CHAPTER 7

CONCLUSION AND POLICY DIRECTIONS

If concerted action is not undertaken to reduce greenhouse gases (GHGs) and promote more environmentally sustainable and equitable patterns of urban development, there will be a deadly collision between urbanization and climate change. The dangerous course to this collision threatens to have unprecedented negative impacts upon human development, quality of life, economic production, political stability and the health and resilience of the ecosystems upon which human beings depend. However, the coming together of urbanization and climate change will also offer an unprecedented opportunity. Urban areas, with their high concentrations of population, buildings, industries and infrastructure, will face the most severe impacts of climate change. Yet, the same urban areas can become hubs of innovation where alternative options can be designed and tested to promote reductions in GHG emissions (mitigation) and vulnerability to climate change impacts (adaptation).

Significant linkages exist between climate change and development. While climate change is jeopardizing development goals, mitigation and adaptation targets could be greatly threatened by unsustainable pathways of development. Climate change cannot be addressed effectively unless more effective actions are undertaken to reduce emissions, cope with climate changes already under way, and create the conditions to enhance the adaptive capacity of poor countries and population sectors (environmental justice). Mitigation efforts need to focus not only on reducing carbon intensity, or increasing the energy efficiency of infrastructure, buildings, and economic and domestic activities, but also on reducing both the total consumption of fossil fuels and emissions of GHGs through other means. Adaptation strategies cannot be reduced to redesigning buildings and infrastructure, but will also require use of local knowledge, greater participation of key stakeholders, and higher institutional capacity of local governments. In many developing countries, urban centres lack all-weather roads, good-quality homes and other preconditions for successful adaptation (i.e. they suffer from an 'adaptation deficit'). It is therefore necessary to relate adaptation and mitigation responses to development and foster sustainable development with mitigation and adaptation strategies in mind.

Equity is a fundamental dimension of the relationship between climate and development. Because of uneven development patterns and distribution of wealth and infrastructure services at global, national and urban levels, within different sectors, and between different individuals, there is often an inverse relationship between responsibility for climate change and suffering of its consequences. The largest national emitters of GHGs are, by far, the developed countries and a few rapidly industrializing developing countries (see Table 1.4), and this trend can also be seen, generally speaking, in the wealthy sectors within countries and cities around the world. Yet, climate change will deal its heaviest blows on those contributing the least to GHG emissions: poor countries and the poor and vulnerable within their societies.

If concerted action is not undertaken to reduce … GHGs … there will be a deadly collision between urbanization and climate change

There are, at present, many actions at different levels designed to respond to the daunting challenge of climate change. Nearly all national governments have signed the United Nations Framework Convention on Climate Change (UNFCCC) and dozens have launched responses at the national level. Numerous provincial/state and local authorities have promoted vigorous, yet varied responses to address climate change, even in the absence of incentives from national governments. Many local authorities are also undertaking a range of mitigation and adaptation measures. Notwithstanding all of these, climate change remains, in practice, a marginal issue for most decision-makers. This Global Report has explored the reasons for this, as well as windows of opportunity that can be used or created to help urban populations and decision-makers reduce their emissions and adapt to climate change in ways that promote sustainable, equitable and resilient paths of urban development.

There is often an inverse relationship between responsibility for climate change and suffering of its consequences

The purpose of this chapter is to provide an overview of the key findings and messages from all chapters of the Global Report. It will briefly revisit the constraints, challenges and opportunities to mitigation and adaptation actions, and point to some of the linkages among drivers and vulnerabilities. Drawing further from the findings of the previous chapters, this concluding chapter reflects on the multiple linkages, synergies and trade-offs between mitigation, adaptation and urban development. The chapter ends with a set of suggestions on future policy directions, focusing on local, national and international principles and policies for supporting and enhancing urban responses to climate change.

KEY FINDINGS AND THEIR IMPLICATIONS

Urbanization and climate change are two human-induced forces that have put humanity at a crossroad of at least two future directions that this Global Report has explored. *First*, there is the plausible future of continuation along a dangerous collision course if national, regional and local governments continue with business as usual. Many of the dysfunctions of the current political, economic and social systems at play could lead inexorably to the very worst outcomes imaginable. For example, it has been difficult for the developed countries, which bear the main responsibility for current GHG emissions,[1] to achieve effective mitigation targets. Notwithstanding decades of development policies, the story of how affluence and poverty affect global climate change is still a tale of two development paths explaining diverse levels of emissions within and across cities. This difference also creates common but differentiated mitigation and adaptation responsibilities (i.e. the wealthy should be most responsible for mitigation and adaptation responses). However, the political reality is that the wealthy also have a greater influence on the political structures at play, making such equitable distribution of responsibility difficult at best. Furthermore, uneven development and inadequate infrastructure and governance structures constrain the ability of populations and local authorities of many urban centres to adapt to existing and future climate change and to other environmental and societal stresses.

Climate change … increases the magnitude of the developmental and environmental challenges and threats that urban governments are already facing

A *second* plausible future, and the only option for humanity to avoid the first, is one for which cities have historically proved their talents as sources of innovation, and laboratories for the transition to different and more sustainable (i.e. less carbon intensive and more resilient) pathways of development. The findings of this Global Report, briefly summarized, contribute to making this second option possible.

Main issues of concern

The main human sources of GHGs are the dramatic rise in energy use, land-use changes and emissions from industrial activities

Trends of urban change in recent decades have a strong bearing upon the present report. Urban population growth has taken place at an unprecedented rate, with a near quintupling of total urban populations between 1950 and 2011. During the same period, the urban population has increased from being less than one third (28.8 per cent in 1950) to more than one half of the global population (50.8 per cent in 2011). The fastest rates of urbanization are currently taking place in developing countries, with the bulk of this growth taking place in smaller urban areas.[2] This, coupled with the increased intensity and frequency of adverse weather events, will have devastating effects precisely where the capacity to deal with the consequences of climate change is weaker, or even lacking. Smaller urban centres in developing countries are often institutionally weak, and unable to promote effective mitigation and adaptation actions. At the same time, a possible advantage also exists as the burgeoning development of these centres may be redirected in ways that reduce their emission levels to a desired minimum – for example, through the promotion of mono-centric urban structures based on the use of public transportation. Their resilience and ability to cope with climate hazards and other stresses may also be enhanced – for instance, through the development of climate-proof urban infrastructures and effective response systems.

This Global Report aims at contributing to an understanding of the drivers of GHG emissions from urban areas. The purpose of developing this understanding is to help urban policy-makers, enterprises and consumers target effective options for reducing these emissions at the same time that they enhance urban resilience to the impacts of climate change. Last, but certainly not least in importance, the dynamics of urban centres are intimately linked not only to the role of geography in determining a city's need for energy to run heating and air-conditioning systems, or to get access to sources of energy, but also to the role that geography plays in giving cities access to biodiversity, clean water and other ecosystem services at risk from the impacts of climate change. Furthermore, since urban areas have developed over existing ecosystems (or 'ecozones') such as coastal areas, wetlands, drylands, etc., intimately linked to geography and to ecosystem services threatened by changes in the climate system, policies aimed at mitigation and adaptation in these areas should also consider protection or enhancement of natural systems – for example, through tree-planting and coral reef restoration.

Climate change is also interacting with urbanization and, in doing so, increases the magnitude of the developmental and environmental challenges and threats that urban governments are already facing as a result of the pace of current urbanization (each year sees the addition of 67 million new urban dwellers, 91 per cent of whom are added to cities in developing countries).[3] The most recent empirical evidence points unequivocally to the conclusion that the Earth's climate is warming and that this warming has been induced by the massive amounts of GHGs that human beings have pushed into the atmosphere. Human-induced changes in the climate system have been further validated by research that has been published after the release of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2007. According to this assessment, the observed increase in global mean surface temperature since 1990 is 0.33°C. At the same time, changes have been documented in the frequency and severity of storms, precipitation, droughts and other weather extremes of relevance for urban centres.

The main human sources of GHGs are the dramatic rise in energy use, land-use changes and emissions from industrial activities. Increases in GHG emissions have been, to a limited extent, offset by increases in efficiency and/or reductions in the carbon intensity of production and consumption. However, the overall global trend has still been towards large increases in the total amount of anthropogenic (or human-caused) GHG emissions.

Since the onset of the industrial era, urban centres have played a key, though not yet fully understood, role in the unprecedented increases of carbon dioxide (CO_2) and methane emissions. Furthermore, emissions are now

increasing above the worst scenario established by the IPCC. In this context, humanity is facing two main challenges that urban centres can help address: the *need to adapt*, at least to some amount of continued warming already under way, and the *need to mitigate* (i.e. to achieve development paths that bring about a peaking of emissions by 2015 and a stabilization of GHG concentrations).

While industrialization is certainly responsible for the rapid pace of global climate change, and urbanization is strongly related to industrialization, two questions of primary importance are still being addressed (i.e. the amount of GHG emissions that urban areas are actually responsible for, and the linkages among levels of urbanization, economic development and emissions). Chapter 3 showed that, because of the complexities involved in calculating the urban contribution to GHG emissions and the lack of agreement by researchers on exactly what items to include in the inventories, no precise figures exist of how high a contribution to global warming cities make. Earlier chapters have also illustrated how a dynamic, complex and strong link exists between economic development, urbanization and GHG emissions. However, this relationship is in no way straightforward. Differences in GHG emissions result from the peculiarities and weight of different emitting sectors (such as industries, buildings and transportation). Diverse factors account for the different levels and sources of urban GHG emissions both within and across countries. These include:

- differences in how energy generation, transportation and other emitters operate;
- levels of economic development and affluence as measured by gross domestic product (GDP) per capita;
- technology and technological innovations and acquisition;
- geographic factors;
- demographic structure and dynamics of a city;
- urban functions and a city's economic base;
- urban form (spatial structure) and, related to it, the layout and structure of a city's transportation system;
- city size (i.e. the 'agglomeration' effect);
- climate conditions and natural endowments; and
- market prices and the wider institutional setting of the city and of the broader – national and international – governance structure within which it operates.

The inverse relationship between being the most at fault for the causes of climate change and suffering its most profound consequences springs directly from historical and existing patterns of inequity in development, distribution of wealth, lifestyle and availability of infrastructure services. This inequity exists not only at the global level, where developed countries and a few rapidly industrializing developing countries are the main contributors to total CO_2 emissions. It also occurs at the national and local levels, creating differentials in contribution to GHG emissions along several different economic and social lines. These differences can be found within and across cities, between the rich and the poor, the racial or ethnic minority and the majority, the old and the young, and between men and women. This follows, in general, the differential access to resources, services and political power among and between these groups. As such – even within developing countries – it is the affluent and politically enfranchised enclaves, groups and communities with access to more services and amenities who consume more, travel more and become the highest GHG emitters within their cities, regions and countries. This deeply entrenched inequity lies at the heart of environmental justice issues surrounding climate change mitigation and adaptation actions.

The concentration, within urban centres, of people and their homes, infrastructure, industries and waste within a relatively small area can have two implications for policies aimed at avoiding the negative urban impacts of climate change. On the one hand, urban areas can be dangerous places in which to live and work; their populations can be very vulnerable to extreme weather events or other hazards, with the potential to become disasters. Furthermore, urban settlements can increase the risk of 'concatenated hazards'. Industrialization, inadequate planning and poor design can be key determinants of secondary or technological risks.

A dynamic, complex and strong link exists between economic development, urbanization and GHG emissions

On the other hand, the same concentration of people, infrastructure and economic activities in urban centres also means economies of scale or proximity for many of the measures that reduce risks from extreme weather events. Policies on enhancing sustainability and on transition from disaster response to disaster preparedness can help urban settlements to increase their effectiveness at coping with climate hazards.

Not all demographic segments of the urban population are equally affected by the hazards that climate change is predicted to aggravate. The capacity of different urban populations to cope or adapt is influenced not only by age and gender, but also by the context-specific combination of factors such as:

It is the affluent and politically enfranchised … groups and communities …who consume more, travel more and become the highest GHG emitters

- labour, education, health and the nutrition of the individuals (*human capital*);
- the financial resources available to people (*financial capital*);
- the extent and quality of infrastructure, equipment and services (*physical capital*);
- stocks of environmental productive assets, such as soil, land and atmosphere (*natural capital*);
- the quality and inclusiveness of governance structures and community organizations that provide or manage safety nets and other short- and longer-term responses (*social capital*).

Urban vulnerability to climate change is a dynamic process in many ways: climate change and other stresses – including market integration, governmental policies and environmental change – constantly change, as do the dimensions defining sensitivity and capacity to adapt. Adaptation is also a process of constant adjustments and learning that may evolve in response to different exposures and past experiences. In this context, high adaptive capacity and successful adaptation to one stress (e.g. drought) may result in

exposure to new stresses (such as the urban heat-island effect or water scarcity), some of them provoked by coping responses (such as the use of air conditioning or increased extraction of groundwater). It is therefore important for decision-makers to understand how such complex processes interact and change over time because this understanding can help to inform more successful adaptation and avoid potential negative feedbacks or unintended consequences.

Cities and the multifaceted nature of climate responses

Representatives from different countries, states and cities are responding at multiple sectoral and governmental levels to the mitigation and adaptation challenges posed by the implications of climate change. These responses go beyond traditional national and state activity, and frequently imply not only multilevel public interventions, but also public–private cooperation and autonomous responses, and self-regulation by individuals and groups. These responses and the issues that they are intended to address are multi-scale in nature because most of the processes involved operate at multiple levels. It is frequently the case that mitigation and adaptation responses do not fit with the issues that they are intended to address. For instance, many of the climatic cause-and-effect relationships are long term and potentially irreversible and, therefore, require preplanning that goes beyond the tenure, administrative power and even the lifetime of most current decision-makers and stakeholders. This makes policy decisions in this area particularly difficult, as uncertainties exist in the understanding of the outcomes and impacts of climate change.

Countries, states and cities are responding at multiple sectoral and governmental levels to the mitigation and adaptation challenges

Ideas and policies centred on development, sustainability, climate change and some of their central issues (poverty reduction, disaster management and climate change adaptation) share key characteristics. For instance, in the area of climate change, the notion of development opens the possibility of promoting deep transformations in models of production and lifestyles. The specific nature of these changes has been defined in different ways. The *first* and dominant way is to use new markets to manipulate the inputs and outputs of the existing market system in an attempt to transform them, thus affecting everything beneath the overarching economic system in a cascading or domino-like fashion (such as by using carbon markets to create incentives to curb GHG emissions). The *second* way focuses first on equity and attempts to create transitions based on models of development that include sustainable use of the environment and non-market-driven alternatives to promote human well-being. It is this vision of sustainable and resilient development that has great potential for a movement away from current, unfair and unsustainable patterns of energy use and their dangerous impacts upon the climate system. This alternative model of development would allow urban populations and decision-makers to move towards equity, minimizing human suffering from climate-related disasters and promoting well-being, while creating the conditions for improvements in quality of life for undeveloped areas, including poor urban slum dwellers of the world. It would create the basis for many alternative development policies and programmes at the international, national, state (or province) and urban levels of governance and in civil society. It would also foster development that can fulfil the twin roles of improving the quality of life of the urban poor, while creating sustainable urban lifestyles that are central to the messages of this report.

Chapter 2 describes the process by which climate change has become part of the international agenda, exploring the main mechanisms, instruments and financing strategies of the UNFCCC and the Kyoto Protocol. The message of climate change, however, only caught public attention with increased scientific knowledge of, and public concern about, global environmental issues that crystallized in the creation of the UNFCCC. This new public awareness was further catalysed by an array of extreme events that are increasingly affecting the world, and the creation of the IPCC. The chapter also identifies the key actors, components and actions of climate governance other than the Climate convention and protocol at the international, regional, national and sub-national levels. The implications of the international climate change milieu for local action at the city level are described and the extent to which actors of this level have benefited from the various funding and support mechanisms currently available is reviewed.

Chapter 2 also outlines some common features that have defined the international climate regime, such as the use of a 'framework' scheme with general formulations that are deliberately ambiguous in order to limit conflicts between the positions of all representatives. The basic principles arrived at are then fleshed out through regular post-agreement meetings of the countries that have adopted the UNFCCC. Particularly in negotiations during key sessions of the Conference of the Parties (COP) to the UNFCCC, little progress is made during most of the negotiation period. Precisely because effective policies to reduce GHG emissions imply deep transformation in energy systems, lifestyles and economic activities, an understandably high contentiousness exists every time the COP discusses how much needs to be mitigated by whom, when and where (burden and timetables of commitments); who will pay for the responses and how (financial assistance and technology transfer); and what institutions and implementation mechanisms need to be in place to ensure participation and compliance.

Conflicts and uncertainties can help to understand, at least partially, the complex and fragmented governance of climate issues. Yet, equally important is to be aware of the fact that rather than being a wholly rational process, policy-making is an incremental undertaking. Climate governance is made up of a patchwork of binding agreements (e.g. the Kyoto Protocol), organizations (such as the UNFCCC secretariat, the IPCC and the United Nations) and networks that are quite different and distinct in their functions and approaches (e.g. rule-setting and information-sharing), their constituencies (private and public), their spatial scope (local, bilateral to global), their focus (e.g. mitigation, adaptation, disaster management and development), and their capacity to steer climate-relevant action. The Climate Convention

also coexists with a set of parallel initiatives and frameworks (e.g. the Hyogo Framework), operating at different sectoral and spatial levels and exerting deep influence on climate issues. For instance, the adaptation and disaster risk management communities share many commonalities, and can learn and benefit from each other's concepts and experience. Yet, outstanding differences also exist, particularly in terms of terminology, actors involved and types of intervention.

A relatively small number of countries, states/provinces and cities have played leading roles in addressing mitigation and – to a lesser extent – adaptation. Some (e.g. London, UK; California, US; King County, Oregon, US; Durban, South Africa) have launched ambitious climate change programmes; have created positive synergies with other tiers of government; and have mobilized the necessary support from the public and private sectors to curb GHG emissions and adapt to climate change. However, even the leaders and frontrunners in climate change action are faced with multiple challenges and difficulties in achieving their mitigation targets (such as the UK). This is true because many proposed actions are voluntary, and policies in many of the existing plans do not appear adequate to address the problem.

Although existing knowledge lags behind the recent explosion in city responses to climate change, it can be said that some urban actors have been able to take advantage of the opportunities offered by the multilevel governance structures briefly described in Chapter 2. More urban authorities than ever currently participate in transnational networks, research-sharing, learning initiatives and advocacy efforts. These urban actors have developed a more aggressive approach, seeking to secure the economic competitiveness of their cities and to input a local voice in international negotiations (such as the World Mayors Council on Climate Change at the COPs) and organizations.

Climate action at the urban level has been shaped by a myriad of factors. These are given by institutional conditions and incentives, such as existing international instruments and financing mechanisms, supra-regional programmes and national regulation systems. This Global Report has provided different examples of this. The emphasis on mitigation strategies and actions by city-relevant local authorities can be partially attributed to the importance of such international mechanisms and programmes as the Clean Development Mechanism (CDM), which were made operational earlier than adaptation funding mechanisms, such as the Adaptation Fund.[4] This mitigation emphasis is also the result of the design, within the European Union, of the European Emissions Trading Scheme – the largest multinational GHG emissions trading scheme in the world – and the leadership of such countries as the UK, Germany and Norway that have been key promoters of climate policies aimed at mitigation. These countries have assembled an array of policies to achieve long-term reductions.

Action on climate change issues – for mitigation or adaptation – is largely a function of knowledge, whether generated by scientific communities or brokered by the media, scientific entrepreneurs or non-governmental organizations (NGOs) at different levels (from the international to the local). It is, hence, necessary for academic institutions, local authorities and key stakeholders to generate the necessary information and create the sense of identity and the buy-in necessary to affect change. Equally important, however, has been the power that different groups have to make their points of view prevail.

Individual and organizational leadership has been another factor shaping climate action and creating windows of opportunity offered by transnational networks. However, administrative structures, party politics, political timetables, inertias and many other institutional constraints need to be overcome, thus requiring a broader-based institutional capacity for climate protection. The absence of this institutional capacity has deterred key mitigation and adaptation efforts. Yet, paradoxically, in some cases (e.g. US actions at the state and urban levels), it has become another source of opportunity for state and local actors to fill a leadership gap.

More urban authorities than ever currently participate in transnational networks, research-sharing, learning initiatives and advocacy efforts

A fundamental goal of urban actors has been to offer the conditions for business and investment to flourish. This can attract jobs and tax revenue in carbon-relevant sectors (such as renewable energy and production of more efficient appliances). However, it can also create an environmental race for the bottom, as regulations protecting the health and well-being of urban inhabitants are cut in order to promote a business-friendly environment, thus negatively affecting adaptive action.

Creating policies to address climate change is not only about goodwill or institutional capacity, it is also about understanding *the inertia and endurance* characterizing many of the issues that adaptation and mitigation actions are supposed to address. Power plants, refineries and other energy investments have long lifetimes. Similarly, this is also the case with water systems, roads, houses and other components of the built environment at risk from the impacts of climate change. Although increased research, development and actions to reduce emissions are required within the next few years to achieve the target of no more than a 2°C increase in the Earth's average temperature, it will take decades to centuries to move the world's current energy system away from its dependency on fossil fuels, the main source of GHG emissions. Urban form changes at slow rates, cannot be easily shaped by design and takes a very long time to build urban infrastructures.

Individual and organizational leadership has been … shaping climate action and creating windows of opportunity

A key problem outlined in Chapter 2 is that actors and agents of climate change at all levels, including governments, NGOs and civil society, are, most often, preoccupied with immediate and often localized interests and priorities; but these same actors need to move within short timeframes to guarantee long-term and wide-ranging global interests that can seem remote and unpredictable at best. Much action on mitigation and adaptation will need to come from local actors and agents, focusing their work at the local level where all the impacts of climate change will ultimately be felt. Networks of local actors can further energize this movement and may accelerate action at the global level. This work must include education and outreach to build broad-based support for mitigation and adaptation initiatives to increase the adaptive capacity of areas and populations that are most vulnerable to the effects of climate change. It will also

require a shift in paradigm, from the current focus on international responses to one that is more broad based and inclusive of actions at national and local levels.

Sources and drivers of cities' GHG emissions

To explore the sources and drivers of urban areas' contribution to climate change is of utmost importance for several reasons. *First*, transportation, energy generation, industrial production and other urban sources are associated with cities and their functioning. Each of these sectors constitutes a universe by itself, not only in terms of the types of GHGs that they generate, or the factors explaining differences in the levels and carbon intensities of their emissions, but also in terms of the mitigation opportunities that they offer, all of which will be briefly discussed here.

Energy is by far the most relevant sector for assessing GHG emissions

Energy is by far the most relevant sector for assessing GHG emissions, as the combustion of fossil fuels for electricity generation, heating, cooling, cooking, transportation and industrial production is the major source of GHGs. The energy systems that urban areas rely heavily on are shaped by the quantity of energy used, the energy structure (i.e. the types of energy forms used) and the quality of the energy (e.g. natural gas is less carbon intensive than coal). Variations in emissions by one of the main urban energy sectors, electricity consumption – both between and within urban areas around the world – depend on several factors that policy-makers can address: access to the grid; the type of fuel used to generate electricity; technologies applied; and existence of alternative sources of generation (renewable, nuclear, etc.).

Transportation is another key emitter that increases as economies grow, especially in developing countries, and as incomes rise. Emissions by the sector are expected to continue increasing in the coming decades. Particularly in developed countries, urban areas often generate smaller amounts of per capita GHG emissions from ground transportation than rural areas. Density plays a key role in this difference, and is one of the most important factors influencing differences both in the amount of energy used and GHGs emitted across urban areas. This should not lead decision-makers, however, to simply base their actions on a snapshot of *urban form* at a particular moment in time. It should, rather, lead them to address the dynamics of such processes as the extent of automobile use, quality of public transit, land-use planning and governmental policies, all of which determine the impact of urban density upon energy use and emissions by the transport sector. Policies aimed at reducing emissions by the sector need to consider that differences in emissions for a mode of transport (e.g. private vehicles) also depend on several factors: size and types of vehicles, efficiency of engines, maintenance practices, vehicle-trip frequencies and operating speeds, and driving behaviour.

It has been difficult to develop a standardized globally comparable methodology for GHG emissions at the local or municipal level

Commercial and residential buildings are key sources of direct emissions, indirect emissions and emissions associated with embodied energy (i.e. commercial energy used to make products). These are related to onsite combustion of fuels, public electricity use for street lighting and district heat consumption, and through the materials used for their construction. Decision-makers need to pay attention to such factors that determine emissions from buildings as the need for heating and cooling (determined by climate conditions, but also by cultural preferences and access to monetary resources), the construction of the building, the behaviour of building occupants, the type of fuel used, the size of the space to be heated or cooled, and the orientation of the buildings.

Two other key emitting sectors are *industry and waste*. Because many industrial activities are energy intensive in their operation, their increasing dominance in the economies of such cities as Saldanha Bay in South Africa or Shanghai in China (see Chapter 3) can make up a big part of their emissions. Mitigation policies and strategies need to address the following factors accounting for differences in industrial emissions: location, size and age of the industrial facilities, as well as the carbon intensity of their energy sources. Although waste is a small contributor to global emissions, rates of waste generation have increased during recent years, particularly in rapidly industrializing developing countries that have been experiencing increasing affluence. Waste generation is linked to population, affluence and urbanization; yet – as exemplified by Barcelona (Spain), London (UK) and New York (US) – emissions from waste generation can be greatly reduced by such measures as efficient collection, and technologies for methane capture and storage, as well as for methane to energy conversion.

The *second* reason for highlighting the need for an understanding of the sources and drivers of GHG emissions relates to a twofold purpose of measuring emissions from cities: inventories of emissions provide a basis for comparisons and for inter-urban competition and cooperation; and they constitute a crucial first step in identifying potential solutions. However, cities also rely on inward flows of food, water and consumer goods that result in GHG emissions from areas outside the city.

Notwithstanding the importance of emission inventories, it has been difficult to develop a standardized globally comparable methodology for GHG emissions at the local or municipal level. There are a number of reasons for this:

- It is difficult to attribute to cities emissions by such sectors as aviation and shipping. For example, many of the passengers using major international airports situated in or close to major cities may be from elsewhere in the country, or may only be using these airports for transit purposes.
- The different methodologies used to measure emissions can result in different numbers (i.e. scope issues). For example, Scope 1 inventories only include direct emission sources within the political boundary of a city, while Scope 3 would include all indirect and embodied emissions (such as GHG emissions embedded in food).
- A wide range of boundary definitions are used to define urban areas and cities. It is clear from Chapter 3 that the smaller the scale, the greater the challenges posed by 'boundary problems', which make it increasingly hard to identify which emissions ought or ought not to be allocated to a particular place.

The above should lead policy-makers to be extremely cautious about statements or numbers on the total contribution of urban areas to GHG emissions – not only because of the lack of an accepted definition of an 'urban area' or 'city', or of globally accepted standards for recording emissions,[5] but also because little clarity exists on the relative allocation of responsibility from 'production-based' or 'consumption-based' approaches. This is illustrated by the fact that vastly different proportions of emissions can be attributed to the manufacturing sector of Chinese or African cities discussed in Chapter 3, which produce goods for consumption in many other locations around the world.

What is clear is that a large measure of the responsibility for the emissions in the producing country should be borne by individuals consuming the produced goods. In contrast with most assessments of the urban contribution to climate change, focused on the emissions that are produced by activities taking place within given territorial boundaries, Chapter 3, therefore, suggests an alternative approach which also considers the emissions associated with the consumption patterns of individuals. This idea acknowledges the fact that many agricultural and manufacturing activities that meet the needs of urban residents take place outside city boundaries, and often in other countries. Furthermore, and most importantly, it leads to the conclusion that unsustainable levels of consumption – as partially determined by the marketing strategies of corporations, but which also drive the processes of production – are crucial to understanding the contribution that urban areas are making to climate change.

Besides patterns of consumption, a variety of overriding factors account for the different contributions of urban areas to GHGs, both within and across countries. The *first* are the various dimensions of geography that can be broadly categorized as climatic situation, altitude and location in relation to sources of energy resources (e.g. hydroelectricity and coal).

The *second* is the demographic composition and dynamics of a society given by changing age structures, and the increasing trend (at least within wealthier groups) towards smaller households. Demographic dynamics relate to GHG emissions in very complex and shifting ways.

Urban form and urban density are the *third* factor, related to a series of social and environmental outcomes. For instance, the extremely low densities of many suburban areas (particularly in North America and Australia) are associated with high levels of household energy consumption and emissions as a result of sprawling buildings and extensive car usage. On the other hand, the extremely high densities of many developing country cities can be related to increased health risks, and high levels of vulnerability to climate change and extreme events. Some of the many factors determining climate risks can be exacerbated by density: coastal location, exposure to the urban heat-island effect, high levels of outdoor and indoor air pollution, and poor sanitation.[6] These same factors, however, can create opportunities for simultaneously improving health and cutting GHG emissions through policies related to transport systems, urban planning, building regulations and household energy supply.

Finally, the types of economic activities taking place within an urban centre are another key determinant of GHG emissions, not only because the dominance of industrial activities has a huge influence on patterns of emissions, but also because – as illustrated by many cities in South Africa – extractive activities and energy-intensive manufacturing, particularly if depending on fossil fuels, are obviously associated with higher levels of emissions.

The multiple urban faces of climate impacts and vulnerabilities

Chapter 4 highlights the potential cumulative and multiplicative effects of loss of lives, damage to infrastructure and of other climate-related impacts. It also addresses the distributional nature of climate change impacts both within and among cities. However, not all of the outcomes of climate change are negative. As illustrated by cities as diverse as Durban (South Africa), Manizales (Colombia), New York (US) and London (UK), the potential also exists for cities to serve as sources of resilience to climate change, taking advantage of opportunities to address multiple developmental problems at once and to lead the world on adaptation efforts.

Unsustainable levels of consumption … are crucial to understanding the contribution that urban areas are making to climate change

Chapter 4 also points to current findings on the recent and future trajectory and geographical variations in climate hazards. For instance:

- Although showing significant regional variation, average sea levels have been rising and are expected to continue to rise around the world, thus putting coastal urban areas at risk from property damage, displacement of residents, disruption of transportation and wetlands loss.
- Tropical cyclones and extra-tropical storms have been increasing in intensity since the 1970s.
- Severe precipitation events have become more intense and more frequent, and are predicted to cause a greater incidence of urban flooding.
- As a result of climate change, extreme heat events are predicted to become more intense, longer lasting and more frequent over most land areas.

Climate events can … result in different sets of social and environmental impacts upon the economic sectors, infrastructures and population groups of a city

Urban areas are already facing an array of hazards, with some that are related to climate change and others that are not; but together these hazards may present a complex set of circumstances that will increase impacts. Heat waves coalesce with urban heat islands and air pollution to put urban populations at increased risk from respiratory mortality. When hitting areas subjected to processes of deforestation and erosion, heavy precipitation events result in flooding and landslides, whose primary victims are populations living in slums.

Climate events can also result in different sets of social and environmental impacts upon the economic sectors, infrastructures and population groups of a city. For instance, severe weather events, including heavy precipitation and wind, can decimate the built environment, including homes and places of business. They can also

disrupt and cause lasting damage to highways, seaports, rivers, bridges and other components of the transportation systems that urban centres depend on. These weather impacts can affect such infrastructures as water supply, sanitation and energy provision. They can also affect the insurance industry and its beneficiaries by increasing the costs of insurance coverage and can negatively affect not only retail and commercial services, but also industrial facilities, especially if they are located in risk-prone areas or depend on climate-sensitive inputs. Furthermore, they can make it difficult for residents of informal settlements to conduct small-scale commerce, petty trading and artisan trades.

When considering how climate change will impact upon urban areas, it is important to distinguish between risk and vulnerability. The same risk factors (such as hurricanes and floods) can be experienced differently by different individuals, demographic groups, cities and countries. Most climate change risks have a high degree of regional and local variation. The level of risk to an urban area from these impacts depends, in part, on how much of the city's population and economic assets are located in high-risk areas (i.e. exposure). In many cases, exposure level will be a function of the location of the city itself. Exposure can also be linked to land-use planning within a city, including continued development in known hazardous zones, and the destruction of natural protective areas.

Similar climate change impacts are not experienced the same way by cities in developing and developed countries

Similar climate change impacts are not experienced the same way by cities in developing and developed countries. The degree to which urban areas are vulnerable to climate hazards or can suffer negative impacts depends not only on the nature and dynamics of physical hazards, but also on social and environmental factors such as the:

- integrity of infrastructure and urban planning, or lack thereof;
- availability of financial and human resources;
- presence of disease and malnourishment;
- availability of information and level of awareness of risk; and
- extent of dependence on natural resources.

Over the past two decades … cities have become a 'crucial arena' where the challenges of climate change are being addressed

Differences in climate impacts also exist between men and women, the elderly and children, and the wealthy and the poor, both in developed and developing countries. For example, men and women differ in their livelihoods, family roles, behaviours, access to assets and perceptions of risk. Both can be treated differently with respect to planning and relief efforts during and after disasters. Impacts are also frequently more severe for the disabled, and ethnic and other minorities, who are frequently and relatively more disadvantaged in terms of access to assets and adaptation options. The vulnerability of children relates more to their physiological immaturity or to their limited cognitive ability and behavioural experiences, compared to adults. The vulnerability of the elderly can depend upon such factors as poverty (greater in developing countries), social isolation (more common in developed countries) or deteriorating physical health and mobility.

It is also important to note the issue of compounding vulnerabilities – that is, the fact that some population groups fall into more than one such category (e.g. poor old women) and can thus find themselves dramatically constrained in their ability not only to cope with future climate hazards, but even to prepare for and respond to the varied stresses that they already face.

Government intervention can fundamentally improve urban resilience to climate change impacts through targeted adaptive finance, broad institutional strengthening and more attention to the causes of vulnerability. The opposite, however, can also be the case. Maladaptive policies – such as ineffective or completely lacking land-use controls, weak building code standards or ineffective enforcement – have directly resulted in increased vulnerability of urban areas or of households and communities within them to sea-level rise, flooding and coastal storms.

In order to improve resilience to climate impacts, it has been suggested that urban governance should target the most vulnerable populations – namely, the urban poor and individuals living in informal settlements. These two groups have often been ignored in more conventional urban planning and intervention. Policies will need not only to reduce the vulnerabilities of existing populations, but also to address the underlying issues that permit settlement in marginal and vulnerable urban areas in the first place.

Mitigation responses

Because cities represent concentrations of populations and economic activities with expanding energy demands for heating, cooling, lighting, transportation, industrial processes, water provision, waste disposal and telecommunications, they can be seen as one 'part of the problem' of climate change. Reducing GHG emissions is, therefore, one of the key policy challenges that cities face. Beyond this view of cities as a major culprit in global climate change, however, there is also great promise for these same cities to become 'part of the solution'. Cities may play a major role in mitigation efforts for three reasons. *First*, they have direct or indirect jurisdictional responsibility for some of the key processes that may be involved in the production or reduction of GHGs – processes such as transportation, energy generation and use, land-use planning, and waste collection and disposal. *Second*, by virtue of the fact that cities concentrate populations and businesses, they may also make feasible such potential solutions as mass transit and energy savings in office buildings. *Third*, they may act as a catalyst to other potential levels of action on climate change as municipal governments interact with stakeholders in the private sector and civil society. Over the past two decades, in fact, cities have become a 'crucial arena' where the challenges of climate change are being addressed.

Chapter 5 notes that there are five key sectors where mitigation actions are taking place in urban areas. These sectors are urban form and structure; the built environment; urban infrastructures; transport; and carbon sequestration. In terms of the first of these, *urban sprawl* is an area of concern for both developed and developing countries. This is

so because distances travelled between home and work, education or leisure activities equate to a greater reliance on motorized transportation. Sometimes sprawl has also led to middle-class urban fringe districts where more available land and a release from some of the building constraints of the central city has meant larger house sizes and higher per capita GHG emissions. In other cities, however, sprawl is fuelled by the growth of informal settlements.

In order to address these issues, many strategies have been used to limit urban expansion, reduce travel and increase energy efficiency of the urban form. Some of these take the form of small- and large-scale regeneration projects (urban renewal), and these have taken place primarily in developed countries. Within developing countries there are few mitigation initiatives that make explicit use of urban form; when attempted, they are often constrained by a lack of capacity among local governments to implement them effectively. They also have been criticized for their exclusive nature and potential for exacerbating social inequalities (e.g. the eco-city Dongtan in China).

The design and use of the *built environment* is an area that is critical to urban mitigation efforts, and actions fall into three broad categories. These are economic incentives, regulatory requirements and information programmes. More recently, a growth in voluntary public–private partnerships and a mixing of these approaches has led to an explosion in the range of approaches used, including micro-generation and new building materials. Nonetheless, built environment projects primarily take place within the cities of developed countries, and have sometimes taken the form of efforts to help the urban poor. Some of these projects[7] have been led by grassroots organizations and housing co-operatives, suggesting that innovative forms of social organization are emerging and creating initiatives that address climate change mitigation, while also potentially taking on issues of social and environmental justice. The combination of social and environmental gains may be particularly useful in developing countries and for addressing such issues as fuel poverty.

Many of the *urban infrastructure* initiatives focusing on energy efficiency are primarily driven by such factors as a desire for energy security and financial savings, and – to a lesser extent – by the opportunities offered by international instruments such as the CDM. Both drivers may have helped to keep these projects economically and politically feasible, but, at the same time, may limit their effectiveness in long-term GHG savings, as financial savings have sometimes led to increased usage. Because of this, measures must be taken against the rebound effect, where increased efficiency leads to higher energy consumption. Thus, energy efficiency projects need to be coupled with the development of low-carbon renewable fuel sources and efforts to reduce energy consumption.

As noted above, the *transport* sector is a large contributor to GHG emissions. Growth in GHG emissions also reflects a modal shift, since higher incomes increase the affordability and desirability of private automobiles, and middle- and high-income groups within developing countries move towards the use of private vehicles and away from public transportation. Climate change mitigation schemes in the transport sector may be grouped into seven categories, including low-carbon transport infrastructure; low-carbon infrastructure renewal; fleet replacement; fuel switching; enhancing energy efficiency; demand-reduction measures (for private motorized vehicles); and demand-enhancement measures (for public and other low-carbon modes of transportation, such as human powered).

Carbon sequestration involves removing carbon from the atmosphere, either through promoting natural carbon sinks (such as planting trees or protecting forests) or by technological means for carbon capture and storage. While carbon sequestration schemes have mostly been on the periphery of urban mitigation efforts, new technologies for carbon capture and storage and international carbon finance are bringing carbon sequestration to the fore. Most carbon sequestration schemes at the urban level relate to tree-planting schemes, as well as restoration or preservation of carbon sinks. Carbon sequestration projects combine well with city beautification programmes where measures such as creating and protecting green spaces and facilitating public access can be brought together.

The design and use of the built environment is an area that is critical to urban mitigation efforts

Despite the array of mitigation responses by urban centres to date, a piecemeal rather than a strategic approach is very common. Furthermore, notwithstanding the existence of initiatives to measure mitigation outcomes,[8] there is limited information about the individual and collective impact of existing responses, especially when they extend beyond municipal buildings and infrastructure systems or involve behavioural change. The reasons for this include the relatively short time-scales involved and the fragmented nature of the data available, especially with regard to levels and reductions of GHG emissions within and across urban communities and sectors.

Of the four types of municipal governance described in Chapter 5, *self-governing*, the one mostly emphasized by municipal authorities, faces a limitation: frequently, municipal GHG emissions make up a small percentage of the total city emissions. This means that too much attention to the self-governing mode may detract resources from the broader mitigation challenges faced by a city. Seeking to govern climate change through the *provision* of infrastructure and services holds the most potential in cities where municipal governments retain ownership or control of infrastructure networks, and where basic needs have been met. Because of their targeted and enforceable nature, taxation, land-use planning and other *regulation* mechanisms can also be very effective in terms of reducing GHG emissions. Yet, these are also the least popular approaches adopted by municipal governments and, therefore, the most difficult to sustain politically. The *enabling* mode of governing has significant mitigation advantages: it results in (relatively) low upfront economic and political costs, and can also increase the transparency and legitimacy of urban governance. However, enabling initiatives are restricted to those who are willing to participate, and cannot be enforced.

Despite the array of mitigation responses by urban centres to date, a piecemeal rather than a strategic approach is very common

Chapter 5 also explores three modes of public–private governance of climate change action: voluntary, private provision and mobilization. The chapter uses the limited available data on this relatively new phenomenon to draw

some preliminary conclusions. These approaches tend to be adopted by partnerships or networks, and to focus on the adoption of voluntary standards. They have the potential to offer win–win options (i.e. tackling mitigation through a progressive, inclusive and environmentally fair approach). They are also faced with problems, however: they are small in scale and often politically marginal. They may serve to shift accountability away from actors with much higher responsibilities for the bulk of (urban) GHG emissions. Although partnerships may provide shared resources, knowledge and other benefits, they are often fragile and threatened by the potential of promoting the points of view of a select group of individuals and serving powerful interests at the expense of the disenfranchised.

Adaptation responses

Adaptation actions are urgently needed to address both current and future climate risks in urban areas

Because mitigation efforts at all levels have so far not been able to move the global climate system away from its current and dangerous trajectory of change, adaptation actions are urgently needed to address both current and future climate risks in urban areas. What decision-makers at different levels do today to cope and adapt will have an influence on the lives and livelihoods of millions of urban dwellers. Buildings, infrastructures, energy systems and other key components of cities are long lasting. Therefore, what is designed and built now will be fundamental in coping with climate change many decades into the future.

Urban populations have long had to cope with a wide range of risks to their economic activities, lives and livelihoods. In the absence of effective local government actions, these become the most frequent types of response to climate change. Yet, these responses are generally small scale; they do not address the underlying root causes of vulnerability and are therefore best described as coping strategies.

Community-based adaptation is important in urban areas, as it helps to address the limitations or inadequacies of governmental intervention

Wealth and access to assets, information or social networks can help individuals to reduce the risk of negative outcomes. Wealth, for instance, allows individuals to buy, build or rent homes that can withstand extreme weather in districts that have not been at risk from flooding. As illustrated by such cases as Dhaka (Bangladesh) and Lagos (Nigeria), populations lacking access to these use other strategies to reduce the risks of negative outcomes. Most of the measures taken to help cope with climate events are impact minimizing or impact reducing, rather than preventive.

Community-based adaptation is important in urban areas, as it helps to address the limitations or inadequacies of governmental intervention (such as in the provision of infrastructure and services); and because it can become an important part in the enhancement of resilience to extreme, and increasingly unpredictable, weather events. Community-based adaptation is based on the premise that local communities have the skills, experience, local knowledge and motivation, and that, through community organizations or networks, they can undertake locally appropriate risk reduction. However, to be effective, community-based adaptation depends on the actual existence of a collective 'community-based' organization in which the needs and priorities of those most at risk or most vulnerable are represented and actually taken care of in effective ways. It also needs to focus on the reasons why the urban poor are disproportionately vulnerable to climate change, such as through their greater exposure to hazards, the lack of hazard-reducing infrastructure, the lack of state provision for assistance after extreme events, and the lack of legal and financial protection.

Equally relevant can be other grassroots organizations. For example, by enhancing the capacity of the urban poor to save regularly, by helping to identify and purchase land for housing, and by promoting other actions of community organization, slum federations (such as in the Philippines and India) are helping to build the resilience of low-income households to many potential shocks.

Yet, community-based adaptation and grassroots organizations are faced with constraints arising from the immense cost, energy and time required to construct, develop and maintain the key determinants of resilience for the inhabitants of many cities in developing countries. These determinants of resilience include infrastructure and services, warning systems, emergency responses, education, etc. In fact, most climate change-related risks exacerbate risks already present, which are the result of inadequacies in local governments' capacities or willingness to manage and govern urban areas. Thus, there is a large deficit in the basic infrastructure and services needed to address not only risks related to extreme weather and water constraints, but also 'everyday' risks.

Cities in developed countries do not have very large infrastructure deficits. Most or all of their inhabitants live in buildings that meet building standards, have access to education and are served by piped water supplies, sewers, drains and solid waste collection. Therefore, their adaptation responses are frequently relatively easier to design, implement and fund. This does not mean that adaptation easily gets the political support that it deserves. Many cities need major upgrades in their infrastructure and should take account of likely climate change impacts. Most cities need to expand their capacity to anticipate and manage extreme weather events. Some cities are located on sites that are at risk from the implications of climate change (such as coastal areas). Finally, key actors in many developed country cities which struggle with economic decline see climate change risks as a distant danger.

Some components of effective adaptation responses can be drawn from the analysis of different case studies presented in Chapter 6. An essential first stage is the recognition among authorities and stakeholders that climate change impacts need to be considered. Then an information base on current conditions (i.e. on impacts of past extreme weather and other disasters) needs to be developed. Involved parties need to build on community and district assessments, as well as projections of future climate change, to develop risk/vulnerability assessments for the city. Strategic plans for the city as a whole and for its different sectors should be developed in association with other stakeholders. Furthermore, measures should be undertaken to

support those adaptation responses that are already taking place.

Financing for adaptation revolves around two main issues: whether funds will be available to cover the cost of adaptation for urban areas, and whether there is the capacity to use such funds to ensure that the needed adaptation can take place. Financing for adaptation can complement development assistance. While the latter can help focus on the drivers of vulnerability that are associated with weak institutional capacity, the Adaptation Fund (see Box 2.2) can support the broader climate risk management strategies of developing countries. Furthermore, both can help to overcome the contentious issue of the boundary between climate change adaptation and development, if designed with this in mind.

A further related issue refers to the costs of adaptation. Most estimates of the costs of adaptation relevant to urban areas are estimates of the costs of adapting infrastructure, and these are faced with some problems. First is the ambiguity as to what to include under infrastructure (housing, for example, is sometimes included by the IPCC, sometimes excluded). Second is the assumption made that costs can be calculated by applying a small increment to existing investment flows into infrastructure that is climate sensitive, with no account taken of the very large infrastructure deficits. This leads to overestimates of the proportion of investment allocated to developed countries and to underestimates of the sums needed for Africa and other places where there are very low/inadequate investment flows into infrastructure. The third is the belief that the availability of funding from international agencies is the 'solution' for adaptation, forgetting that local governments in many developing countries are often weak, ineffective and unaccountable to local populations. As a result, their capacity to design and implement appropriate adaptation strategies responding to the requirements of those most at risk from climate change must be in doubt. Last, but not least, is the idea that 'adaptation' and 'development' can be kept separate. As noted in earlier chapters, climate change impacts upon the ground are exacerbating non-climate change impacts, and addressing both is inhibited by institutional/governance failures. It is therefore necessary to study carefully what adaptation would involve in particular locations and what component of this is related to the existing infrastructure deficit.

It is also important to keep in mind that it will not be possible to adapt to climate change impacts in a number of locations – because adaptation is considered too expensive or technically unfeasible. Such consequences are often referred to as 'residual damage', and the number of such locations (and populations at risk) is likely to rise without successful mitigation. In addition, the issue of migrants who are forced to leave their homes due to future climate change needs to be addressed. As noted in Chapter 6, people whose lives and homes cannot be adapted *in situ* fall outside the scope of most national and international legislation. Thus, there have been some, though still marginal, calls for the development of new international legislation to address the concerns of 'climate migrants' – perhaps in the form of an international convention for persons displaced by climate change.

ADDRESSING URBAN GHG EMISSIONS AND VULNERABILITIES: CHALLENGES, CONSTRAINTS AND OPPORTUNITIES

Based on the findings of the previous chapters of this Global Report, this section explores the challenges, constraints and opportunities of efforts to decrease urban GHG emissions and thereby enhance society's resilience to climate change. The global mitigation challenge will be to achieve development paths that will bring down emissions by 2015 and stabilize them by the end of the century at 445 to 490 parts per million CO_2 equivalent (CO_2eq) by volume.[9] Only in this way can the global average temperature increase be kept below 2°C, which, as recognized in the Copenhagen Accord, is necessary to prevent harmful human interference with the climate system.

Financing for adaptation can complement development assistance

Considering an estimated global population of 9 billion by 2050 and an increasing urban share of that population, this means individual carbon footprints around the world will have to be kept at an average of less than 2.2 tonnes per year. Yet, annual per capita emissions in some US cities reach (or even exceed) 20 tonnes of CO_2eq.[10] Thus, there is a need to reduce the emissions of many cities and citizens in developed countries (and even in some developing countries) considerably. In order to address this challenge, multilevel and multi-sectoral actions – including many measures at the urban level – will need to achieve:

There is a need to reduce the emissions of many cities and citizens in developed countries … considerably

- reductions in the quantities of fossil fuels used;
- reductions in the carbon content of the fossil fuels used (such as a switch from coal to natural gas); and
- changes in the energy structure (such as increased reliance on renewable energy sources) by switching to other sources of energy, while ensuring that the quality of energy provision is kept.

For example, measures need to be undertaken to ensure that electricity, a key component of urban life, is generated through less carbon-intensive energy sources.[11]

All of these require that the decline in the *carbon intensity of fuels* and the increase in both *energy efficiency* and provision of low carbon-intensity clean fuels are achieved in such a way that the global amount of emissions from fossil fuels is substantially reduced. And as can be concluded from this Global Report, this is not always the case.

Mitigation responses formulated so far have primarily focused on improving energy efficiency or reducing carbon intensity, which does not necessarily translate into a reduction in the total amount of emissions. A focus on energy

efficiency savings in current infrastructure and devices (such as cars) can result in a 'rebound effect' – that is, an increase in consumption (resulting, for instance, from the use of smaller engines but driving longer distances) following financial savings in their operation. Furthermore, such a focus can downplay other more effective options. For example, sizeable renewable energy installations, including wind, solar and hydropower, have received relatively lower emphasis.[12] Thus, regulations and incentives by decision-makers operating at international and national levels need to be set, focusing on a portfolio of energy alternatives (i.e. not only on fossil fuels or biofuels, but on combinations of all fuels that take advantage of and respond to differing circumstances and contexts).

Cities are and can contribute to addressing the mitigation challenges of climate change in several ways:

Mitigation … is already happening at different levels of government, but not at all levels or with the required effectiveness

- as initial seedbeds and niches for entrepreneurial experiments with radically new technologies (by commercial private-sector actors);
- as lively laboratories for experimentation among emerging and future-looking communities (such as Hammarby Sjöstad in Stockholm, Sweden[13]) that share particular perceptions, visions and ideas as to how to move urban communities away from current unsustainable development paths; or
- as communities that build networks and platforms (such as workshops and conferences) to facilitate the exchange of knowledge and experiences, as well as the articulation of best practices.[14]

Depending on their national contexts and histories, urban local authorities have a highly variable level of influence over GHG emissions. They can induce emissions reductions in the energy sector through measures such as retrofitting commercial, domestic and municipal buildings, by switching traffic lights to energy-saving bulbs, etc. Besides having influence over the efficiency of their transportation fleets, they can implement transport planning policies which encourage alternatives to the private car, such as the Transmilenio in Bogotá (Colombia). They can design zoning measures to promote certain patterns of settlement, energy efficiency measures in new buildings, and standards for domestic and commercial buildings, as exemplified by the experiences of London (UK) and Chicago (US). They can implement programmes to reduce GHG emissions in the waste sector, such as through methane capture. Non-governmental actors such as private-sector organizations are now voluntarily involved in actions to decrease energy use in commercial buildings. A similar movement is happening within civil society groups, such as the 'transition towns' movement.[15]

Determinants of mitigation responses are the availability of financial resources, of technical expertise, as well as … the material infrastructure and cultural practices of a city

The number of actions currently taking shape show that involved stakeholders do acknowledge the urgency of mitigation, and demonstrate their awareness that action should be taken now to avoid abrupt or irreversible impacts. Mitigation, indeed, is already happening at different levels of government, but not at all levels or with the required effectiveness. As indicated in Chapter 2, there are many challenges faced even by such ambitious endeavours as the European Emissions Trading Scheme and the mitigation responses of the UK and Germany.[16] Furthermore, although climate change is firmly on the urban policy agendas in both developed and developing countries, it remains a marginal issue in terms of implementation.

Diverse institutional factors explain the challenges, constraints and opportunities of mitigation responses by local authorities. The first relates to the influence of the context-specific interactions between different tiers of government on local authorities' response capacity (multi-level governance). International and national policies provide the enabling – but also constraining – context within which urban responses are framed; determine the autonomy and competencies – the duties and powers – for municipal authorities to act in response to climate change; and enable policy integration within and between local authorities. Another set of institutional factors shaping local authorities' mitigation responses is their institutional ability to implement and enforce policies and measures. In many policy areas, municipal authorities, especially but not exclusively in developing countries, are unable or unwilling to enforce building codes, land-use zoning, fossil fuel standards and other regulations.

Two other factors are critical for the development of mitigation policies – namely, the dynamics of network creation and leadership – the latter both at the individual and institutional levels. Local Governments for Sustainability (ICLEI), organizations compiling and disseminating expert knowledge such as the IPCC, the United Cities and Local Governments and the Urban Leaders Adaptation Initiative, among other international, national and municipal networks of governmental and non-governmental organizations, have also been important in developing municipal capacity.[17] Evidence suggests, however, that these have been more important in developing the capacity of those municipalities that are already leading responses to climate change. Individual political champions and organizations, using climate change as a means and window of opportunity for fostering organizational reputation, have been equally fundamental in shaping action. Yet, if authorities lack the financial and technological resources to execute programmes, the power of leadership and of these networks to affect change can be limited.

Of no lesser relevance as determinants of mitigation responses are the availability of financial resources, of technical expertise, as well as the weight of such structural and enduring factors as the material infrastructure and cultural practices of a city. For instance, the mitigation challenges in the transportation sector will be strongly determined by the urban form of a city, with high-density areas offering compatibility with options to develop metros, trams and other high-efficiency modes of public transportation, while sprawling low-density areas are more compatible with systems of buses and minibuses to cover commuting needs. Options to reduce emissions are constrained by the fact that investments in power plants, industrial facilities and other components of the urban environment have long lifetimes. As for financial resources, given the many competing demands in urban areas, local authorities lacking the money

to provide even basic services for their constituents are unlikely to invest in the mitigation of climate change. Furthermore, the international financial resources available for mitigation (and adaptation) activities under the UNFCCC and the Kyoto Protocol (see Boxes 2.2 and 2.3) are quite simply not sufficient to meet the requirements, particularly of developing countries. As discussed in Chapter 6, this is particularly the case in cities, as very limited resources have so far been made available for initiatives in urban areas.

It is likely that GHG emissions will continue to increase until 2030 even if effective actions are taken now to stabilize emissions around the end of the century, and despite current commitments within the Kyoto Protocol.[18] Thus, adverse impacts of projected climate change and variability are inevitable, and urban centres will be particularly at risk. Regardless of the scale of mitigation undertaken over the next two to three decades, adaptation action will be necessary, which will be another challenging and fundamental dimension of the urgent response to climate change.

The responsibilities of local authorities with regard to the built environment, infrastructure and services that have relevance for adaptation include:

- urban planning and regulatory instruments designed to influence land availability and to authorize and oversee hazardous activities that can produce disasters;
- provision and pricing of various public services, infrastructure and resources; and
- enabling, proactively facilitating and coordinating actions to manage hazards through partnerships with the private sector, the academic sector, non-governmental and grassroots actors (e.g. households and communities) to reduce risk.

Each urban centre may use these areas of responsibility to design adaptation actions. However, the particularities – often determined by the national contexts of these urban centres – will dictate which of these measures will be most effective.

As with mitigation, adaptation is already taking place, at least on a small scale, and the world is witnessing the beginnings of city-based adaptation strategies in some urban centres. As yet, however, too few cities have developed coherent adaptation strategies. Furthermore, in contrast to such sectors as agriculture or forestry, there is relatively much less explicit city-wide attention to urban adaptation. In fact, most of the literature on climate change adaptation in cities is on what should be done, not on what is being done, the main reason being that too little is actually being done. The relatively lower emphasis on adaptation, and particularly on urban adaptation, is partly a result of the existing structure of incentives under the Climate Convention. For instance, funding is available[19] for mitigation activities such as landfill gas capture and for electricity generation, for transportation or carbon capture from reforestation and conservation of forests. However, while very little (only 8.4 per cent of the CDM projects are urban) is readily available for urban mitigation projects, practically nothing is allocated to adaptation efforts at the city level.[20]

Among urban areas, this relatively low interest in adaptation can also be related to the fact – clearly illustrated by Durban (South Africa) – that getting more widespread attention by city and municipal governments to climate change adaptation requires clear and detailed risk assessments (knowledge). It also requires a better understanding of how adaptation measures can serve and be integrated not only within disaster risk reduction, but also within such components of the development agenda as land-use planning, as well as access to water, sanitation and housing. It also depends on diverse institutional factors, in addition to leadership and local authorities' willingness to act. For example, effective adaptation actions can depend on whether authorities have the autonomy, resources and decision-making power to design and implement actions on the built environment, infrastructure and services that have relevance for adaptation; and whether and how adaptation options and challenges are related to such development issues as the need to protect the poor or to provide land and shelter for them (such as Manizales, Colombia, and the Homeless People's Federation of the Philippines).[21]

Too few cities have developed coherent adaptation strategies

A fundamental challenge in this context relates not only to whether adaptation is responding effectively to potential climate change impacts in different sectors, but also to social equity issues – that is, whose needs are served (and whose are not) by adaptation responses, especially in relation to income, gender and age. For instance, are the adaptations aimed at protecting the wealthier groups and districts; or those living in informal settlements; or women and their particular risks and vulnerabilities; or the city's most economically important assets; or the city's populations most at risk? Decision-makers can be more effective and legitimate if they include these groups – or at least their genuine representatives – in the process of addressing these questions.[22]

In the urban areas of many developing countries … adaptation responses will need to happen in the context of adaptation (or development) deficits

It is not only the city authorities of some early frontrunners that are responding to the adaptation challenges of climate change. Households and communities are already coping with climate-related hazards – for example, by raising plinth levels, saving money and by participating in community initiatives to clear blocked drainage channels to respond to the impacts of flooding (see Chapter 6). However, these cannot be substitutes for serious government investment and action to improve drainage and sanitation, water supplies, roads and other hard infrastructure that is so crucial for risk reduction, or for a city-wide provision of urban services, as well as warning and emergency responses systems.

In the urban areas of many developing countries, household, community and government adaptation responses will need to happen in the context of adaptation (or development) deficits. In many cities of developing countries, at least a percentage of their populations lack water, sanitation, health services, shelter, sound emergency policies and other factors to adapt to the current range of climate variability, let alone to any future climate change impacts. It is impossible to adapt or climate-proof infrastructure, services and emergency responses that do not exist.[23]

Another key challenge concerns the social impacts of adaptation measures. Actions such as control of urban growth in risk-prone areas and investment in storm and surface drainage systems can increase the vulnerability of some populations. If not carefully designed, they have the potential to displace informal settlements – especially those alongside existing drains and rivers. Furthermore, they can constrain a population's capacity to make their livelihoods; they can shift risks from the populations of one district to the inhabitants of another district; and they can shift risks to future generations.

ADAPTATION AND MITIGATION: RELATIONSHIPS WITH URBAN DEVELOPMENT AND POLICY

Attention needs to be given … to the synergies and trade-offs between actions addressing both mitigation and adaptation

Although a distinction between climate change adaptation and mitigation is deeply set in climate change policy and research, some cities tend to look at the world differently. Early experience with both adaptation and mitigation planning in developed country cities suggests that urban leaders and stakeholders resist focusing on one and not the other, and that they find it difficult to consider either without considering sustainable development goals and development pathways more generally at the same time.[24] In fact, the goal is sustainable development for their cities, and climate change responses are either a means towards that end or impediments to achieving that end. In this context, attention needs to be given not only to the implications of mitigation and adaptation for urban development, but also to the synergies and trade-offs between actions addressing both mitigation and adaptation and other dimensions of policy-making. However, experiences from many cities in developing countries contradict this, as their leaders and stakeholders tend to consider developed countries the culprit of climate change and, thus, responsible for mitigation. Such cities therefore tend to focus on adaptation interventions.

Global pressures to push the boundaries of climate change mitigation are likely to be a challenge for urban development

Cities can respond to concerns about climate change impacts in two ways: by contributing to mitigation or by adapting to possible impacts – either of which can promote urban development or impede it.

Climate change mitigation and urban development

In the coming decades, urban authorities will – in many cases and in many regions – find that the need for global, national, regional and local climate change responses poses significant concerns. The urgency and severity of this challenge cannot be overstated. Recent analyses of potentials for GHG emissions reduction and efficiency improvement, given current global trends and potentials for known technologies, make even relatively moderate goals such as stabilization at 445 to 490 parts per million of CO_2eq (in order to keep average global warming no higher than 2°C) virtually unachievable unless every major technological option realizes the most optimistic hopes for it (including affordable carbon capture and sequestration from coal).[25] In other words, the world seems headed towards climate changes that are even more severe than the sobering descriptions in Chapter 4. Meanwhile, at the Copenhagen COP in December 2009, low-lying island states and other vulnerable developing regions argued that any stabilization level that means average warming above 2°C implies unacceptable levels of impacts and must be avoided. Two apparent crises lie ahead: a crisis of emerging impacts in vulnerable cities as they become ever more urgent and a crisis of global responses to growing pressures for mitigation and adaptation, which are likely to be sources of great controversy and, perhaps, forceful policy developments.

Globally, the mitigation challenge is to reduce GHG emissions from buildings, industry, transportation, energy production and land use, and to reduce or reverse deforestation. As stated earlier, emissions reduction focuses on efficiency improvements in buildings, industry, transportation and energy production, and shifting energy production and use from GHG-emitting fossil sources to alternatives such as renewable energy, nuclear energy and 'decarbonized' energy from fossil sources.[26]

It is important to note that mitigation policies can represent opportunities for cities and their development prospects. As exemplified through the experience with ICLEI's International Local Government GHG Emissions Analysis Protocol, in many cases, actions by cities to reduce their GHG emissions from systems under the jurisdiction of metropolitan governments actually save them money, such as through increases in the efficiency of urban lighting systems or in public transportation systems that reduce costs to the city's budget.[27] Less directly, cities can partner with their own private-sector operators of industrial and transportation systems to seek reductions in GHG emissions from private-sector sources, with city policies (such as taxation) encouraging or discouraging such actions. Even less directly, new energy facilities that help to reduce GHG emissions – such as bioenergy and other renewable energy production facilities – will need to be located somewhere, and cities can seek to be their sites, creating jobs and tax revenues.

But global pressures to push the boundaries of climate change mitigation are likely to be a challenge for urban development as well. Two potential impacts are especially important. *First*, if an urban area's economy depends, even in part, on fossil energy production, it is likely to be adversely affected by any move away from fossil energy. There are many examples of cities whose economies are built, in part, on coal, oil or natural gas production, such as in Nigeria, Angola, China and India.

A *second* impact is that energy costs and prices are likely to increase in most parts of the world as energy systems shift from relatively low-cost fossil energy sources to somewhat more expensive alternative energy systems. Because affordable energy is vitally important as a driver of the development engines of many cities, this could become a

challenge for sustainable development – especially in cities whose development paths are likely to be especially energy intensive. In most cases in developing regions, paths for socio-economic and technological development imply *increases* in GHG emissions, not reductions in emissions, including both emissions from the cities themselves and emissions from systems that meet urban needs, such as electric power plants located elsewhere.

However, local authorities often play broader roles, as well, in shaping the development choices of their urban areas, their larger regions and their countries, and these roles have implications for climate change mitigation more broadly than within their own boundaries alone. They are the focus of driving forces for climate change responses, including financial resources, information and communication systems and media, and both technological and policy innovation. Where public decision-making is based on democratic processes, local authorities can dominate 'one-person/one-vote' political contests and thus influence national voting patterns.

There are both synergies and trade-offs between actions addressing the mitigation challenge and other policy dimensions (such as industrial development, energy, health and air pollution).[28] As illustrated by Mexico City, Denver (US) and many Chinese cities, climate change mitigation is more an outcome of efforts driven by economic, security and local environmental concerns, or simply by the need to be at the forefront of initiatives among a peer group of city leaders, rather than being a strategic priority.[29] It is therefore necessary to take advantage of existing synergies between climate protection and other development priorities. For instance, strong synergies exist in the transportation sector between climate change and energy supply and security. Measures replacing oil with domestic biofuels can reduce both emissions and reliance on oil imports (such as in Brazil). A more decentralized electricity system based on new renewable generation may reduce gas imports.

A key question is whether cities have the potential to tap into options such as carbon markets opened by the Kyoto Protocol.[30] For example, could the construction or building materials industries receive financing from the CDM or similar mechanisms for producing cement (or other materials) which incorporates carbon capture and storage? Such carbon credit trading could, potentially, be a way to subsidize the construction of adequate housing for low-income groups in developing countries. This and other options could open a completely new discussion dealing with synergies between GHG emission control and poverty reduction.

Policies addressing other environmental and social problems, such as air pollution or provision of shelter to the poor, can often be adapted at low or no cost in order to reduce GHG emissions and improve the health of the population simultaneously, especially in developing countries. The burning of fossil fuels is linked to both climate change and air pollution. Thus, reductions in the amount of fuel combusted will result in both lower GHG emissions and lower health and environmental impacts from reduced emissions of air pollutants. Aware of these co-benefits, organizations such as the World Health Organization and the US Environmental Protection Agency have applied, at the urban and national levels, environmental assessments of the co-benefits of addressing both air pollution and other issues (such as economic costs and energy). This has helped to introduce policies that address local pollution and GHG emissions together.[31] However, attention needs to be given not only to the synergies, but also to the conflicts between these policy domains. For instance, increases in the energy efficiency of vehicles can result in increased atmospheric emissions, and thus in negative health impacts, if vehicle travel distances increase or drivers switch to vehicles with larger engines (the 'rebound effect').[32]

This means that trade-offs may exist between mitigation and other policy domains. For instance, security arguments may impel countries to increase their dependence on internal reserves of coal rather than relying on natural gas imports.[33] Use of biofuels that are dependent on crops such as corn has been linked to food shortages and cost increases as farmers switch food-producing croplands to more profitable biofuel crop cultivation. This may also be an unintended effect of government subsidies aimed at increasing production of biofuels, but making the growing of food crops less profitable.

There are both synergies and trade-offs between actions addressing the mitigation challenge and other policy dimensions

Climate change adaptation and urban development

Adaptation-related issues for urban development across the world include two dimensions: first, the implications of climate change impacts for urban development projects that are likely to call for adaptations; and, second, the relationships between adaptation action to reduce the impacts of climate change, on the one hand, and urban development, on the other.

Climate change poses particularly severe threats for urban development in those areas that are most vulnerable to climate change impacts.[34] For example, many cities are located in coastal areas and river valleys, as well as areas where the economic base is rooted in climate-sensitive sectors, such as agriculture, forestry or tourism, and areas where these regional climate-related activities face increased competition with population and economic growth. If climate change is relatively severe in local contexts rather than moderate, some cities will find that incremental adaptations that protect current activities and ways of life may no longer be adequate.

Some cities will find that incremental adaptations that protect current activities and ways of life may no longer be adequate

A current example of what future climate change could mean for urban development can be found in the polar regions of the world, where temperature increases (and emerging sea-level rise) are not only affecting urban infrastructure as the permafrost melts, but are irreversibly destroying polar ecosystems and indigenous ways of life that are closely linked to them.[35] In these and similar cases, adaptations that are 'transformational may be required', such as changes in land uses and movement of investment away from vulnerable areas, or shifts in directions of urban development to different economic sectors or land uses. Climate

change impacts are therefore a critically important challenge for urban development, and if climate change is severe (rather than moderate), the number of cities at risk will be multiplied many times over.

Experience suggests that, given human resources and access to knowledge, urban dwellers often have impressive capabilities to adapt in ways that are good for their development, even with limited financial resources. For example, low-income residents of Lagos (Nigeria), Dhaka (Bangladesh) and Dar es Salaam (Tanzania) already cope with a range of climate-related challenges, especially seasonal flooding.[36] This is particularly evident where effective grassroots organizations are active. This is not to say that decisive action is not needed at all levels; but it is important to note the many actions are already being undertaken by households and communities – frequently in the absence of actions by local government and other stakeholders.

Most … adaptation options offer considerable co-benefits… for urban development and/or environmental stress reduction in the near term

One of the most fundamental challenges in relating climate change adaptation with urban development in many regions, however, is a limited capacity to identify vulnerabilities and adaptation pathways, along with a limited capacity to make adaptation happen. Many small- and medium-sized cities, especially in sub-Saharan Africa, South Asia and Central America, currently show low levels of capacity to adapt to the current range of climate variability, let alone any future climate change impacts. Problems in many such cities include a lack of provision for infrastructure (including all-weather roads, piped water supplies, sewers, drains, electricity, etc.), urban social services (such as health and education) and institutional capacity.

Neither mitigation nor adaptation alone can protect the world from the undesirable impacts of climate change

Yet, many cities have shown an ability to adapt to local climate conditions, whether related to climate change or not; and where climate change adaptation is being considered seriously (in urban areas from Bangkok, Thailand, to Melbourne, Australia), in nearly every case adaptation options are being identified that are relatively low cost and have broad constituency support.[37] Some developing country cities have moved beyond option identification to adaptation planning (such as Durban and Cape Town, South Africa).[38] Furthermore, most of the adaptation options offer considerable co-benefits – that is, benefits for urban development and/or environmental stress reduction in the near term, as well as added resilience to impacts of climate change in the longer term, which is often critically important in sustaining attention to adaptation while impacts are gradually emerging.

There are positive examples of cities, such as in Manizales (Colombia) and Ilo (Peru), that are taking steps to promote development and reduce vulnerability at the same time. These cities have implemented actions to prevent rapidly growing low-income populations from settling on dangerous sites. Although these actions have not been driven by climate change concerns, they illustrate how pro-development and pro-poor policies can enhance adaptive capacity. Conflicts and trade-offs between development policies and adaptation are also possible, as in the development of infrastructure whose design and construction have the potential to displace informal settlements.[39]

Mitigation and adaptation: Seeking synergies rather than conflicts

It is now known that neither mitigation nor adaptation alone can protect the world from the undesirable impacts of climate change. Both must be a part of the global response. Mitigation is essential in order to keep climate change impacts as low as possible; but some impacts can no longer be avoided. This is so because progress is slow on international agreements to implement mitigation, and strategies for GHG emission stabilization in major developing countries are unclear at best. Adaptation is, therefore, essential because some impacts will not be avoided. It is clear that costs will be a constraint for some locations and populations, and adaptation will be limited in its ability to reduce costs from abrupt events, at least in the short run. And, as noted above, some of the impacts are beyond the scope of adaptation: the so-called 'residual damage'. While allocating resources for mitigation and adaptation, it is essential to find solutions for the populations and industries that may be displaced by the impacts of climate change.

Meanwhile, early initiatives with either climate change mitigation or adaptation planning suggest that some urban local authorities and stakeholders are unwilling to discuss mitigation or adaptation options separately, without placing these discussions in the context of where the city and its citizens want to go in the longer run.[40] Cities are one of the most important of all the world's settings for integrating actions to reduce vulnerabilities and mitigation responses as they relate to broader social and economic objectives, such as job creation, improvements in the quality of life, and access to health and water services. The fact that climate change response planning often catalyses these discussions within communities is one of its most important co-benefits.

A major problem is that mitigation and adaptation options often differ in important ways. For instance, they tend to differ as to *when* benefits are realized (mitigation benefits lag in time, while adaptation benefits may be nearer term), *where* benefits are realized (mitigation is global while adaptation benefits are more localized) and *what sectors* are the focus of action (mitigation focused on GHG emitters or sinks, and adaptation focused on activities, infrastructure and population segments sensitive to impacts). Furthermore, it is also important to note that mitigation actions are urgent. If no action is taken within the next ten years or so, the impacts will exponentially increase. This is less the case with adaptation action, which can be phased in time and which will be a continuous process for many decades to come. These differences substantially complicate attempts by urban areas (or by the countries and regions whose policies affect them) to develop integrated climate change response strategies.

Pathways to mitigation and adaptation can be mutually exclusive and competitive alternatives – such as development investments in alternative energies which do not enhance resilience in vulnerable areas versus policies to move development activities away from vulnerable areas;[41] but they may also be complementary and reinforce each

other. A simple example of this would be building insulation, which can reduce the need for burning fossil fuels while enabling adaptation to increased temperatures projected with climate change. An important general guideline is that mitigation and adaptation options which offer synergies and complementary pathways should be given special attention. For example, mitigation options that reduce net GHG emissions – such as tree-planting and other biomass sink preservation and/or restoration, along with regional or local renewable energy development – can be complementary parts of an overall mitigation strategy. However, this synergy can be taken one step further with the addition of adaptation benefits. Tree-planting or forest preservation, for instance, can also be an important part of an urban adaptation strategy to prevent heat-island effects, thereby preventing an array of cascading negative effects such as heat-related morbidities, mudslides and coral sedimentation, etc.

In many cases in urban areas, the focus is on investment in major infrastructure that lasts for a number of decades: transportation systems; commercial, residential and government buildings; and industrial development. These investments can profoundly shape both urban mitigation and adaptation not only in the short term, but for as long as half a century or more.

Currently, and with some notable exceptions, most urban initiatives that might be associated with mitigation or adaptation are fragmented, and historically much of the policy attention has been focused mainly on mitigation, with little or no consideration of adaptation. In many cases, the focus is not on climate concerns but on energy security and other development priorities related to economic growth.[42] Even where existing initiatives explicitly address mitigation, they often focus only on one aspect of the whole issue (such as energy efficiency, or even, more narrowly, energy efficiency in metropolitan public-sector functions).[43]

Only a handful of city-wide initiatives – such as in London (UK), Durban (South Africa) and New York (US) – are beginning to grasp the need to address at least some of the complex linkages between mitigation, adaptation and development, and thus have launched mitigation and adaptation programmes. For instance, to increase the uptake of decentralized energy technologies in London, developments over a certain size are required to meet 20 per cent of their projected energy needs through onsite low-carbon or renewable energy generation,[44] thus promoting new economic activities and the creation of green jobs. Furthermore, national and local authorities have already identified adaptation responses to three key climate risks – floods, drought and overheating – thus opening alternatives to avoid damage to infrastructure, increased mortality among the aged and other impacts that might constrain the livelihoods of some populations. This means that climate change responses are getting the necessary ingredients to move towards more integrative approaches.[45] However, even these exemplary cases illustrate the challenges of responding to climate change.

FUTURE POLICY DIRECTIONS

This section explores future policy directions for achieving climate-resilient cities, reflecting on both recent policy developments and more general long-term policy needs. In the face of climate change, policy decisions and actions are not just the responsibility of a city, or of its country or region, or of the international community more broadly – or even of governments alone at any of these levels. Urban development will be shaped by the policies of all levels of government, of private-sector organizations, of non-governmental issue-oriented institutions, of research communities,[46] and of representatives of local communities and civil society organizations. The challenge, and it is an immense one, is to knit together a global response to urban needs and potentials in which a wide variety of partners each contribute what they do best – for instance, combining the resources available at large scales with the innovativeness and knowledge of local realities available at local scales.

From this perspective, this section outlines some principles for policy development at all levels and discusses what policies should be considered at the international, national and local levels and, more briefly, by non-governmental partners, to strengthen planning and decision-making in urban areas in response to global climate change.

Mitigation and adaptation options which offer synergies and complementary pathways should be given special attention

Principles for policy development

Several principles are fundamental to an integrated multi-partner approach:

- No single mitigation or adaptation policy is equally well suited to all cities. Reflecting a common saying that 'one size does not fit all', cities are so diverse in terms of the set of societal and environmental drivers of their GHG emissions, their governance structures, their vulnerabilities, adaptive capacities and development aims that policy approaches should recognize and be sensitive to the diversity of urban areas worldwide.
- The appropriate approach is not to try to precisely project future climate change and socio-economic conditions, which is burdened by far too many uncertainties to encourage decision-making, but to take an *opportunity/risk management* approach in a sustainable development perspective: considering not only emissions but also risks that are present in a range of possible climate and socio-economic futures.
- Policies should emphasize, encourage and reward '*synergies*' and '*co-benefits*' (i.e. what policies can do to *achieve multiple objectives* related to both development and climate change response goals).
- Climate change policies should address both near-term and longer-term issues and needs. Near-term perspectives are likely to focus on relatively straightforward 'no regrets' decisions with, *first*, few or no net costs, offering substantial co-benefits for urban development (such as increasing resilience to climate variability; reducing chronic environmental stresses, such as poor drainage;

No single mitigation or adaptation policy is equally well suited to all cities

or addressing critical current needs of especially vulnerable populations who will only get worse with climate change); and, *second*, with broad stakeholder support and representation, not only of the better off, but also of populations more at risk from climate change (the poor, women, children, the elderly, the disabled, ethnic and other minorities, etc.). Longer-term perspectives need to consider risk management for more substantial mitigation pressures and adapting to more significant impacts, focused on contingency planning for a range of possible climate/development futures, monitoring emerging climate and policy conditions, and reassessing risks periodically.

- Policies need to recognize that institutional roles and potentials differ between scales and sectors of action. In recent history, too often well-intentioned initiatives developed at large scales and implemented top down have discouraged local action by imposing daunting bureaucratic requirements as a condition for access to available resources.[47] Meanwhile, initiatives developed and implemented at small scales and implemented bottom up (such as community-based adaptation) often lack financial and other resources to undertake the necessary investments in urban infrastructure and services, may lack valuable information, and may lead to actions that have adverse consequences for other localities. The challenge is to design new approaches that support multi-scale, multi-sector action, rooted in new kinds of mutual sensitivities, in order to realize the differing and often complementary potentials of a wide range of partners (Chapter 6).[48]

International public-sector policies related to urban responses to climate change should be supportive and enabling without being directive or constraining

International policies

International public-sector policies related to urban responses to climate change should be supportive and enabling without being directive or constraining (see also Box 7.1):

Box 7.1 Key principles for urban climate change policy development: The international community

There are three main areas in which the international community can support and enable more effective urban mitigation and adaptation responses:

1 Financial resources need to be made more directly available to local players – for example, for climate change adaptation in vulnerable cities, investment in a portfolio of alternative energy options, and investment resources for mitigation partnerships between local governments and local private-sector systems.

2 Bureaucratic burdens on local access to international support should be eased. The international community can help to create direct communication and accountability channels between local actors and international donors through intermediary organizations that can help disperse resources and monitor performance.

3 Information of climate change science and options for mitigation and adaptation responses should be more widely available. The Intergovernmental Panel on Climate Change (IPCC), the United Nations and other international organizations need to widen the spectrum of available knowledge on observed and future climate change impacts upon urban centres; on mitigation and adaptation alternatives available for urban responses; and on the costs, benefits, potentials and limits of these options.

- *Resources.* The international community has access to vitally important financial resources that can be provided to support many vulnerable cities that need additional resources to respond to climate change. For example, international policies should include much more significant financial support for climate change adaptation in vulnerable cities, for investment in a portfolio of alternative energy options, and to support mitigation partnerships between local governments and local private-sector actors. In particular, it is essential that action is taken to facilitate the use of the Adaptation Fund and the CDM for initiatives in urban areas.
- *Information and options.* The IPCC is already helping cities and influencing development pathways by providing information about climate change science and response options, alerting local leaders (and the people to whom they listen) to emerging issues and resolving some disputes about scientific facts. International policies should continue these roles, with increased attention both to widening the spectrum of mitigation and adaptation alternatives available for urban responses, and to improving information about the costs, benefits, potentials and limits of the options. A similar role has been played by the Clinton Climate Initiative and ICLEI (see Box 2.7), which have been prominent in the exchange of ideas, best practices and experiences, at least for urban areas that are already at the forefront of climate change responses.
- *Reduced bureaucratic burdens.* International policies should do a better job of balancing legitimate concerns about accountability (such as establishing 'additionality' through detailed quantitative analysis) with a need to make access to support much easier, simpler and less bound up in expensive analysis. Options might include a wider use of third-party intermediary ('boundary') organizations to disperse resources and monitor performance. Likewise, streamlined approaches for approving investments in certain types of projects that, time and again, have been shown to yield climate change-related benefits should be developed and approved (e.g. through the CDM). Likewise, in order to ease access to carbon finance for cities in developing countries, the CDM Executive Board should approve the new city-wide programme of activities methodology that was recently submitted for their consideration.[49]

National policies

As illustrated by some countries – such as the UK, Germany, Norway, Brazil and the Republic of Korea – the mitigation responses of national governments can go beyond the endorsement of international climate conventions and accords. Driven by reasons as diverse as energy security and an actual concern for the implications of climate change, they may engage in the design and implementation of national mitigation strategies and adaptation planning. However, from the perspective of urban areas, national governments generally assist development by determining

sets of policy and market conditions and rules that shape decentralized activities – incentives, limits and expectations for the future – and by helping to coordinate responses that involve a wide range of individual partners. They also play essential roles in looking beyond current conditions and priorities, both for countries as a whole and cities in particular, towards longer-term changes in conditions and the possible need for changes in rules that define development pathways and risk management 'playing fields' (see also Box 7.2):

- *Enabling framework.* National (and local) governments should facilitate the climate change mitigation and adaptation interventions of all stakeholders. The example of the Philippines (see Box 6.3) illustrates how governments, through the provision of an enabling framework, can enhance the effectiveness of interventions of other actors, particularly people living in poverty.
- *Incentives.* Some countries already offer incentives for climate change mitigation actions, while many countries, in effect, discourage mitigation and adaptation actions through policies enacted with other issues in mind – or during earlier periods before climate change became a reality. Countries can promote urban area initiatives related to climate change mitigation or adaptation by removing 'maladaptations' that are counterproductive and by providing incentives such as favourable tax treatment, eligibility for federal funding support and high-visibility public recognition.
- *Coordination.* As cities, sectors, regions and other parties act to support mitigation and adaptation, these dispersed activities need coordination in order to ensure that they are mutually reinforcing rather than causing problems in other contexts. For example, a decision to convert a natural forest area to a bioenergy plantation can contribute to mitigation by reducing the need for fossil fuels, but it can threaten biodiversity protection. A decision by one city to protect coastal areas with barriers can have impacts upon wetland ecologies that are important to the economic base of other cities inland. Countries should make it standard policy to ensure information-sharing about localized plans and to provide mechanisms to resolve conflicts as they arise.
- *Risk-sharing.* Countries can contribute to mitigation and adaptation by cities in two ways related to risk-sharing. On the adaptation side, a frequent concern is with climate change threats that have high probabilities of occurring at a national level but low probabilities for any single city, such as extreme weather events. Here, countries can work together with private, non-governmental (such as slum federations) and public providers of insurance and reinsurance to offer protection to each city without requiring each to make a sizeable investment in order to reduce risks from a particular kind of low-probability threat. On the mitigation side, some possible actions involve technologies that are so innovative that their economic value has not yet been fully established. Here, countries can encourage innovation through such policies as offering partial loan guarantees in case the technology does not perform as well as hoped.
- *Assistance where transformational adaptations are required.* Countries should help their cities in looking ahead to the possibilities of much more substantial climate change impacts and adaptation needs in the longer term than those that are currently anticipated in the next decades. An example might be a city located in a vulnerable coastal area subject to threats from more severe storms and sea-level rise over the next half century, where in the longer run, moving some populations and economic activities away from the most vulnerable areas might need to be considered. As indicated earlier in this chapter, policies should support contingency planning, monitoring of emerging conditions and the development of response alternatives.

Box 7.2 Key principles for urban climate change policy development: National governments

National governments should primarily use the following mechanisms to enable mitigation and adaptation actions at the local level:

- Engage in the design and implementation of national mitigation strategies and adaptation planning.
- Offer tax rebates, tax exemptions and other incentives for investments in alternative energy sources, energy-efficient appliances, climate-proof infrastructures, houses and appliances, among other climate change mitigation and adaptation actions.
- Encourage appropriate climate responses. For example, redesign policies enacted with other issues in mind or during periods prior to climate change, such as policies that use the definition of a 100-year floodplain, which can result in maladaptations.
- Enhance coordination and streamlining between sectoral and administrative entities. For instance, make sure that decisions by one city to protect coastal areas with barriers do not have impacts upon basins that are suppliers of fresh water, or wetland ecologies that are important to the economic base of that city or other cities inland.
- Develop partnerships with non-governmental actors to share risks (see also Box 7.4). For example, national governments can work with private insurance providers to offer protection to each city without requiring each to make a sizeable investment in order to reduce risks from a particular kind of low-probability threat.
- Anticipate and plan for the possibility of much more substantial climate change impacts and adaptation needs in the longer term than those that are currently anticipated in the next decades.

As cities, sectors, regions and other parties act to support mitigation and adaptation, these dispersed activities need coordination

City policies

Urban areas are the main loci of action, rooted in local development aspirations and preferences, local knowledge of needs and options, local awareness of realities that shape choices, and local potentials for innovation. One of the major challenges for policies in most urban areas, however, is to broaden the discourse about policy directions beyond conventional structures of political power and government action, and to engage their communities much more inclusively (see Chapter 5). With this challenge in mind, urban policies should (see also Box 7.3):

Box 7.3 Key principles for urban climate change policy development: Local authorities

Urban policy-makers should begin from an awareness of local development aspirations and preferences, local knowledge of needs and options, local realities that shape choices, and local potentials for innovation. Urban authorities should:

- Develop a vision of where they want their future development to go and find ways of relating climate change responses to urban development aspirations.
- Expand the scope of community participation and action by representatives of the private sector, neighbourhoods (especially the poor) and grassroots groups, as well as opinion leaders of all kinds in order to ensure that a broad-based collection of perspectives is gathered.
- Using an inclusive participatory process (as referred to above), cities should conduct vulnerability assessments to identify common and differentiated risks to their urban development plans and their different demographic sectors, and decide on objectives and ways to reduce those risks.
- Pay particular attention to the importance of adding climate-sensitive features to major infrastructure, especially when they are being designed, as the cost of adding these features will almost always be smaller before the infrastructure is built than they would after it is in place.

Box 7.4 Key principles for urban climate change policy development: Other partners

In order to achieve more effective policies, local governments need to expand the scope, accountability and effectiveness of participation and engagement of NGOs, such as community and grassroots groups, the academic sector, the private sector and opinion leaders. This will serve multiple purposes:

- It will become a source of innovative options, as well as both scientific and locally relevant knowledge.
- It will allow participants to understand and mediate the diverse perspectives and interests at play.
- It will provide a broad-based support for decisions and promote knowledge on the causes of emissions and vulnerabilities, as well as mitigation and adaptation options thus achieved.

Partnerships with the private sector and NGOs are of special relevance in this context. For example:

- Resources from international, national and local private organizations can be mobilized to invest in the development of new technologies, housing projects and climate-proof infrastructures, and to aid in the development of climate change risk assessments.
- The widespread involvement of NGOs in climate arenas as diverse as climate awareness and education and disaster relief should be welcomed rather than making attempts to keep them outside of these structures and interactions. The inputs and perspectives of these organizations can be harnessed to help develop a more integrated urban development planning.

Broad-based oversight organizations, such as advisory boards, representing the interests of all actors should be created to help avoid the danger that private or sectarian interests may distort local action – for instance, by investing in technologies, infrastructures and housing that only benefit a minority, or by hijacking the benefits of grassroots funding. This is especially of concern in urban areas within countries that have experienced strong centralized control in the hands of local elites and state agents; but the principle of broad-based oversight can and should be practised everywhere.

- *Develop a vision of the future.* A city is not in a position to evaluate how climate change responses relate to its urban development unless it has a vision of where it wants that development to go. This requires not only the development of possible scenarios of future economic, demographic and land-use futures, along with resource requirements, but also richer 'narratives' of a set of futures that help to explain why they are desirable from the city's perspective.
- *Expand the scope of community participation and action.* In connection with developing its vision, a city needs to become a community of communities – reaching beyond formal governmental structures to the private sector, neighbourhoods and grassroots groups, as well as opinion leaders of all kinds in order to ensure a broad-based collection of perspectives is gathered. This is crucial for ensuring knowledge, innovation and broad-based support for a city's response strategy (see Chapter 6).
- *Conduct participatory risk assessments and turn the assessments into action plans.* Using inclusive participatory processes, in which both women and men, as well as all socio-economic and age groups are represented, supplemented by scientific knowledge, cities should assess risks to their urban development plans and objectives, identify ways to reduce those risks through actions in the near term that offer development co-benefits, develop a plan of action to take high-priority actions, and consider longer-term risks that may require larger-scale planning and strategy development (see Chapter 6).
- *Pay particular attention to the importance of investment in major infrastructure.* Major infrastructure casts long shadows through time for both mitigation and adaptation. Particularly important is investment in small- and medium-sized urban centres, including in large residential and commercial developments, government structures, industrial structures, transportation systems, energy facilities, and other facilities such as water supply and waste disposal systems. The time to consider mitigation and adaptation is when these types of infrastructure are being designed, when the cost of climate-sensitive features is almost always smaller than after the infrastructure is in place. An example of a policy option in vulnerable coastal or riverine cities would be a building code for new infrastructure developments that requires them to be able to withstand significant future flooding.

Policies of other partners in a global policy response

Governments do not, in isolation, determine appropriate responses to climate change in development contexts. The private sector and NGOs are critically important partners. Other organizations may be important in some urban areas as well, such as community and/or faith-based organizations (see also Box 7.4):

- *The private sector.* Positive connections between climate change responses and urban development will only become mainstreamed when they become part of normal day-to-day decision-making in local markets and local economic institutions. Ranging from activities of large multinational corporations to local informal industries, the private sector must be included in urban, national and global policy-making on climate-related issues. For localities, this starts with including the private sector in discussions of urban needs and alternatives; encouraging private-sector organizations to conduct their own climate change risk assessments; looking for roles that they can play better than the public sector (such as stockpiling and providing emergency supplies); and encouraging innovative thinking about how private-sector business strategies can find opportunities in helping cities strengthen their commitments to climate change mitigation and adaptation.
- *Non-governmental organizations.* NGOs range from international environmental groups that provide information, technical assistance and policy advocacy; philanthropic foundations that take the lead in developing urban climate change response initiatives when governments and the private sector prove unwilling to move ahead quickly enough; and local community organizations, formal and informal, that play major roles in emergency response situations in cities – and are stepping forward to represent the interests and concerns of especially vulnerable populations in many cities. Here, the policy challenge is to incorporate these roles within integrated urban development planning rather than hold them outside these structures and interactions.

CONCLUDING REMARKS

In summary, policy directions for linking climate change responses with urban development offer abundant opportunities; but they call for new philosophies about how to think about the future and how to connect different roles of different levels of government and different parts of the urban community. In many cases, this implies changes in how urban areas operate – fostering closer coordination between local governments and local economic institutions, and building new connections between central power structures and parts of the population who have often been kept outside of the circle of consultation and discourse.

The difficulties involved in changing deeply set patterns of interaction and decision-making in urban areas should not be underestimated. Because it is so difficult, successful experiences need to be identified, described and widely publicized as models for others. However, where this challenge is met, it is likely not only to increase opportunities and reduce threats to urban development in profoundly important ways, but to make the urban area a more effective socio-political entity, in general – a better city in how it works day to day and how it solves a myriad of problems as they emerge – far beyond climate change connections alone.

It is in this sense that climate change responses can be catalysts for socially inclusive, economically productive and environmentally friendly urban development, helping to pioneer new patterns of stakeholder communication and participation.[50]

Climate change responses can be catalysts for socially inclusive, economically productive and environmentally friendly urban development

NOTES

1 I.e. the Annex I countries of the UNFCCC; see Chapter 2.
2 UN, 2010.
3 UN, 2010.
4 The Adaptation Fund only became operational in 2010. See also Boxes 2.2 and 2.3.
5 However, and as noted earlier, an International Standard for Determining Greenhouse Gas Emissions for Cities was launched by UNEP, UN-Habitat and the World Bank at the World Urban Forum in Rio de Janeiro, Brazil, in March 2010.
6 It should, however, be noted that the provision of modern sanitation facilities becomes less expensive with densification.
7 Such as housing co-operatives in Tel Aviv, Israel (see Chapter 5).
8 Such as the Project 2° (see Chapter 5).
9 See Chapter 1.
10 Such as Denver and Washington, DC (see Chapter 3).
11 See Chapter 5.
12 See Chapter 5.
13 See Box 5.4.
14 In line with the activities and recommendations of the C40 and ICLEI (see Chapters 2 and 5).
15 See Chapter 5.
16 See Chapters 2 and 5.
17 See Chapter 2.
18 Sims et al, 2007.
19 Through the CDM (see Box 2.3) and through such programmes as the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) (see Table 2.2).
20 See Chapter 2.
21 See Chapter 6.
22 See Chapters 4 and 6.
23 See Chapter 6.
24 See NRC, 2010.
25 NRC, 2009, 2010; Greene et al, 2010.
26 'Decarbonized' as a result of carbon capture and storage initiatives (see Chapter 5).
27 See Chapter 3.
28 Barker et al, 2007.
29 See Chapter 5.
30 See Chapter 2.
31 Barker et al, 2007.
32 See Chapter 5.
33 Barker et al, 2007.
34 See Chapters 4 and 6.
35 ACIA, 2004.
36 See Chapter 6.
37 This having been said, it is important to note that some climate change adaptation interventions can be very costly and/or contentious.
38 See Chapter 6.
39 See Chapter 6.
40 NRC, 2010.
41 Wilbanks and Sathaye, 2007.
42 Such as in Beijing (China) (see Chapter 5).
43 See Chapter 5.
44 See Chapter 5.
45 NRC, 2010.
46 See, for example, Rosenzweig et al, 2011.
47 See Chapter 5.
48 Wilbanks, 2007.
49 The proposal was submitted by the World Bank in July 2010. Under present rules, the CDM Executive Board cannot approve programmes of activities that use multiple methodologies. By their very nature, city-wide programmes draw on a range of methodologies that support GHG mitigation technologies; but as such they cannot be considered for approval through the CDM – unless the guidelines of the CDM Executive Board are revised.
50 Wilbanks, 2003.