only sites where lower-income groups can find housing they can afford or can build their own homes.

Wealth allows individuals and households to reduce risks – for instance by having safer housing, choosing safer jobs or locations to live in, having assets that can be called on in emergencies and protecting their wealth by insuring lives and assets that are at risk. Although it should be through good governance that provision for risk reduction is ensured for the whole city population and disparities in risk between income-groups reduced, wealthier groups often have more influence on public expenditures – and it has long been common for middle- and upper-income groups to be the main beneficiaries of government investment in infrastructure and services. If government does not provide these, higher-income groups have the resources to solve most of these problems themselves – for instance by developing their own provisions for water, sanitation and electricity, or moving to private developments which provide these. Indeed the reconstruction process, post-disaster, can offer real opportunities for private gain and it has been argued that this is one reason why disasters are managed through post-disaster reconstruction rather than pre-disaster risk management that would favour more socially progressive policies to reduce the vulnerability of the poor and enhance city-wide critical infrastructure such as drainage and sanitation.

The quality of government – both at national level and, as crucially, at local (district or municipal) level – influences the levels of risk from climate change facing those with limited incomes or assets in several ways:

- *quality of provision for infrastructure for all areas* (which should limit risks of flooding for the whole city area, not just for the wealthier areas) and land-use management (to limit or make more resilient settlements in high-risk areas);
- *quality of provision for disaster-preparedness* (including warnings, measures taken to limit damage and, if needed, good provision to help people move to safer areas quickly);
- *quality of planning for and coordinating disaster-response* (for instance rescue services and appropriate emergency and health care services) and reconstruction (to help those who have lost their homes and livelihoods) which should aim to improve resilience, but seldom achieves this;
- *extent to which poorer groups can buy, build or rent “safe” housing in “safe” sites;*
- *degree to which local government creates an enabling environment for local civil-society action* to contribute towards addressing the practical aims identified above.

D. HOW ADAPTATION RELATES TO THE CORE FUNCTIONS OF MUNICIPAL GOVERNMENTS

1. The lack of adaptive capacity

City and municipal governments have the main responsibilities for planning, implementing and managing most of the measures that can diminish risks (and the high vulnerabilities of sections of the population) from the direct and indirect impacts of climate change – through provision of infrastructure and services, disaster preparedness and the planning and regulatory framework.

The IPCC's Fourth Assessment noted the high adaptive capacity that is inherent within well-governed cities (Wilbanks, Romero Lankao et al., 2007). In high-income nations, urban populations have become so accustomed to a web of institutions, infrastructure, services and regulations that protect them from extreme weather/floods that these are taken for granted. Many of the measures also serve everyday needs as well as protection from extreme weather – for instance, through health care services and storm and surface drainage. Early warning for approaching storms are expected, as is a rapid emergency response from the police, health services and fire services, if or when needed. In high-income nations, it is very rare for extreme weather events to cause a large loss of life or to seriously injure many people. Occasionally, they cause serious damage to property in specific locations, although for most property owners, the economic cost is much reduced by insurance. All this adaptive capacity is also underpinned by almost all buildings conforming to building regulations and to health and safety regulations and served by piped water, sewers, all-weather roads, electricity and drains 24 hours a day. The costs of such infrastructure and services represents a small proportion of income for most citizens, whether paid direct as service charges or within taxes. City and municipal governments have great importance in most or all of these – although within very different systems in terms of what roles are taken by local government in the planning, provision and financing of these and in terms of the nature of local government relationships to higher levels of government. Private companies or nonprofit institutions may provide some of the key services, but the framework for provision and quality control is provided by local government or local offices or national or provincial government. For the most part, most citizens engage very little in the management of these because it is assumed that government systems will ensure provision, although there are channels for complaints if needed – for instance local politicians or lawyers, ombudsmen, consumer groups and watchdogs. Thus, the vast majority of urban dwellers are protected from extreme weather without them having to engage in the institutions that ensure such protection. While coverage for some services may be sub-standard and some groups ill-served or excluded, a high proportion of the urban population are well served and well protected. At least for the next few decades, this “adaptive capacity” can certainly deal with most of likely impacts from climate change in most urban centres in high-income nations. However, there may be some locations that are judged to be too expensive to defend – and obviously, the possibilities of adaptation being able to keep down risks depends on effective mitigation.

Whether this high adaptive capacity will actually produce appropriate adaptation is another issue; a detailed assessment of the possibilities and constraints on adaptation around the Gulf of Mexico gave many examples of local governments in the USA not fulfilling their responsibilities on risk reduction and allowing buildings and enterprises in high-risk zones; it also gave examples of perverse public policies and subsidies that acted to increase development in high-risk zones (Levina, Ramos and Ortiz, 2007). One post-Katrina assessment noted that municipal governments in the USA were still instrumental in increasing population concentration on coasts. “They can disregard federal flood maps, have key decisions over zoning and land use, can facilitate drainage and landfill projects, reduce taxes in locally defined enterprise zones... In hazard prone areas, pro-growth initiatives typically outstrip disaster mitigation and these processes erode wetlands, forests and other natural buffers to hurricanes. Coastal regions become more dangerous not just in terms of growing numbers of people and properties but also in terms of the increasingly outdated and receding protections from hazards generated by over investment in growth and under investment in environmental sustainability and disaster mitigation” (Elliott, 2008).

But the institutional basis for municipal adaptation is so much weaker in all low-income nations and most middle-income nations. Large sections of the urban population and the urban workforce are not served by a comparable web of institutions, infrastructure, services and protective regulations. It is common for between a third and half the entire urban population to be living in illegal settlements formed outside any land-use plan. These include “squatter settlements” (where the land occupation is illegal) and illegal sub-divisions (where occupation is legal in the sense of involving an agreement with the land-owner but municipal sub-division and infrastructure regulations are not followed). These settlements also tend to concentrate in areas at high risk from extreme weather, precisely because this high-risk lowers the value of the land and increases the inhabitants’ chance of avoiding eviction.

If one examines the roles and responsibilities of city and municipal governments in low and middle-income nations (UNCHS Habitat, 1996; Stren 1991; Davey, 1992; Shah with Shan, 2006), they generally have the primary role in a great range of infrastructure and service provision that is essential for good quality living standards and for livelihoods – for instance, provision for water, sanitation, drainage and solid waste collection – and often for some schools and health care facilities and for fire and other emergency services. They also generally have the primary role in implementing the regulatory framework essential for ensuring public health and safety (for instance through building and sub-division regulations, occupational health and safety, pollution control, traffic control and police) and in theory, a key role in urban planning (and within this land-use management). Of course, there are many variations in the form of local government intervention in these, including what is done or what is contracted out and the extent to which some infrastructure and service provision within their jurisdiction are the responsibility of higher levels of government. But the extent to which city and municipal governments actually meet their responsibilities has very large implications for living standards and the quality of life (including the quality of the urban environment) – and obviously, for adaptive capacity.

Almost all city and municipal governments in low- and middle-income nations fail to meet many of their responsibilities or only meet them for particular sections of their population. This can be seen in the scale of the inadequacies in provision for the infrastructure and services that they are meant to provide (or ensure provision through other providers) and in the extent to which the homes, neighbourhoods and livelihoods of their population fall outside their regulatory framework (UN Human Settlements Programme 1996; Hardoy, Mitlin and Satterthwaite, 2001). However, the scale of these inadequacies varies greatly. At one extreme, there are cities and smaller urban centres where most of the population live in homes and neighbourhoods that are illegal and informal with very inadequate or no public provision for infrastructure and services. For instance, most urban centres in low-income nations in Africa and Asia have no sewers at all, including many major cities and much of the population have no water supply piped to their home and no official solid waste collection service (UN-Habitat 2003, 2006; Hardoy, Mitlin and Satterthwaite, 2001). These inadequacies reflect local governments lacking the resources to meet their responsibilities – and often with very limited capacities to invest (as almost all local revenues go to recurrent expenditures or debt repayment). These inadequacies often reflect local governments that are unrepresentative, unaccountable and anti-poor – as they regard the population living in informal settlements and working within the informal economy as “the problem.” At the other extreme are examples of cities and smaller urban centres that still have some inadequacies and deficiencies in provision for infrastructure and services but these affect a much smaller proportion of the population. This often reflects city and municipal governments that are more accountable to the citizens in their jurisdiction and within national government structures that have strengthened and supported this level of government – with stronger local democracies in many instances. In many urban centres in Latin America, the quality and coverage of provision for water and sanitation has improved very considerably over the last two decades; there are also many urban centres with close to 100 percent coverage (UN Habitat, 2006; Heller, 2006). Several nations have also had constitutional or legal changes that have increased the revenues of city and municipal governments and strengthened local democracies (Campbell, 2003; Fernandes, 2007; Cabannes, 2004). There are also an increasing number of local governments that have developed successful partnerships with low-income groups and their community organizations which demonstrate cheaper, more effective ways in which they can meet their responsibilities for infrastructure and services (D’Cruz and Satterthwaite, 2005; Hasan, 2006).

Many reasons can be given for the inadequacies in local government. In many nations, these include institutional legacies from colonial rule and centralization in post-independence governments. There is also the application of imported models of urban planning and government that proved inappropriate to local contexts and possibilities. For instance, the utility of housing sub-division standards that have minimum lot-sizes and infrastructure standards that make it impossible for most of a city's population to get land for housing is obviously questionable. If half a city's population is living in illegal settlements and most new housing units are being built in illegal settlements, it suggests that the law is at fault, not the illegal housing and settlements.

But in the last two decades or so, other factors have had importance including the external pressures for dismantling or weakening the state and support for deregulation and privatisation (Rakodi, 1999). This was driven by the hope that this would help underpin stronger economies. It can be argued that the lack of progress in most urban centres in improving provision for water and sanitation over the last 20 years was the result of many international agencies greatly over-estimating the potential role of privatisation to improve and extend provision (Budds and McGranahan 2003; Warwick and Cann 2007). In addition, although international agencies began to recognize the importance of supporting "good governance" in the early 1990s, their "good governance" programmes were generally at national level with little attention paid to increasing the competence, capacity and accountability of local governments (Satterthwaite, 2005).

There is also the fact that most bilateral aid agencies and many international NGOs refused to work in urban areas, underpinned by (a usually mistaken) belief that urban populations benefited from "urban bias." There may be evidence of particular cities benefiting from urban bias in government policies and expenditures but in general this bias brings little or no benefit to the majority of those living and working in these cities – especially low-income groups. Just because hospitals, universities and investments in piped water supplies and sewers are concentrated in particular cities, it does not mean that their low-income population get any benefit from them. In addition, in most nations, there is little or no evidence of policy or expenditure biases benefiting most urban centres (Satterthwaite, 2007b; Corbridge and Jones, n.d.). The backlog in the population lacking provision for infrastructure and services continues to grow in most urban centres in low-income nations, as the powers and resources available to city or municipal governments bear little relation to their responsibilities.

2. The roles and responsibilities of urban governments

It is important to understand the scale and scope of local government involvement in urban centres, if their role in adaptation to climate change is to be understood. Urban governments typically have a range of roles that can be ordered under the eight headings listed below – although with many differences as to how these are arranged (or combined) within each urban centre and how lines of authority and accountability are structured between politicians and civil servants. Of course, there are also very large differences in the scope of their responsibilities within each of these and the competence with which these are fulfilled.

Generally there are divisions of departments for:

Finance: Budget/accounts management (which may also manage local government tenders) and revenues (managing the collection of whatever taxes or charges permitted to local governments; these may include a range of licenses that are important for control too).

Engineering/Public works: usually includes road repair and maintenance within their jurisdiction, street lights, management of government buildings and perhaps of some public housing stock.

Development planning and development control: building control/inspection, land use planning and management (including regulation), property registration and urban plans.

Environmental health: water, sanitation, storm and surface drainage (although this may be lodged within public works), implementation of environmental health regulations within certain enterprises (for instance restaurants, cafes and hotels, slaughter houses, markets) and public areas (although some of these may be lodged in other divisions).

Public health: Medical services (including hospitals and health care centres), solid waste collection and management.

Social/community/safety services: Some of the items listed above under environmental and public health may be within this. Often traffic management and management of social housing, libraries, some role in public transport, some role in schools and kindergartens (although usually with responsibilities shared with higher levels of government), youth policy, sport and recreation, parks; sometimes local police.

Emergency services: fire services, ambulances, some of the responsibility for disaster response.

Administration: usually including human resources and often includes the registration system for births and deaths and marriages.

Many city governments also have departments for promoting local economic development and some also have roles within electricity production or distribution.

It is easy to list a set of local government responsibilities for infrastructure, buildings and services that have great importance for the four critical aspects of adaptation: long term protection, pre-disaster damage limitation, immediate post-disaster response, and rebuilding – see table 2. It is also easy to point to large inadequacies in what is provided. Perhaps table 2's main utility is to highlight just how many areas of local government should be active in adaptation. But there is such diversity in the forms of local government and their relationships to higher levels of government that it is impossible to generalize in regard to:

1: how much of these fall to local governments to fulfil; and

2: the extent of local government engagement with each of these in terms of who has responsibility for planning, constructing and maintaining the buildings and infrastructure or providing the services, coordination, finance, monitoring and regulation.

There are also no obvious generalisations in regard to the 'best' local government structures. For instance, it can be argued that local governments with a high reliance on intergovernmental transfers for funding infrastructure and services are at a disadvantage because this reduces the link between local needs and local resources – but some nations with cities with high adaptive capacity have such a high reliance. The need to root adaptation in local contexts and realities suggest primary roles for local governments, yet local governments often focus on short-term goals and often prioritize economic growth over longer-term risk reduction.

Clearly, adaptation involves changes in policies and practices within many parts of local government. The key question – is there a mechanism by which these can be encouraged and integrated? For instance, if there is a strong local development plan that provides the framework for future investments and land use management, then it is possible to incorporate adaptation measures into this. But for so many urban centres, there is no such development plan – or if there is, much new investments, urban developments and buildings fall outside it.

3. Formulating and implementing adaptation policy

Most urban governments in low- and middle-income nations have not considered adaptation seriously. For instance, in India, Chile, Argentina and Mexico, central government is beginning to take an interest in adaptation, but this interest has yet to engage the interests of the larger, more powerful national ministries or agencies or city and municipal governments (Satterthwaite, Huq, Pelling et al., 2007). It is likely that there is considerable confusion among many local government politicians and civil servants in regard to climate change and to what responses they should make. Even among the cities in high-income nations with the greatest awareness of climate change – and that have made substantial efforts to reduce emissions – there has been no move on adaptation (Ligeti, Penney and Wieditz, 2007). Of course, this lack of attention to adaptation is not helped by the lack of locally relevant data on the likely direct and indirect impacts of climate change in each urban area. The city of Durban in South Africa is unusual in having developed an adaptation programme as described below in Box 1.

Box 1: Durban's adaptation – Debra Roberts

Durban established an Environmental Management Department in 1994. Much of the initial work of the Department was to see how the municipality's strong developmental orientation could also incorporate pressing environmental concerns. Durban was one of the few cities in Africa to have a Local Agenda 21, in line with what the world's governments agreed to at the UN Earth Summit in 1992. Various departments within the municipal government also became aware of the need to factor climate change into their plans – for instance for water supply and health care. But municipal officials are unlikely to act if they have little idea of what climate change means for their city. To address this, the Environmental Management Department initiated the development of a Climate Protection Programme in 2004. The roll-out of this programme has occurred in three phases:

Phase 1: Reviewing and developing an understanding of the global and regional climate change science and translating this into an understanding of the implications of climate change for Durban. Key impacts include increases in temperatures, changes in the distribution of rainfall (long periods of no rainfall punctuated by short periods of intense rainfall), decreased water availability, increased range of water and vector borne diseases, sea level rise, and the loss of biodiversity.

Phase 2: Developing a “Headline Climate Change Adaptation Strategy” for the city to highlight how key sectors within the municipality should begin responding to unavoidable climate change. Interventions look to enhance and expand existing initiatives (such as the modelling of vector-borne diseases and their relationship to climate change) or stimulate new activity such as the “climate-proofing” of the city's open space system through matrix management (i.e. the management of the urban landscapes surrounding natural areas in a way that assists the survival and dispersal of indigenous species) and the creation of north-south dispersal corridors.

Phase 3: Incorporating climate change into long-term city planning, which includes developing a model enabling the simulation, evaluation and comparison of strategic urban development plans within the context of climate change. This seeks to understand the effects of climate change in Durban and allow a model-based assessment of the effectiveness of alternative approaches to mitigation and adaptation. This will involve the use of greenhouse gas emissions accounting (i.e. producing an inventory or all the greenhouse gases produced by activities within the Municipal area) together with an assessment of the city's vulnerability in key sectors such as health, water and sanitation, coastal infrastructure, disaster management and biodiversity.

Source: Roberts 2008

Perhaps the two key messages that will get the attention of city/municipal governments are:

1: The very large overlap between most of the measures needed for adaptation and local development (especially improving and extending provision for piped water, good sanitation and drainage, solid waste collection, garbage disposal, prevention-focused health care and support for upgrading within informal settlements);

2: The very large overlaps between climate-change adaptation and building resilience to extreme weather/disasters (regardless of whether the extreme weather or other catalysts for disasters are related to climate change).

The key to adaptation in most instances is competent, capable, accountable urban governments that understand how to incorporate adaptation measures into most aspects of their work and departments. Many needed measures may seem to be quite minor adjustments to current practices – for instance in adjusting building codes, land sub-division regulations, land-use management and infrastructure standards - but the sum of all the minor adjustments over time can build greater resilience without high costs. The urban centres that face the greatest challenges are those in the more high-risk sites that lack competent, capable, accountable local governments – and very often have very large backlogs in protective infrastructure and services.

As Table 2 makes clear, good adaptation will need to involve a great range of urban government divisions and departments – some of which may be semi-autonomous public agencies. It will often need to involve many government agencies that work within sub-city or municipal levels and at higher (provincial/state and national) levels. It is difficult to specify the most appropriate intervention points within local government structures. First, this depends on the structure of the city or municipal government and often also on higher levels of government (which may control or have a major role in many city-level aspects of government). Super- or supra- government levels are often important – for instance for many urban centres, there are key functions managed at sub-municipal level (eg district or ward level). Many large cities are also formed by many separate municipalities with serious constraints on inter-municipal cooperation (for instance as they are governed by different political parties) and with great variation in the extent of functions managed at a higher (metropolitan or provincial) level. There is also the need to engage a great variety of local government staff – from elected councillors to technical discussions with particular specialists and specialist departments.

4. The interventions needed to adapt to climate risks

1. *Develop an information base on current conditions.* An important part of this is considering the impact of past extreme weather and other disasters on each city or municipality. This should seek as much detail as possible, drilling down to include “small disasters” (disasters that do not get included in international disaster databases).⁽¹⁾ This can draw on the DesInventar methodology developed in Latin America and now widely applied elsewhere which looks more intensively at disasters in any locality and includes “small disasters.” For instance, a database in Cape Town that sought to record all events registered over 12,500 incidents which contrasts with the 600 identified large events and declared disasters (Bull-Kamanga et al., 2003). Almost half of these occurred in informal settlements. An analysis of disaster events in Mexico, 1970 to 2001, sought to document all events with at least one mortality and found that floods were the most common disaster, and a quarter of all deaths from flooding came from events with fewer than four deaths – i.e. much too small to be included in international disaster datasets (see Awuor, Orindi and Adwerah 2008 for an example of this for Mombasa).

2. *Initiate risk/vulnerability assessments for the city* with as much geographic detail as possible; this needs to link hazard maps with details of what is currently located within the hazardous zones – including identifying population groups or settlements most at risk and activities that may pose particular risks (for instance water treatment plants vulnerable to flooding). From this, an assessment can be developed of whether the infrastructure and buildings will be able to withstand extreme events.

3. Based on the above, discuss how addressing the above can be incorporated into the different aspects of local government.

This whole process should be seen as useful far beyond climate-change adaptation as it documents and maps other key environmental hazards and who is most at risk from them.

There may need to be a “prequel” to the above – to convince urban governments of the need to initiate this. A review of progress in OECD nations on adaptation to climate change produced a useful figure, showing key stages in moving from assessing impacts to intention to act and finally implementing adaptation options (see Figure II). Although this diagram was intended to reflect national processes, it can equally be applied to city governments. In most low- and middle-income nations, it is likely to need innovation and leadership from local governments not only to demonstrate what is possible but also to help set or improve national policies.

E. GOOD LOCAL GOVERNANCE AND DEVELOPMENT ASSISTANCE

It could be argued that there needs to be a very large increase in the international funding available for investment in addressing the backlog in urban infrastructure and this is an important part of what new or expanded funding for climate change adaptation should be spent on. If international donors want to focus such funding specifically on adaptation, this would be problematic – not least because of a need for so many cities to adapt to climate variability when the role of climate change in such variability is not known. From a development perspective, it makes no sense to separate funding and implementation for adaptation to climate change risks from funding and implementation to improve and extend provision for infrastructure and services to reduce other environmental risks (including those arising from climate variability and earthquakes). It may be necessary to distinguish between the responsibility (and hence liability) of high-income countries to pay for adaptation in low- and middle-income nations to protect against the increased risks from climate change. Thus, funding for climate change needs to be in addition to existing development assistance flows – even if the funding it provides needs to be strongly integrated within development investments.

But increasing funding flows for adaptation will not achieve much unless there is the local government capacity to use it well and to work well with groups most at risk. This presents many more difficulties for official development assistance agencies than the actual funding. Developing more competent and accountable city and municipal governments is a complex and usually highly contested process. It is very difficult for any external organization, however well informed, to know how best to support this. In addition, official development assistance agencies have to work with and through national governments – which often strongly oppose needed changes, especially for the decentralization of decision-making and revenue-raising powers. There are also obvious political difficulties – for instance as national governments do not want resources channelled to city governments in which opposition parties predominate. In addition, official development assistance agencies are not set up to support the kind of long-term local engagement that supports the enhancement of local adaptive capacity. The boards or governments that oversee official development assistance agencies bring strong pressures to minimize staff costs (seen as a key measure of efficiency), produce tangible measurable results and limit the duration of any initiative. There is often a strong pressure to spend – or for the development banks to increase their loans. This is not the appropriate financial framework to support them working with national and local governments to build the competence, capacity and accountability of city and municipal governments and local government-grassroots organizations partnerships. To do this is likely to be a slow process in most nations; it needs a long engagement. It is difficult to measure its effectiveness with conventional quantitative indicators. Ironically, in most instances, good practice would be to minimize the amount of external funding needed, because to sustain this process and to allow it to expand to reach a high proportion of all urban centres, it needs to develop models that can be sustained primarily by local resources.

If development assistance agencies accept the need to support more competent, effective, accountable pro-poor city and municipal governments – for climate change adaptation and also for more effective development – it will need some significant changes in how they structure development assistance. It will need their long-term engagement with supporting this and innovative financial systems that allow support to flow rapidly and easily to a multiplicity of locally-determined initiatives. What is possible and what should be prioritised in any nation obviously depends on the competence, capacity and accountability of local governments. Table 3 illustrates this by highlighting the different local government contexts with which external donors would have to work, if consideration is given to these.

An important part of building local adaptive capacity is supporting adaptation that serves low-income groups, especially those that live in homes and locations most at risk from the direct and indirect impacts of climate change. There are good experiences on which to draw on “slum and squatter upgrading” in which local governments have worked with the inhabitants of informal settlements to provide infrastructure and services and improve the quality of housing (see for instance Boonyabancha, 2005). There are also many examples of “upgrading” and of new housing developments undertaken by federations formed by “slum” or “shack” dwellers themselves that are both more effective and less costly than those supported by international agencies – and where these receive support from local government, these have demonstrated a very considerable capacity to “go to scale” (as in, for instance, India, South Africa, Thailand and Malawi) (ibid; Burra, 2005; d’Cruz and Satterthwaite, 2005; Manda, 2007; Muller and Mitlin, 2007). But these kinds of grassroots initiatives also require donor support. And this should not be seen as funding alternatives to local government but as central to building the competence, capacity and accountability of local governments.

Thus, in conclusion, support for adaptation to climate change needs to think through the financial systems and mechanisms that will allow support for a multiplicity of city or municipal innovations by local governments and by grassroots organizations – and that reinforces and works with “good local development” and “good local governance.” The current focus on National Adaptation Programmes of Action (NAPAs) and on community-based adaptation leaves out the key role of local government (although some community-based adaptation has involved local governments). There need to be local LAPAs and city CAPAs to underpin and drive innovations in NAPAs.

It is also important to stress that in almost all instances, there needs to be **development+adaptation**. Even competent and accountable national and local (city and municipal) governments will not engage with adaptation to climate change unless it is seen as supporting and enhancing the achievement of development goals. This also implies drawing on the knowledge of the few official development assistance agencies with experience in urban development.

Obviously, consideration needs to be given as to how urban adaptation can also contribute to mitigation in all nations and there are some obvious complementarities between the two. But some care is needed in this, especially in assumptions that measures that reduce greenhouse gas emissions necessarily serve adaptation or development. Because mitigation in high-income nations focuses so strongly on increasing energy efficiency, there is often an assumption that the measures used to achieve this should be transferred to low and middle-income nations – even as some of these nations have 1/50th or even 1/100th of the carbon emissions per person of high-income nations. In most urban centres in low- and middle-income nations, adaptation priorities need to focus on the expansion and improvement of protective infrastructure and services, not on energy efficiency.

Finally, there is also an obvious need to draw on the “disaster-preparedness” community of scholars and activists who have transformed our understanding of what causes disasters and the extent to which “natural” disasters are preventable (because the actual disaster is so much to do with inadequate planning and infrastructure and lower-income groups having no alternative but to live in high risk areas). It is surprising that they have not had a more central role in adaptation, given how much they can contribute to understanding the possibilities and constraints on adaptation that reduces risks from disasters.

NOTES

1. The Centre for Research on the Epidemiology of Disasters (CRED), which holds the only publicly accessible global disaster database, defines disaster as “a situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance.” To be entered into the EM-DAT database, at least one of the following criteria has to be fulfilled: 10 or more people reported killed; 100 people reported affected; a call for international assistance; and/or declaration of a state of emergency; CRED EM-DAT; see <http://www.em-dat.net/>. See also International Federation of Red Cross and Red Crescent Societies 2002.

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Table 1: Selected examples of current and projected impacts of climate change on industry, settlement and society and their interaction with other processes

Climate-driven phenomena	Evidence for current impact/ vulnerability	Other processes/ stresses	Projected future impact/ vulnerability	Zones, groups affected
a) Changes in extremes				
Tropical cyclones, storm surge	Flood and wind casualties & damages; economic losses; transport, tourism, infrastructure (e.g. energy, transport), insurance	<i>Land use/ population density in flood-prone areas; flood defences; institutional capacities</i>	<i>Increased vulnerability in storm-prone coastal areas; possible effects on settlements, health, tourism, economic and transportation systems, buildings & infrastructures</i>	<i>Coastal areas' settlements, and activities; regions and populations with limited capacities and resources; fixed infrastructures; insurance sector</i>
Extreme rainfall, Riverine floods	Erosion/landslides; land flooding; settlements; transportation systems; infrastructure	<i>Similar to coastal storms plus drainage Infrastructure</i>	<i>Similar to coastal storms plus drainage infrastructure</i>	<i>Similar to coastal storms</i>
Heat- or cold-waves	Effects on human health; social stability; requirements for energy, water and other services (e.g. water or food storage), infrastructures (e.g. energy transport)	Building design and internal temperature control; social contexts; institutional capacities	Increased vulnerabilities in some regions and populations; health effects; changes in energy requirements	<i>Mid-latitude areas; elderly, very young, and/or very poor populations</i>
Drought	Water availability, livelihoods, energy generation, migration, transportation in water bodies	<i>Water systems; competing water uses; energy demand; water-demand constraints</i>	Water-resource challenges in affected areas; shifts in locations of population & economic activities; additional investments in water supply	<i>Semi-arid and arid regions; poor areas and populations; areas with human-induced water scarcity</i>
b) Changes in means				
Temperature	Energy demands and costs; urban air quality; thawing of permafrost soils; tourism and recreation; retail consumption; livelihoods; loss of meltwater	Demographic and economic changes; land-use changes; technological innovations; air pollution; institutional capacities	Shifts in energy demand; worsening of air quality; impacts on settlements and livelihoods depending on melt water; threats to Settlements / infrastructure from thawing permafrost soils in some regions	Very diverse, but Greater vulnerabilities in places and populations with more limited capacities and resources for adaptation

Precipitation	Agricultural livelihoods, saline intrusion, tourism; water infrastructures, tourism, energy supplies	<i>Competition from other regions/ sectors; water-resource allocation</i>	<i>Depending on the region, vulnerabilities in some areas to effects of precipitation increases (e.g. flooding, but could be positive) and in some areas to decreases (see drought above)</i>	Poor regions and populations
Saline intrusion	Effects on water infrastructures	Trends in groundwater withdrawal	Increased vulnerabilities in coastal areas	Low-lying coastal areas, especially those with limited capacities and resources
Sea-level rise	Coastal land uses: flood risk, water logging; water infrastructures	<i>Trends in coastal development, settlement and land uses</i>	<i>Long-term increases in vulnerabilities of low-lying coastal areas</i>	<i>Same as above</i>
c) Abrupt climate change	Analyses of potentials	Demographic, economic, and technological changes; institutional developments	Possible significant effects on most places and populations in the world, at least for a limited time	Most zones and groups

Dark shading with text in italics indicates very significant in some areas and/or sectors; light shading indicates significant; no shading indicates that significance is less clearly established.

SOURCE: Wilbanks, Tom and Patricia Romero Lankao with Manzhou Bao, Frans Berkhout, Sandy Cairncross, Jean-Paul Ceron, Manmohan Kapshe, Robert Muir-Wood and Ricardo Zapata-Marti (2007), "Chapter 7: Industry, Settlement and Society," in Parry, Martin, Osvaldo Canziani, Jean Palutikof, Paul van der Linden and Clair Hanson (editors) *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge and New York, pp. 357-390.

Table 2: The role of city/municipal governments in adaptation

Role for city/municipal government	Long term protection	Pre-disaster damage limitation	Immediate post-disaster response	Rebuilding
Built environment				
Building codes	High		High*	High
Land use regulations and property registration	High	Some		High
Public building construction and maintenance	High	Some		High
Urban planning (including zoning and development controls)	High		High*	<i>High</i>
Infrastructure				
Piped water including treatment	High	Some	High	High
Sanitation	High	Some	High	High
Drainage	High	High**	High	High
Roads, bridges, pavements	High		High	High
Electricity	High	Some?	High	High
Solid waste disposal facilities	High	Some?		High
Waste water treatment	High			High
Services				
Fire-protection	High	Some	High	Some
Public order/police/early warning	Medium	High	High	Some
Solid waste collection	High	High**	High	High
Schools	Medium	Medium		
Health care/public health/environmental health/ambulances	Medium	Medium	High	High
Public transport	Medium	High	High	High
Social welfare (includes provision for child care and old-age care)	medium	High	High	High
Disaster response (over and above those listed above)			High	High

* Obviously it is important that these do not inhibit rapid responses

** Clearing/desilting drains and ensuring collection of solid wastes has particular importance just prior to extreme rainfall; many cities face serious flooding from extreme rainfall that is expected (for instance the monsoon rains) and this is often caused or exacerbated by the failure to keep storm and surface drains in good order.

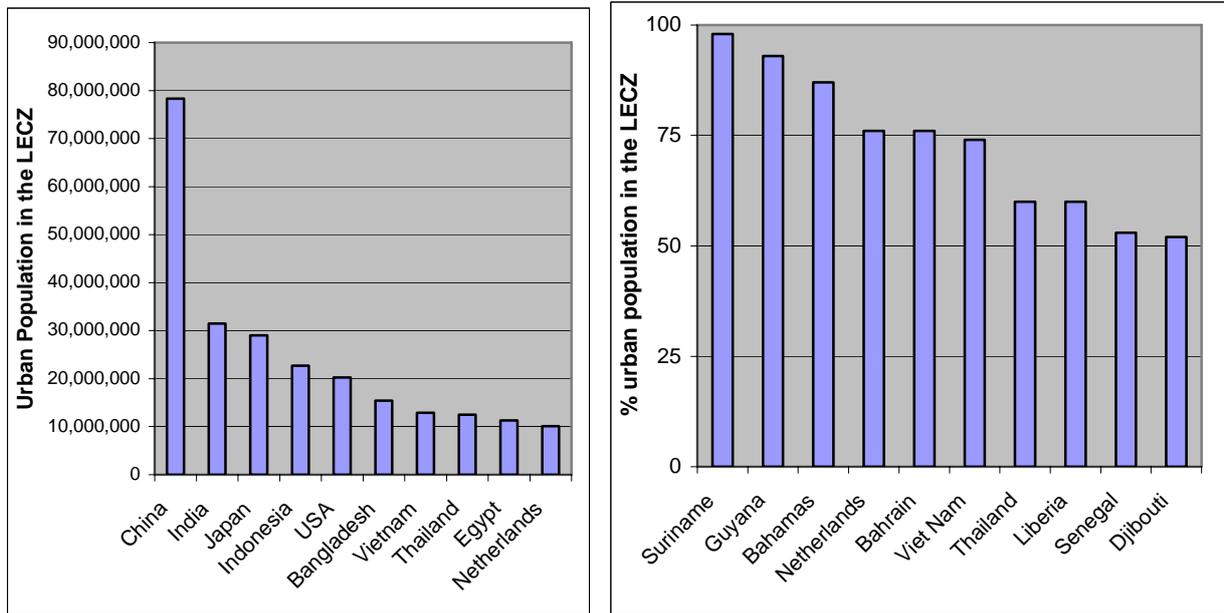
SOURCE: Satterthwaite, David (2007), *Integrating Adaptation to Climate Change in Decision-making at the Urban/Municipal Level in Low- and Middle-income Nations*, (first draft), prepared for the OECD Development Assistance Committee, OECD, Paris, 33 pages.

Table 3: Different local contexts through which national governments and international agencies can pursue “good governance” for adaptation

Resources available to local government	The quality of local government/governance	
	From democratic and accountable local government structures...	...to undemocratic, unaccountable and often clientelist local government
From relatively well-resourced, local government institutions with the needed technical competence...	Local government can be well served by external funding, including funding to support adaptation by households and private enterprises, and funding for needed infrastructure and support services (whether provided by community organizations, NGOs, private enterprises or government agencies)	Long-term support needed for governance reforms at all levels of government; also support needed for local private and community provision both to improve conditions and to build local pressure on government for better governance
...to poorly resourced local governments lacking funding, a strong local revenue base and technical capacity	Need for a strong focus on capacity building for local government and support for its partnerships with civil society and local private-sector infrastructure and service providers (including informal providers)	As above but with strong support for local private providers and community provision within a long-term goal of supporting more competent, accountable and transparent local government

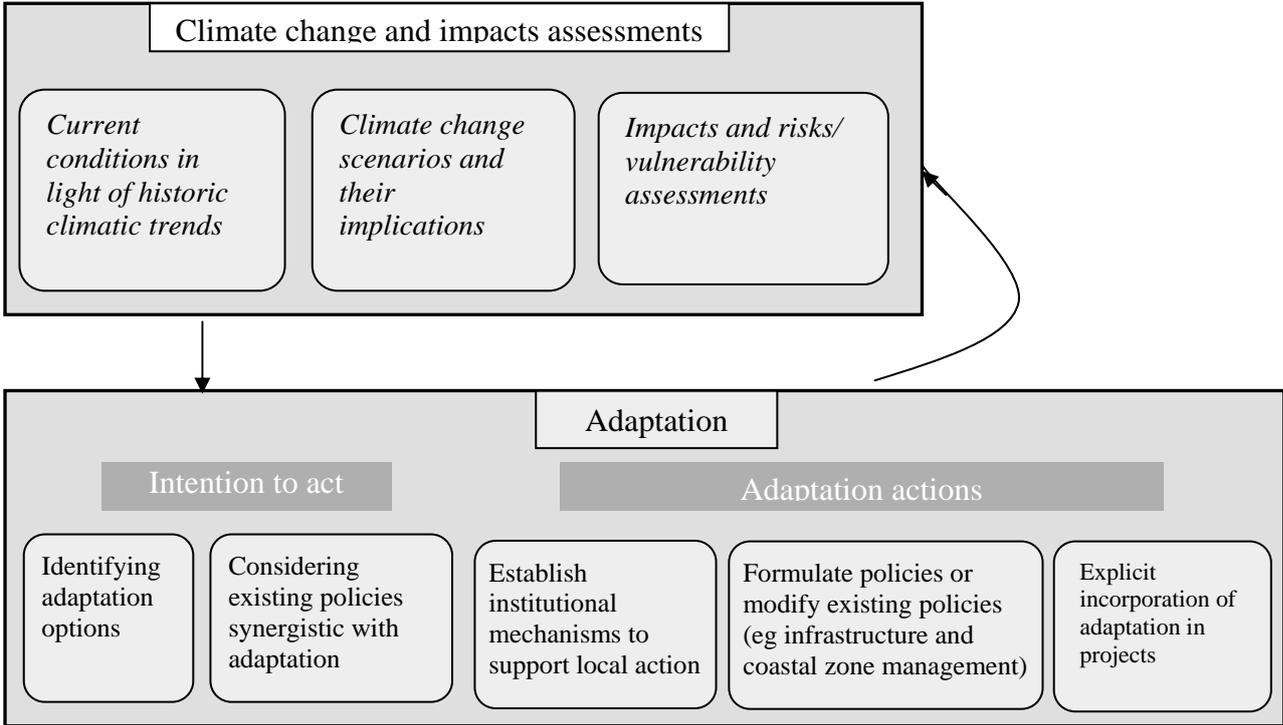
SOURCE: Satterthwaite, David (2007), *Integrating Adaptation to Climate Change in Decision-making at the Urban/Municipal Level in Low- and Middle-income Nations*, (first draft), prepared for the OECD Development Assistance Committee, OECD, Paris, 33 pages.

Figure I: Nations with the largest urban populations and largest % of their urban population in the Low Elevation Coastal Zone



SOURCE AND NOTES: These figures were prepared by Gordon McGranahan, Deborah Balk and Bridget Anderson from the GRUMP database; see McGranahan, Gordon, Deborah Balk and Bridget Anderson (2007), "The rising tide: assessing the risks of climate change and human settlements in low-elevation coastal zones," *Environment and Urbanization*, Vol. 19, No. 1, pp. 17–37. For Figure 2, countries with an urban population of fewer than 100,000 were excluded.

Figure II: Moving from assessment to intention to act and finally adaptation actions



SOURCE: Based on Figure 6 in Gagnon-Lebrun, Frédéric and Shardul Agrawala (2006), *Progress on Adaptation to Climate Change in Developed Countries; An Analysis of Broad Trends*, ENV/EPOC/GSP(2006)1/FINAL, OECD, Paris, 59 pages.