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Deutsches Institut für Entwicklungspolitik

German Development Institute

Discussion Paper 25/2009

Climate Change, Vulnerability, and Adaptation in Sub-Saharan African Cities

New challenges for development policy

Lutz Meyer-Ohlendorf

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DIE Research Project
"Climate Change and Development"

Bonn 2009

Discussion Paper / Deutsches Institut für Entwicklungspolitik
ISSN 1860-0441

Meyer-Ohlendorf, Lutz: Climate change, vulnerability, and adaptation in Sub-Saharan African cities : new challenges for development policy / Lutz Meyer-Ohlendorf. DIE Research Project "Climate Change and Development" – Bonn : DIE, 2009. – (Discussion Paper / Deutsches Institut für Entwicklungspolitik; 25/2009)
ISBN 978-3-88985-475-9

Lutz Meyer-Ohlendorf, M. A., Geographer, PhD student at the Potsdam Institute for Climate Impact Research (PIK) since January 2009.
Currently working in the project 'Hyderabad as a Megacity of Tomorrow' with a focus on lifestyle dynamics and climate change mitigation and adaptation as well as international climate policy.
E-Mail: meyer-ohlendorf@pik-potsdam.de

Tulpenfeld 6, 53113 Bonn
☏ +49 (0)228 94927-0
🖷 +49 (0)228 94927-130
E-Mail: die@die-gdi.de
www.die-gdi.de

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Abbreviations

CAPAs	City Adaptation Programs of Action
CBA	Community Based Adaptation
CBO	Community Based Organizations
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geo-Information Systems
GWP / TAC	Global Water Partnership / Technical Advisory Committee
IPCC	Intergovernmental Panel on Climate Change
IPCC-AR4	IPCC Fourth Assessment Report
IUWRM	Integrated Urban Water Resource Management
IWRM	Integrated Water Resource Management
LAPAs	Local Adaptation Programs of Action
LDCs	Least Developed Countries
LECZ	Low Elevation Coastal Zone
MAP	Municipal Adaptation Plan
MDG	Millenium Development Goal
NAPA	National Adaptation Programs of Action
NGO	Non-Governmental Organizations
PVA	Participatory Vulnerability Analysis
UN	United Nations
UNDP	UN Development Program
UNFCCC	United Nations Framework Convention for Climate Change
WHO	World Health Organization

Summary

Cities in Sub-Saharan Africa show the highest population growth rates in the world today. By the year 2035 more than half of the region's population will live in cities. This development puts tremendous pressure on cities and towns in Sub-Saharan Africa, as it is likely to be accompanied by a rapid growth of informal settlements and slums without adequate provision of infrastructures. Already today, more than 70 per cent of the urban population in Sub-Saharan Africa lives in slums and squatter settlements without adequate shelter or basic services. Climate change-related impacts will significantly add to already existing problems in urban areas. Therefore, climate change adaptation will be among the greatest challenges for future development of urban areas in Sub-Saharan Africa.

This study describes the most important trends, reasons and effects of urbanization in Sub-Saharan Africa and outlines the major climate change-induced impacts and vulnerabilities in urban areas. It then discusses the most important options for adaptation in the context of urban areas by first examining possibilities at the local and community levels. Options on municipal and regional scales are also discussed, giving special emphasis to integrated planning options, institution building, good urban governance, and Integrated Urban Water Resource Management in cities. Finally the role of development policy in the context of adapting Sub-Saharan cities to climate change is examined.

Environment and climate-related impacts and vulnerabilities

Climate and environment-related risks and hazards are an integral part of the urban environment and have a significant impact on the living conditions of the urban population in the cities of Sub-Saharan Africa. Many of these risks have less to do with climate change in the first instance, because they already exist without climate change. But in many cases, climate change will exacerbate these risks and hazards.

Cities and urban areas will face an increasing risk from climate-related extreme events (e. g. hurricanes) as well as gradually changing environmental conditions (e. g. sea level rise). Most of the important urban centres in Sub-Saharan Africa are located in low-lying, often flood-prone coastal areas and river deltas lacking adequate protection from both extreme events and insidious risks. But also non-coastal cities will directly be affected by climate change through heat waves, inundation due to torrential rains, drought, and hunger. Neither national nor local administrative bodies are currently prepared for the complexity of such developmental and environmental challenges.

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) points out that there will be a growing number and intensity of extreme weather events, such as heavy rainstorms, cyclones and hurricanes. This will lead to serious problems, especially with regard to flooding. Coastal cities are additionally affected by sea-level rises and face higher risks of storm surges and high tides. Additional risks arise from the dilapidation of building foundations and saline water intrusion into ground water sources.

Less rapid changes will increase the risks in urban areas through – for instance – heat waves and emergent air pollution, droughts, water shortages, and climatic effects on agriculture.

Climate change will also create significant impacts on human health, such as temperature and air pollution-related illnesses, an increase of water- and food-borne diseases, health effects from food and water shortages, and effects from population displacement.

One very critical issue is related to the links between rural and urban areas. Both are often perceived as quite separate and in competition with each other for investments, services or other forms of support. This view neglects the strong interplay between towns and the countryside, especially in most parts of Africa. Rural-urban linkages are highly complex with respect to flows of people and goods, money and information, but also in terms of social relations that are crucial in organizing these links (Bolnick et al. 2006, 18). Climate change is likely to add to this complexity, since it might create new sources of conflict (for example over water use) while also influencing rural-to-urban migratory patterns. Rural-to-urban migration – whether permanent or temporary, internal or international – has always been an important strategy for coping with environmental change and is thus also likely to be adopted in the face of climate change. This will have significant implications for the growth of urban areas and slums and underscores the need to pay greater attention to the links between rural and urban areas in Sub-Saharan Africa.

The outlined environment and climate related impacts in cities are substantial, and the exposure to the risks and related vulnerabilities are unequally distributed over certain segments of the urban population. In Sub-Saharan Africa, rapid urbanization often occurs in the form of newly emerging, unplanned settlements that lack the most basic infrastructure and services. These are often located in high-risk areas, thus increasing the vulnerability to climate change. Apart from differences in location (e. g. settlements in dangerous locations lacking a protective infrastructure), other determinants of differences in vulnerability are income level, age, and gender (Satterthwaite et al. 2007, 45 f.). The urban poor are likely to bear the brunt of nearly all environmentally and climate-related impacts due to higher exposure and a very low adaptive capacity. In order to be effective, adaptation strategies will have to consider these differences.

Adaptation in cities of Sub-Saharan Africa

The impacts of climate change will exacerbate the problems of urbanization; they will add to existing losses, and they will compromise the progress of economic and social development. Therefore a broader definition of adaptation to climate change is needed, one which will integrate it into all sectors of the development process while taking current aspects of vulnerability into consideration. Adaptation should aim to enhance societal resilience to future climate and environmental impacts regardless of their cause. This may also clear up worries that adaptation to climate change will draw resources away from other priority areas, thus helping to show the considerable cumulative benefits from adaptation. Otherwise, against the background of rapidly growing cities that lack the most basic infrastructures, it will be difficult to regard action on climate change as a priority area.

What are the options for adaptation in cities? *First*, the assessment of current and future risks and vulnerabilities at the *local* level is integral to a prioritization of the most urgent local adaptation activities and an identification of the required local human and financial resources. This should be undertaken under consideration of the complexity of urban risks

across all sectors and with consideration of the significant differentials by location as well as in certain segments of the population. Such an assessment and the integration of all relevant information will facilitate the building of a strong local knowledge base and help to develop a comprehensive Municipal Adaptation Plan (MAP) as e. g. suggested by Mukheibir and Ziervogel (2007)

Second, for the implementation of adaptation measures it is critical to involve those who are directly affected by climate change-related impacts. One innovative approach in this regard is Community Based Adaptation (CBA).

The *third* strategy focuses on sustainable water resource management in cities, taking into account the larger regional aspects of water consumption and management. Integrated Water Resource Management (IWRM) is a framework that assists countries in tackling the problems related to water scarcity in a cost-effective and sustainable way. With a focus on urban areas, Integrated Urban Water Resource Management (IUWRM) suggests a combination of "hard", infrastructural, and "soft" institutional, measures that need to holistically include aspects of environmental sustainability, economic efficiency, and social equity into the different water management objectives.

Fourth, most of the urban growth in Africa will come in the next few decades. This knowledge offers the ultimate chance to channel the projected new urban growth into more sustainable pathways and away from high risk sites through adjusted and integrated urban planning. Here the most challenging issue is to meet the needs of low-income groups. One important option lies in the promotion of mixed land uses, i.e. the mix of residential, employment, leisure, health care and education within one locality, combined with measures to ensure land availability for low-income households so that these groups are not forced to build their homes within high-risk areas.

The *last* and most crucial option with respect to adaptation in urban areas is related to good urban governance. The management of cities is generally the responsibility of city authorities who can be directly held accountable by the population; but the long history of colonial rule in Africa has strongly worked against successful local governance. Resilient systems generally incorporate diverse mechanisms for living with and learning from change and unexpected shocks. To enhance coping capacities on the basis of diverse sources of resilience, a multilevel integration of all actors across sectors and institutions is therefore needed. This also includes long-term security of tenure for the vast number of informal settlements as the most critical precondition for slum upgrading, building of social capital and community stabilization. This helps to increase investment in pro-poor housing, infrastructure and adaptation measures. In the long run, it enhances the adaptive capacity of communities, facilitates the process of participative urban planning, and significantly enhances adaptive capacities.

New challenges for development policy

The complex situation in cities and the projected impacts related to climate change clearly deserve and require international support not only due to the fact that climate change is closely associated with the past and present lifestyles of high-income groups in high-income nations.

There are and will increasingly be significant implementation problems in terms of adaptation, and it is therefore crucial to build up, support and strengthen the systems and structures that encourage and support locally driven adaptation. Here it is critical to convince national and city governments to understand adaptation as complementary to the overall development agenda.

The most comprehensive international institution for adaptation for Least Developed Countries (LDCs) is represented by the National Adaptation Programs of Action (NAPA) process, which identifies priority activities that respond to the urgent and immediate needs of LDCs to adapt to climate change. It has been criticized that there is an inherent bias in the NAPA process in placing less emphasis on the urban poor than on the rural poor, and that there is a lack of community-based adaptation plans, reflecting the fact that most LDCs do not have ministries with a focus on urban issues. For these reasons NAPAS should be downscaled to city and local levels through the promotion of City Adaptation Programs of Action (CAPAs) and smaller scale Local Adaptation Programs of Action (LAPAs) – especially for the settlements and areas most at risk (Satterthwaite et al. 2007, 74). Such a bottom-up approach may facilitate participation on a local scale and enhance the process of locally adjusted adaptation. Locally driven adaptive measures are most likely to succeed, since they respond to existing local needs, and contribute to other development goals (McGranahan / Balk / Anderson 2007, 35 f.).

Moreover, urban areas have also long been neglected by the German and international development community. Although more than half of the world's population lives in cities, the German development policy has not set an urban focus until today, and there is no overarching concept to tackle urban development problems. Successful mitigation of and adaptation to climate change in developing countries is intimately connected with finding new, sustainable paths of urban development by taking into account the complex interrelation between rural and urban areas, as well as between various sectors. This includes finding ways to accommodate future rural-to-urban migration and not trying to retain people in rural areas.

The greatest challenge to sustainable adaptation in urban areas is directly associated with the problems of local governance. These can only be addressed through comprehensive capacity- building programs targeting the facilitation of local self-government, and obviously there is a great need for innovative new approaches that go beyond traditional top-down solutions. It is necessary to facilitate research that focuses less on scientific analysis and more on the formulation of concrete priorities and recommendations for action. Moreover, capacity development in urban planning and adaptation should promote a process and problem-oriented perspective away from a rather sectoral view that is not capable of taking into account the complexity of the various processes and problems (Kraas / Nitschke 2006, 27).

Finally, at the international level there is a significant deficit of funds for addressing the complex issue of adaptation, especially in urban areas. Additional funding and the mainstreaming of adaptation into existing development projects are needed here.

Rapid, often uncontrolled urbanization, poor infrastructure supply, dominance of informal settlements, and the lack of good urban governance are key factors in determining the

exposure and the adaptive capacity of urban areas and their citizens to environment and climate-related impacts. Adaptation poses great challenges to cities, but it also opens new avenues for a sustainable social-economic development in urban areas. Development policy can and should play a role in supporting city governments in identifying and implementing locally adjusted solutions.

1 Introduction

In 2008, according to the latest UN statistics, more than half of the world's population will live in cities (UNFPA 2007, 6). Though being the least urbanized area in the world, Sub-Saharan Africa has an urban population that is already as big as North America's. The region's urban population is growing at the highest rate in the world (Tibaijuka 2006, 13; UNFPA 2007, 11; UN 2007). This implies a near-doubling of the urban population in the coming fifteen years (Kessides 2006, 3). By 2035 more than half of the region's population will live in cities (UN 2007).

Significantly, cities and urban areas in Sub-Saharan Africa lack the most basic infrastructures and services due to bad governance and corruption as well as considerable deficits in financial and administrative resources. As a result, the social, economic, and political problems in cities and urban areas of Sub-Saharan Africa are among the worst in the world. In most of the cities of Sub-Saharan Africa more than half of the urban population lives in slums or under slum conditions and almost all of the current growth is the result of slum and informal settlement proliferation. Against this background, the vulnerability to climate and environmental risks and hazards is significantly high among the urban population. Problems related to flooding and tropical storms, shortages of water and food, coastal inundation, and a large variety of tropical diseases have a substantial impact on living conditions in cities and urban areas already today. It is therefore one of the major challenges to channel future rapid urbanization towards a rather sustainable development pathway.

Sub-Saharan Africa will most probably be hit hard by climate change, and climate change is most likely to exacerbate the existing environmental and climate-related impacts. Besides mitigation of these impacts, adaptation is very crucial, because climate and environmental impacts are already happening now, and will worsen in the future. Coupled with the challenges of rapid urbanization, climate change impacts will undermine most of the efforts that were undertaken to achieve the goals of sustainable development. The rapid growth of informal settlements and slums and the lagging behind of adequate infrastructure provision also pose a major challenge to the implementation of adaptation strategies in urban Africa. On the other hand, future urbanization may offer new chances for a more sustainable development in Sub-Saharan Africa, since cities also offer a broad range of opportunities.

The rest of this study paper is organized as follows. It starts with an outline of the major trends and prospects of urbanization in Sub-Saharan Africa and depicts the most important impacts of rapid urbanization (Chapter 2). It then briefly introduces the major climate change impacts in urban areas of Sub-Saharan Africa (Chapter 3). The study then moves on to outline the key concepts related to vulnerability and climate change adaptation, relates these to the holistic concept of the urban environment, and draws on potential opportunities that urban areas may offer with respect to sustainable development and adaptation (Chapter 4). It then discusses the most important options for adaptation in the context of urban areas by first looking at possibilities on the local and community level. It then moves up to the municipal and regional level by discussing integrated planning options in cities. The Chapter ends by looking at new avenues for adaptation through institution building, good urban governance, and Integrated Urban Water Resource

Management (Chapter 5). The paper then broadens the scope to examine the role of development policy (Chapter 6) and then gives a short conclusion (Chapter 7).

2 Trends, reasons and impacts of (mega-)urbanization in Sub-Saharan Africa

With an aggregate urbanization level of only 39 % in 2008 (35 % in 2005) Sub-Saharan Africa is still one of the least urbanized continental regions in the world (UN-Habitat 2008a), with a significant diversity among its constituent countries. According to data from the UN Development Program (UNDP) there are altogether 13 Sub-Saharan African states with over half their population recorded or estimated as "urban" in 2005. Five out of these are exceptional cases since they are micro-states (Djibouti) or small island countries (Réunion, Seychelles, Sao Tome and Principe, and Cape Verde) with a total population of less than one million people. However, Gabon, Congo, South Africa, Liberia, Botswana, Cameroon, Gambia, and Angola are comparatively highly urbanized countries with urbanization levels above 50 %. At the other extreme are countries like Burundi, Uganda, Niger, Ethiopia, Malawi, Burkina Faso, Rwanda, and Eritrea all featuring urbanization levels below 20 per cent. As Table 1 demonstrates, there is thus a considerable difference in urbanization levels between individual countries.

In contrast to the low level of urbanization, Sub-Saharan Africa has the highest urban growth rates in the world. The African urban population is projected to more than double by 2030, increasing from 373.4 million in 2007 to 759.4 million in 2030. To put these figures into perspective – this means that about half of the total African population will live in cities by 2030. The total African urban population in 2030 will also be larger than today's total number of city dwellers in the entire Western hemisphere (UN-Habitat 2008a, 4).

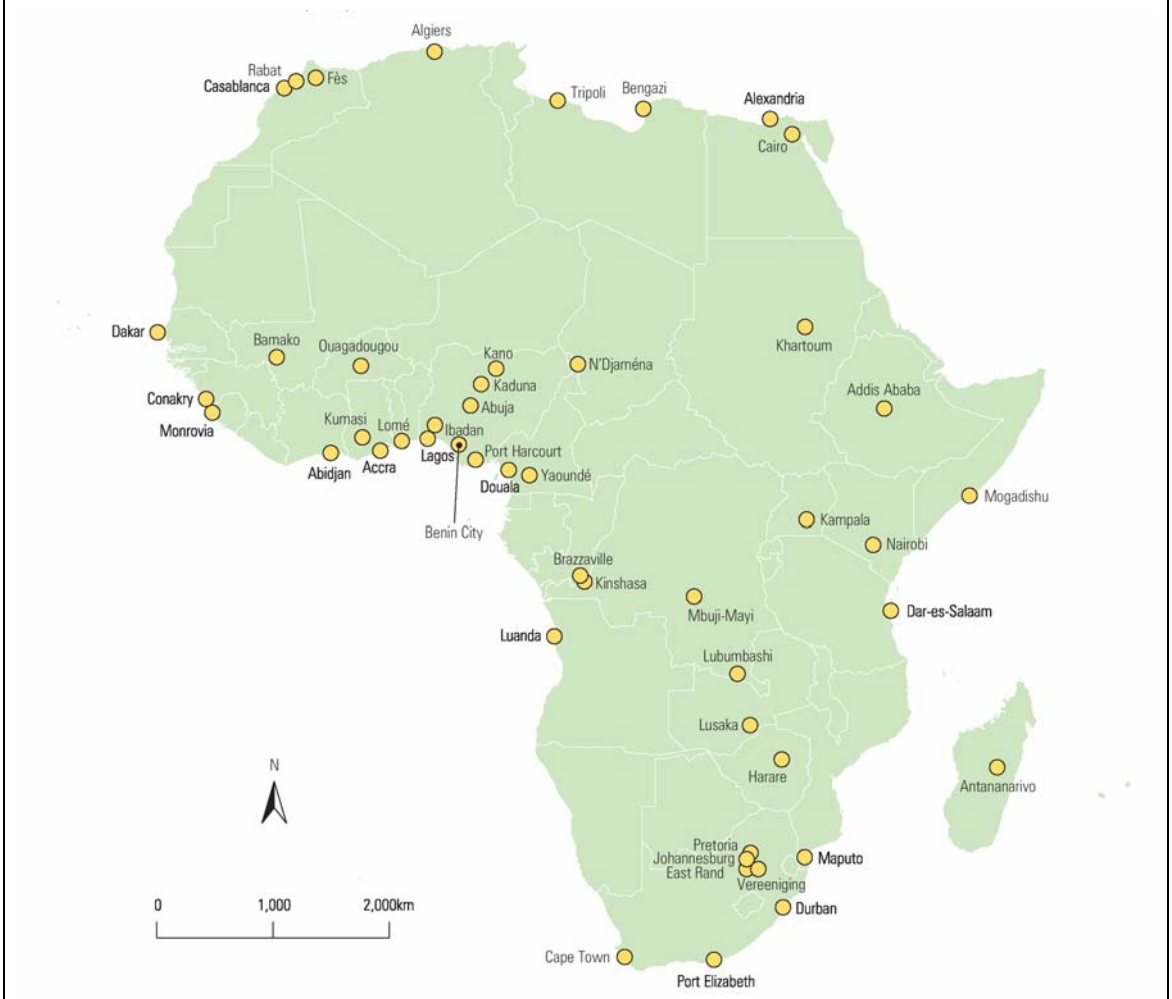
However, as Table 1 shows, there are also considerable differences in growth rates between individual countries. Only a few countries exhibit annual growth rates below 3 per cent, including Namibia, Sierra Leone, Congo, Botswana, Zambia, Central African Republic, Zimbabwe, and South Africa. The majority of countries have growth rates that exceed the 3 per cent benchmark (in comparison: India and China have annual urban growth rates of 2.4 and 2.7 per cent respectively) (UN 2007). Between 2005 and 2007, there were 20 countries with a growth rate higher than 4 per cent (see Table 1). With a few exceptions there is a negative correlation between the levels of urbanization and annual urban growth rates: Countries with low levels of urbanization tend to have the highest rates of urban growth.

There are also significant regional differences. Southern Africa holds the continent's highest urbanization figures, but its annual rates of urbanization, as expected, are now declining (UN-Habitat 2008a, 4). By contrast, Eastern Africa has significantly low levels of urbanization but an annual growth rate of almost 4 per cent (see Table 1). With this significant rate the latter region will double its urban population to a projected 106.7 million by 2017.

Table 1: Urban growth rate and level of urbanization in countries of Sub-Saharan Africa					
Country / Region	Level of urbanization (%) in 2005	Urban annual growth rate (%) in 2005	Country	Level of urbanization (%) in 2005	Urban annual growth rate (%) in 2005
Sub-Saharan Africa	35	3,7	Saint Helena	39	1,5
			Equatorial Guinea	39	2,8
Southern Africa	56	1,5	Centr. African Republic	38	2,3
Western Africa	42	3,8	Sierra Leone	37	2,9
Middle Africa	40	4,3	Zimbabwe	36	2,2
Eastern Africa	22	3,9	Zambia	35	2,3
			Namibia	35	2,9
Réunion	92	1,6	Mozambique	35	4,1
Djibouti	86	2,2	Somalia	35	4,2
Gabon	84	2,1	Guinea	33	3,5
Congo	60	2,7	Dem. Rep. of the Congo	32	5,1
South Africa	59	1,4	Mali	31	4,8
Sao Tome and Principe	58	3,0	Guinea-Bissau	30	3,3
Liberia	58	5,7	Madagascar	29	3,8
Botswana	57	2,5	Comoros	28	2,7
Cape Verde	57	3,5	Chad	25	4,7
Cameroon	54	3,5	Swaziland	24	1,7
Gambia	54	4,2	United Rep. of Tanzania	24	4,2
Angola	54	4,4	Lesotho	23	3,5
Seychelles	53	1,4	Kenya	21	4,0
Ghana	48	3,5	Eritrea	19	5,4
Côte d'Ivoire	47	3,2	Rwanda	18	4,2
Nigeria	46	3,8	Burkina Faso	18	5,0
Mauritius	42	0,9	Malawi	17	5,2
Senegal	42	3,1	Niger	16	4,0
Mauritania	40	3,0	Ethiopia	16	4,3
Benin	40	4,0	Uganda	13	4,4
Togo	40	4,3	Burundi	10	6,8
Source: UN (2007)					

Most of the population growth will not take place in Africa's largest cities. African cities with less than 500,000 inhabitants are now absorbing about two-thirds of all urban population growth. Yet Africa's larger cities also continue to grow, and it is projected that by 2015 there will be 59 cities (cf. Figure 1) exceeding one million inhabitants (UN-Habitat 2008a, Tibaijuka 2004).

Figure 1: Overview of African cities with a population exceeding 1 million in 2008



Source: UN-Habitat (2008a)

The figures for rapid urbanization in Africa given above advert to a major social-demographic transformation with very new spatial urban configurations for a region that has been predominantly rural in the past. After independence, Africa's cities started to grow very rapidly. Initially this growth was driven predominantly by rural-urban migrations, but today it is more the result of natural growth.

The first megacity in Sub-Saharan Africa that reached a population of 10 million is Lagos. Kinshasa will be the second and is projected to surpass Lagos in size by 2025, with Lagos and Kinshasa then having 16.7 and 15.7 million inhabitants respectively. However, this is not the full picture. Traditional city-based urbanization is moving towards regional urbanization patterns, including the emergence of city regions and their associated urban corridors, creating what is known as mega-urban regions. Such regional urban systems

comprise several multi-million urban cores, as the North Delta Region (comprising Cairo, Alexandria, Port Said and Suez), with a population exceeding 77 million in 2007; the Gauteng Urban Region of South Africa (Johannesburg, Tshwane/Pretoria and Emfule/Vereeniging) with an estimated 10.5 million inhabitants; and the GILA urban corridor (Ibadan, Lagos, Cotonou, Lomé and Accra) stretching along the Gulf of Guinea coast of Nigeria, Togo, Benin and Ghana, comprising about 25 million people. Some emerging African city regions are prospective gateway cities and could enhance the continent's integration into the global economy. But they have an even greater potential of becoming cores of intense inequity, corruption and deep human suffering if poorly governed and left to the voracity of unregulated market forces (UN-Habitat 2008a).

In Africa, both natural growth as well as internal migration are poverty-driven processes and not an industrialization-induced socio-economic transition (UN-Habitat 2008a, 7). With respect to rural-urban migration, the driving forces behind it rather relate to declining rural conditions than new urban opportunities (Girardet 2008, 99). The major factors here comprise the failure of agricultural policies, including poor marketing services, pressure on the land through population growth, the failure of land reform, and finally the increasing number of regional and civil conflicts (Tibaijuka 2004, 6). Moreover, the legacy of colonialism, unfair global trade conditions, severe shortages in post-independence policies, conflicts and corruption in many countries, extreme centralization of power, an increasing number of natural disasters, and the scourge of HIV/Aids have had a strong impact on economic and political development (UN-Habitat 2008a, 7). The resulting economic 'growth tragedy' of the past decades has not entailed declines in urbanization rates, in spite of stagnant or downward real wages, rising prices, and skyrocketing urban unemployment (Myers and Murray 2007, 4; Tibaijuka 2006, 13). Although there has been a fair amount of growth in the last few years in some of the countries in Africa, 40 per cent of all Africans are still below the poverty line, living on less than US$1 per day (UN-Habitat 2008a, 7).

The above given trends and figures on rapid urbanization processes in Sub-Saharan Africa suggest the immense impact on living conditions in the vastly growing cities and do indeed match well with the figures for slum population in cities of Sub-Saharan Africa. About 72 per cent of the urban population in Sub-Saharan Africa lives under slum conditions, and this number has almost doubled in only 15 years, reaching nearly 200 million slum dwellers in 2005 (Tibaijuka 2006, 13; UNFPA 2007, 16; UN-Habitat 2003, 246).

Africa's urban slum populations continue to grow, and in some of the fast-growing African cities almost all of the current urban spatial growth results from the proliferation of slums and informal settlements (UN-Habitat 2008a). The first global report on slums published in 2003 by UN-Habitat argues that the number of slum dwellers will continue to increase unless there is serious and concerted action by all relevant stakeholders (UN-Habitat 2003). According to Tipping / Adom / Tibaijuka (2005, 13), the global slum population today is approximately 1 billion, which is expected to grow to 2 billion by 2030 and 3 billion by 2050. This "growth is taking place without the corresponding ability of many cities in the developing world to expand public provision of basic services". Consequently *"we are witnessing the continued and rapid urbanization of poverty and ill health"* (Tipping / Adom / Tibaijuka 2005, 14).

It is especially the rapid growth of informal settlements and slums and the lagging behind of adequate infrastructure provision that poses a major challenge to the implementation of adaptation strategies in urban Africa. Due to several reasons, which will be outlined in the following chapters, the problems associated with the growth of slums significantly conflict with the concept of an integrated and inclusive city. Rich and poor, formal and informal urban neighbourhoods, are diverging with respect to types of hazards and the degree of risks and vulnerabilities. The adverse effects of climate change and variability will exacerbate this divide between urban rich and poor.

This bleak picture of the current state and future projection of urban areas in Sub-Saharan Africa should not tempt the international development community to resign from engaging in urban development. It is noteworthy, against common belief, that urbanization may offer new chances for a more sustainable development in Sub-Saharan Africa. Cities are centers of innovation and modernization; they concentrate creativity, information, education, and communication, and they are likely to provide the critical link between the development of rural areas and the larger global economy (see also Kraas / Nitschke 2006, 21; Sánchez-Rodríguez et al. 2005, 12; Tibaijuka 2006; World Bank 2009). Kessides states that the *"processes of urbanization and the growth of cities and towns favor national development by diversifying incomes, expanding options for more affordable service delivery, and opening horizons for innovation and skill acquisition"* (Kessides 2006, IX). Urban areas are also engines of economic growth. Figures vary, but between 55 and 60 per cent of the continent's total Gross Domestic Product (GDP) is generated in cities (UN-Habitat 2001; 2008a) (see also chapter 4.3).

3 Climate change and climate variability: key future impacts for cities in Sub-Saharan Africa

The biggest impacts from climate variability and change for urban areas with population concentration *"are often expected to be from little-characterized and unpredictable rapid-onset disasters such as storm surges, flash floods and tropical cyclones"* (Boko et al. 2007, 450). Also less rapid changes are expected to threaten the functioning of cities and urban areas and may further constrain development and the attainment of the Millenium Development Goals (MDGs) in Africa. In addition to localized effects, negative impacts in rural or peri-urban areas could also create "a new set of refugees, who may migrate into new settlements, seek new livelihoods and place additional demands on infrastructure" (Boko et al. 2007, 450). The following sections draw on changes that are expected to have major impacts on urban areas in Africa.

3.1 Impacts from rapid-onset disaster events

Although it is not known precisely to what extent global warming contributes to the rise in urban disasters, it is striking how rapidly human and economic costs of storms and floods in urban areas have grown over the last few decades. Almost all the growth in natural disasters since 1950 has been in the form of storms, floods and droughts, and climate change is highly likely to increase the frequency and intensity of such events. The year 2007 already was the worst year on record, and it should be noted that the human costs are

Box 1: Examples of cities at risk from floods and/or sea-level rise

Cotonou has around 700,000 inhabitants. The city faces a continued advance of the sea, coastal erosion and a rise in sea level, exacerbated by human activity on the coast. Some roads, beaches and buildings have already been destroyed by the coastline's regression in the last ten years. In addition, provision for drainage is inadequate; the city has no sewer system and only a small proportion of solid wastes are collected; in addition, most of the population lives in informal settlements.

Lagos (10 million inhabitants) has very inadequate provision for basic infrastructure to cope with flooding. "Normal" rainfall brings flooding to many areas of the city. Provision for sewers, drains and wastewater management is mostly inadequate. Any increase in the intensity of storms and storm-surges is likely to increase such problems, and much of the land in and around Lagos is less than 2 meters above sea level. The site on which Lagos is built is not well suited to a city this size. Many buildings have been erected in ways that block storm-water routes, and many low-income settlements are built in areas at high risk of flooding (many on stilts), largely because safer sites are too expensive.

In **Abidjan** (2.8 million inhabitants) a sea-level rise of 1 meter is likely to inundate 562 square kilometres along the coastline of the Abidjan region; lowland marshes and lagoons dominate the coastal zone. Average retreat will vary from 36 to 62 meters. Although some important areas of Abidjan lie on a plateau and may escape the direct effects of sea-level rise, major economic centres, including the nation's largest port and much of the international airport, are on land less than 1 meter above sea level. Around half a million inhabitants live in precarious housing in informal settlements; a high proportion of these are tenants.

Port Harcourt: An extreme 10-hour rainfall in July 2006 drove 10,000 residents out of their homes and caused widespread traffic chaos. The Niger delta frequently experiences flood problems that are aggravated by structures such as the Port Harcourt–Patani–Warri highway that cuts across natural drainage lines and acts as a barrier to floodwaters. Blockage of channels by debris and obstruction of floodways by new construction were seen as the main obstacles contributing to Port Harcourt's flooding.

Mombasa: An estimated 17 per cent of Mombasa's area (4,600 hectares) could be submerged by a sea-level rise of 0.3 meters, with a larger area rendered uninhabitable or unusable for agriculture because of waterlogging and salt stress. Sandy beaches, historic and cultural monuments, and several hotels, industries and port facilities also negatively affected. Mombasa already has a history of disasters related to climate extremes, including floods that cause serious damage and often loss of life nearly every year.

Bamenda: Around 20 per cent of Bamenda's population lives on floodplains and around 7 per cent lives in informal settlements on steep slopes. There are great inadequacies in provision for water, sanitation, schools, health posts, roads and drainage. Land clearance for settlement and for quarrying and sand-mining, along with other land-use changes caused by urban expansion, have created serious problems of soil erosion – with the soil that is washed down the hills blocking drainage channels and changing peak water flows. These have exacerbated problems with floods, although flooding has long been a problem in Bamenda.

Source: Satterthwaite et al. (2007, 18 f.)

mostly confined to low- and middle-income nations with some 95 per cent of all disaster-caused deaths over the last 25 years (Satterthwaite et al. 2007, 38).

Flooding is among the most frequent rapid-onset events that pose significant harm for urban dwellers, especially in the developing world (see examples in Box 1). The risk of flooding exists in almost every town wherever rainfall occurs. Many cities face growing problems with flooding, as they are situated beside rivers or in the foothills of higher mountains that make them vulnerable to the effects of more intense precipitation. To be sure, floods are natural phenomena, but damage and losses from floods in cities are largely man-made. Buildings, roads, infrastructures and other paved areas prevent rainfall from infiltrating into the soil, and heavy and/or prolonged rainfall produces very large volumes of surface water in any city. This is rarely a problem in cities with good provision for storm and surface drainage, complemented by measures that protect against flooding (e. g.

provision of parks and other open spaces that accommodate floodwaters) (Satterthwaite et al. 2007, 17). However, most cities in Africa lack such protective measures due to poor governance and lack of funds, and it is even common for buildings or infrastructure to be constructed in a way that actually obstructs natural drainage channels as e. g. illustrated for the case of Mombasa (Awuor / Orindi / Adwera 2008). Moreover, in cities or neighbourhoods that lack adequate solid-waste management or the maintenance of drains – often the case in slums and informal settlements – existing drains are quickly clogged through garbage or plant growth (Satterthwaite et al. 2007, 17).

Poor urban communities in the developing world most often face the highest exposure to the risk of flooding due mostly to a lack of adequate drainage systems and protective measures, often higher building densities, and the fact that they are often obliged to reside in flood-prone areas of the city. Furthermore, protective measures aimed at preventing the movement of floodwaters into certain areas of the city often give priority to the main business and administrative centres. This again increases the likelihood and intensity of floodwater spreading into those areas that remain unprotected (Douglas et al. 2008, 188).

In much of the tropics, most rainstorms are highly localized, often with great intensity and short duration, usually lasting an hour or less. In urban areas, intensive rainfall produces enormous volumes of water runoff from roofs and paved surfaces that often leads to sudden flash flooding, with little lead time for warning. Flash floods are fast-moving and generally violent, resulting in a high threat to life and severe damage to property and infrastructure; and they can occur several times a year (Douglas et al. 2008, 188). Climate change is projected to alter rainfall patterns and tends to increase storm frequency and intensity, with an increased effect on the potential for flooding.

Moreover, an increase in storms and tropical cyclones is likely to occur due to climate change, affecting especially cities that are localized in storm-prone coastal areas (see section 3.5). It has been noted that there is evidence of what used to be ‘a once in a hundred years’ event becoming more common than this, and that cities in this case become more vulnerable to any damage to the larger systems on which they depend – for instance for water supply and treatment, transport and electricity (Satterthwaite et al. 2007, 17).

3.2 Impacts on water availability and food security in cities

Water

By 2020, between *“75 million and 250 million people in Africa are projected to be exposed to an increase of water stress due to climate change (high confidence)”* (IPCC 2007, 13). Although domestic water consumption represents only 2 per cent of global abstraction (agriculture requires a much higher proportion), the demand for water in cities is steadily rising due to changing consumption patterns and increasing wealth (Wilbanks et al. 2007, 370). Water supply in urban areas must be considered as a key for human development, but it is a bottleneck factor in many respects: *First*, water supply is critical for economic development (e. g. industrial development, time spent for procuring water)

and health (e. g. water-washed diseases[1]); *second*, massive groundwater withdrawal can lead to land subsidence and increasing flood risks in coastal and delta areas; *third*, the issue of water supply is related to waste water management and the associated implications for health (sanitation, water-borne- and vector-borne-diseases).

Any change in rainfall patterns and stream flow will have direct and indirect impacts on urban water resource management, sanitation and other sectors:

— *first*, in terms of the cost effect on urban water supply,

— *second*, in terms of the effects on electricity supply through hydropower, and

— *third*, in terms of the effect on necessary standards for waste water treatment.

The latter depends on the extent of dilution of effluents when discharged, and any reduction in stream flows requires an intensification of treatment to maintain the same environmental standards (Muller 2007, 106). If these standards are not met – today wastewater treatment is minimal or non-existent in most African cities and untreated effluents are often discharged directly into waterways – downstream user burdens will significantly increase. More impacts related to water are caused through flooding since water supply abstraction and treatment works are often situated beside rivers and are often the first items of infrastructure to be affected by floods. Moreover, electrical switchgear and pump motors are particularly at risk, and pipelines may be damaged in severe riverine floods with high flow velocities (Wilbanks et al. 2007).

Not only water availability, but also accessibility and water demand will be affected. Even without climate change many countries in Africa will exceed the limits of their economically usable land-based water resources before 2025 (Boko et al. 2007). Already today, about 25 per cent of the African population faces water stress. However, large-scale assessments of water availability only reflect half of the picture, and critical aspects such as water quality and access are not considered in these figures (Müller 2008, 39; cf. Muller 2007, 103 f.).

Municipal water supply is often restricted to formal, planned settlements, while informal colonies and squatter settlements are excluded from the supply. People who must rely on informal means to procure their daily water through e. g. water tankers or water vendors are paying much higher prices, as e. g. studies from slums in Nairobi, Kenya show, where people pay 5–10 times more for water per unit than those in high-income areas (UNDP 2006, 7). Additionally, they often have to compromise with the quality of water, since there are no quality standards for informal supply. Thus, inequality in access to water is significantly high within cities of the developing world. While high-income groups enjoy access to several hundred litres of water a day delivered into their homes at low prices by public utilities, slum dwellers and poor households often have access to much less than the 20 litres of water a day per person required to meet the most basic human needs. In Dar es Salaam, Tanzania – for instance – per capita water use is 15 times higher in high-income suburbs linked to the public utility system than in slum areas (UNDP 2006, 7). Especially women and young girls have to face a double burden of disadvantage, since they are the ones who sacrifice their time and their education to collect water (UNDP 2006, 2). It is

1 Water washed diseases are caused by water scarcity where people cannot wash themselves, their clothes or home regularly.

obvious that the costs for water supply will increase with declining availability and rising demand in cities due to the fact that water has to be brought from much further afield and climate change is projected to increase water scarcity in most parts of Africa. These factors will exacerbate inequality in access to water supplies especially in cities.

Food

Food security is significantly linked to climate change and urbanization, with both affecting all sectors of the food systems[2]. Urbanization imposes higher demands for food items such as vegetables, fresh fruits, and meat that need to be transported and distributed to the urban centres. This leads to changes in the traditional chain market system with a diversification of retailing (e. g. discount stores, supermarkets) and adjustments in the whole distribution system (e. g. central markets, large-scale trading) (Drescher / Iaquinta 2002). For instance, in Kenya, supermarkets have grown from a tiny niche market in 1997 to more than 20 per cent of urban food retailing in 2002 (Neven / Reardon 2004). Due to the constraints of infrastructure in most African countries, market-oriented urban agriculture often fills the food-diversity gap that results from the higher demand of fresh and perishable products (Drescher / Iaquinta 2002).

Climate change will have significant impact on agricultural production and food security. The IPCC-AR4 (IPCC Fourth Assessment Report) states that agriculture is already challenged in a number of countries in Africa through semi-arid conditions and climate variability. Global climatic change will be likely to reduce the length of growing seasons and will force large regions of marginal agriculture out of production (Boko et al. 2007, 447).

For urban households there are various food sources for purchase. Access to and availability of food markets is essential for urban food security. Examples from South Africa show that many of the urban poor in the Townships cannot afford to travel to the supermarkets to buy food and therefore have to buy what is available in the neighbourhood or brought in by street vendors. Often small quantities of fruits or vegetables are incomparably highly priced (Drescher 2003).

Food security for cities is highly linked to questions of livelihood, since urban dwellers largely draw on food sources for purchase. Food for urban dwellers becomes more expensive as transportation and distribution costs increase through longer transport distances and because a far greater proportion of processed products are required. Climate changes and variability increase the risks of sudden food price fluctuations that first affect those who spend large proportions of their incomes on food (cf. Gregory / Ingram / Brklacich 2005, 2142). This has an impact on consumption patterns and certainly leads to an increase in urban malnutrition, because the poor have to draw on cheaper and lower-quality food items.

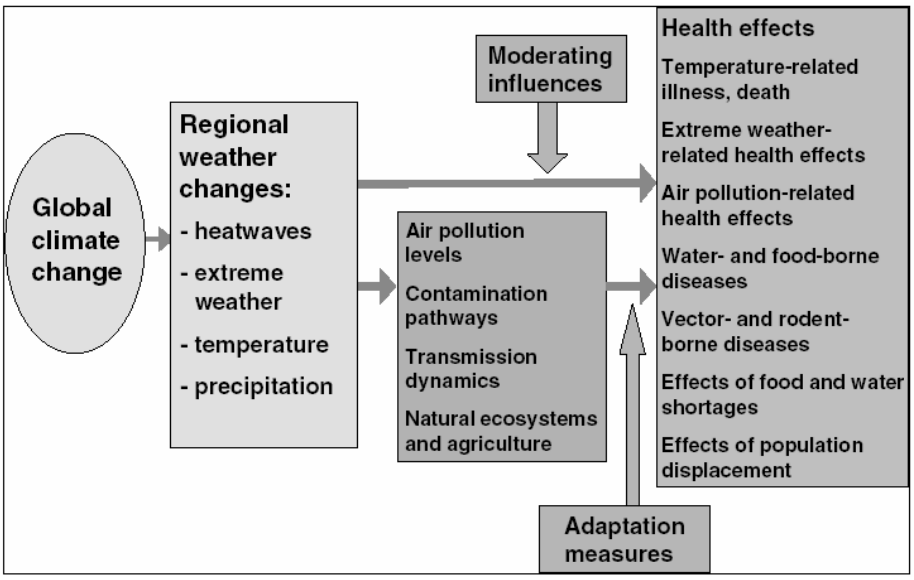
2 *"Food systems encompass food availability (production, distribution and exchange), food access (affordability, allocation and preference) and food utilization (nutritional and societal values and safety), so that food security is, therefore, diminished when food systems are stressed"* (Gregory / Ingram / Brklacich 2005, 2139).

3.3 Impacts on urban health

The above outline of the impacts of climate change on water and food makes it clear that there are significant implications for human health as well. However, there are much more critical aspects to be considered in view of expected climate changes and increased variability. An assessment taken by the World Health Organization (WHO) points out the significant effects of climate change that have occurred since the mid-1970s, causing a global net increase of over 150,000 deaths in 2000, with evidence pointing to an increase in the future (McMichael et al. 2004, cited in Campbell-Lendrum / Corvalán 2007, i111). Figure 2 depicts the channels through which climate change is likely to affect human health. The pattern differs from the effects of other risk factors due to the diversity of causal pathways and the typically long delays between cause and effect and the great difficulties involved in eliminating these risk factors.

As for other risk factors the effects greatly depend on the mitigation of influences and the adaptation to consequences. Therefore, the highest levels of vulnerability are found in poor urban communities such as slums and informal settlements with low income levels, poor housing, inadequate provision of basic services, and no effective regulation of pollution or ecosystem degradation. The most important climate-sensitive health outcomes such as malnutrition, diarrhoea and malaria are already common in these areas, and it is these diseases that mainly affect children (Campbell-Lendrum / Corvalán 2007, i111; McMichael et al. 2004, 1545). Health concerns will therefore become increasingly important in urban areas of Sub-Saharan Africa with the following aspects being most important.

Figure 2: Pathways through which climate change may affect health



Source: McMichael et al. (2004, 1549)

Heat waves, heat island effects, and air pollution

It is projected that the frequency in heat waves will grow due to global trends towards higher and increasingly variable temperatures. Heat waves are particularly harmful to

urban populations because they are exacerbated by the effects of urban heat islands. Urban heat island effects result from lowered evaporative cooling and increased heat storage due to changed surfaces and heat trapping by elevated levels of locally produced CO_2. This is also related to diurnal cycles of absorption and later re-radiation of solar energy. Individual cities show significant heat-island effects, measuring up to 5–11° C warmer than the surrounding rural areas (Campbell-Lendrum and Corvalán 2007, i111; see also Confalonieri et al. 2007, 406).

Heat stress can affect health, labour productivity and leisure activities of the urban population as e. g. documented with the European heat wave of 2003 that claimed over 35,000 lives within a 1- to 2-week period in early August, mostly among the poor and isolated elderly (Kosatsky 2005). In Andhra Pradesh, India, a heat wave killed more than 1,000 people – mostly labourers working outside in smaller urban settlements (Satterthwaite et al. 2007, 27). It is obvious that heat stress and urban heat island effects will also create additional costs of climate-control within buildings.

Moreover, higher temperatures in cities create more problems with air pollution. The concentration of air pollutants may change in response to climate change because a portion of their formation depends, in part, on temperature and humidity. It has been noted that the combined effects of heat stress and air pollution may be greater than the simple additive effects of the two stresses (Satterthwaite et al. 2007, 27). For instance, levels of ozone are affected by atmospheric conditions and tend to be much higher on warmer days. There is little evidence from cities of the developing world, but epidemiological studies from the south eastern USA suggest significant risks associated with increasing temperatures (Campbell-Lendrum / Corvalán 2007, i112).

Floods and storms

The risks from floods and storms have been outlined in the previous chapters. There are direct and indirect health risks associated with rapid-onset hazard events. Direct risks result from injuries and deaths caused by extreme weather events. Indirect risks are associated with the possible effects on the health infrastructure, but also through the displacement of population, crop failure (risk of hunger), increased risk of water-borne diseases due to flooding, or water shortages (water washed diseases) (McMichael et al. 2004, 1556).

Communicable and other diseases

Not only most water-related diseases, but also vector-borne and rodent-borne diseases are highly influenced by climate conditions, and several are very common within cities. The most important vector-borne viral infection is dengue, which has increased dramatically in tropical developing regions in the past few decades due to the weakening of vertical control programs in many regions and the rapid unplanned urbanization that produces breeding sites for Aedes mosquitoes. The global spreading of the four different serotypes of dengue is favoured by increased travelling on the one hand and higher temperatures and rainfall on the other hand. However, there are also studies showing that drought can lead to an increase in dengue if household water storage increases the number of mosquito breeding sites (Campbell-Lendrum / Corvalán 2007, i112; Confalonieri et al. 2007, 403). Another important vector-borne disease that has to be considered as well is malaria.

Climate has a significant impact on malaria incidence, and it is predicted that climate change might cause some modifications to the present global distribution of malaria (Hay / Rogers / Randolph 2000; Tanser / Sharp / Le Sueur 2003). Currently, an estimated 700,000 to 2.7 million people die of malaria in Africa each year, and 75 % of those are children (Boko et al. 2007, 436). Urban areas, however, also provide unhealthy conditions for anopheline species due to lower vector densities that result from a paucity of open and clean freshwater, reduced open spaces for breeding, and increased pollution of the remaining breeding sites. With increased human densities, malaria exposure per capita also decreases (Hay et al. 2005, 83 f.).

Water-related diseases are another important group of communicable diseases. They can be classified by the route of transmission into water-borne diseases (ingested) and water-washed diseases (caused by lack of hygiene). Alterations in rainfall, surface water availability and water quality are likely to affect the spread of water-related diseases. The IPCC AR4 considers the following aspects to be relevant for an evaluation of the relationship between health outcomes and exposure to changes in rainfall, water availability and quality (Confalonieri et al. 2007, 401):

- Linkages between water availability, household access to improved water, and the health burden due to diarrhoeal diseases
- The role of extreme rainfall (intense rainfall or drought) in facilitating water-borne outbreaks of diseases through piped water supplies or surface water
- Effects of temperature and runoff on microbiological and chemical contamination of coastal, recreational and surface waters
- Direct effects of temperature on the incidence of diarrhoeal disease

Diarrhoeal diseases such as cholera are most important in this respect. Although cholera is receding in many parts of the world, it is re-emerging in Africa, mostly due to the relative weakness in disease surveillance and reporting systems. This hampers the detection and control of cholera epidemics and makes it difficult to obtain the long-term linked data sets on climate and disease that are necessary for the development of early warning systems (Boko et al. 2007, 442).

However, there is a need to further examine the impacts of future climate change not only on the re-emergence of cholera, but also on other infectious diseases, such as meningitis. The factors affecting the prevalence of meningococcal meningitis are still poorly understood, but there is evidence that dryness, very low humidity and dusty conditions increase the risk. About 162 million people live in areas with a risk of meningitis (Boko et al. 2007, 439).

Moreover, the possibilities of an emergence of new infectious diseases should be considered, which may spread faster within and between cities due to travel links and higher rates of person-to-person contact (Campbell-Lendrum / Corvalán 2007, i112; Krafft / Wolf / Aggarwall 2003; McMichael et al. 2004, 1556).

3.4 Impacts on rural-urban linkages

'Rural' and 'urban' areas are often perceived as quite separate and in competition with each other for investments, services or other forms of support. But this view neglects the strong linkages between towns and the countryside, especially in most parts of Africa (Bolnick et al. 2006, 2). Rural-urban linkages are highly complex not only with respect to flows of people and goods, money and information, but also in terms of social relations that are crucial in organizing these links (Bolnick et al. 2006, 18). Bolnick et al. (2006, 19) shows how rural-urban linkages in Sub-Saharan Africa have intensified during the last three decades. This has important implications in the context of climate change as well. It is not possible to separate climate change from other factors in this regard, but it makes sense to draw on the interface between various other issues that drive dynamic transformation processes in Africa.

For instance, economic crisis and reform gave rise to highly dynamic social, economic, and cultural change in Africa and created a context of economic uncertainty, both for the rural as well as for the urban populations. In response there were significant changes in livelihood strategies that can be identified along two major lines: (1) "increased mobility accompanied by strong social and economic links with home areas in what can be described as 'multi-local households'" (often reinforced by HIV/AIDS, with rural-based relatives acting as care providers for orphans and those who are ill); and (2) high levels of multi-activity and income diversification, especially among younger people" (Bolnick et al. 2006, 19). Surely, livelihood diversification can be triggered by increased demands for manufactured goods and services by a wealthier rural population, which can also be a major stimulus for the growth of local towns (Tacoli 2006, 6). But a major driver can also be seen in stress on agriculture through climate change and increased variability that can impact various links between urban and rural livelihoods especially with respect to migration.

Cities and smaller urban centres play a major role for income diversification in rural areas inasmuch as they provide the largest and fastest-growing markets for agricultural and manufactured goods and products with strong side-effects for trade and services as well. In most rural areas in Africa, the income share derived from non-farm activities has increased, with a current proportion between 30 and 50 per cent (including migrant remittances) for Sub-Saharan Africa, reaching as much as 80–90 per cent in some regions, such as Southern Africa (Bolnick et al. 2006, 21; see also Bah et al. 2006; Baker 2006; Potts 1997). Findings from different case studies in Sub-Saharan Africa and elsewhere suggest that rural households with a more diversified income base are better able to withstand unfavourable impacts of policy changes and weather shocks than households with a less diverse portfolio (see e. g. Ellis 1998; Ersado 2003). This has implications also for an understanding of the adaptive capacities of households in regard to climate change and it should be noted that policies can create environments that impede rural-urban interactions (e. g. policies that seek to prevent the poor from escaping poor areas) (Ellis / Harris 2004, 16).

The picture outlined above of current trends in rural-urban linkages points to their highly dynamic character, which depends on specific contexts and on the different constraints on farming and opportunities in non-farm activities. General trends can be identified only in that households remain central social institutions that are far from being homogenous,

relatively stable units of production and consumption. Instead they can be defined as "multi-activity and multi-local units, in which members engage in a variety of income-generation in a number of different locations" (Tacoli 2006, 7).

Against this broader background, urban-rural linkages become highly relevant in terms of conflict over critical resources such as water and land, with an influence that goes far beyond city boundaries. The area of land required to sustain an urban region, i.e. its "ecological footprint", is generally much larger than that contained within municipal boundaries or the associated built-up area. Through *"trade and natural flows of ecological goods and services, all urban regions appropriate the carrying capacity of 'distant elsewheres', creating dependencies that may not be ecologically or geopolitically stable or secure"* (Rees 2006, 285).

Stress on water resources is one of the most striking issues in this regard for Africa. Although agriculture remains the largest user of freshwater resources within virtually all national economies, water demands from urban enterprises and consumers will become increasingly important (Satterthwaite et al. 2007, 25). Already, many major cities have to draw fresh water from increasingly distant watersheds, since local surface and groundwater sources no longer meet the demand for water or are becoming depleted or polluted (Showers 2002). This not only has considerable impact on the cost of water supply but also expands the area affected by competition among cities for water (e. g. irrigation) and indirectly for land (Muller 2007, 106; Reed 2006, 20; Satterthwaite et al. 2007, 25; see Chapter 4.4). Generally, this has effects also on the use and removal of both near and distant groundwater. Extraction rates that exceed annual recharge often cause degradation through seawater intrusion along coasts, as has happened in Lomé, or collapse of the aquifer, which reduces future water storage capabilities (Showers 2002, 643).

Climate change and variability will be likely to impose additional pressure on water availability, water accessibility, and water demand (Boko et al. 2007, 444), and an increased conflict potential between rural and urban water supply, agriculture and non-farm activities is to be expected.

Impacts from climate change in Africa will exacerbate water stress, and will make agriculture even more challenging – often to such an extent that large regions of marginal agriculture are going to be forced out of production (Boko et al. 2007). Besides slow-onset climatic changes a growing number of extreme weather events such as hurricanes and flooding may increasingly impact rural livelihoods. Moreover, environmental changes are not only a cause of changing climatic conditions but are also influenced by other major changes that occur on a global scale, such as land use changes and urbanization.

The combination of these impacts might trigger new patterns of migration. In fact, forced rural to urban migration may become an adjustment mechanism, a survival mechanism or, in extreme cases, an expression of failed adaptation (cf. Renaud et al. 2007). As will be shown in the following section, migration represents the most critical link between rural and urban areas. Migration – whether permanent or temporary, internal or international – has always been an important coping strategy in response to environmental changes. However, environmental and climate change today presents a new threat to human security and a new situation for migration (Warner et al. 2008).

Surely, migration and human mobility have a number of different root causes, and to isolate environmental factors from the multiple push-and-pull factors that cause rural-to-urban migration is not feasible. But it is increasingly recognized that environmental factors do significantly contribute to migration. Recent studies suggest that environmentally induced migration occurs after a certain environmental tipping point is passed, i.e. when earning a livelihood is no longer possible in a given climate and environment. Climate-related stressors combined with ecosystem change already drive migration today, and projections speak for a considerable increase in environmentally induced migration (Warner et al. 2008). Rural-to-urban movements are often assumed to be the dominant direction of migration flows. But much, if not more, movement is between rural areas, often short-term and linked to the agricultural calendar. This is because rural-to-rural movements do not generally require as many financial and social resources and new skills as rural-to-urban migration (Bolnick et al. 2006, 23).

In conclusion, it is most likely that the role of migration will become increasingly important as an adaptation strategy for rural dwellers. This has significant implications with respect to the growth of cities. Therefore, adaptation in cities has to consider these important and complex linkages that can better be understood as a continuum.

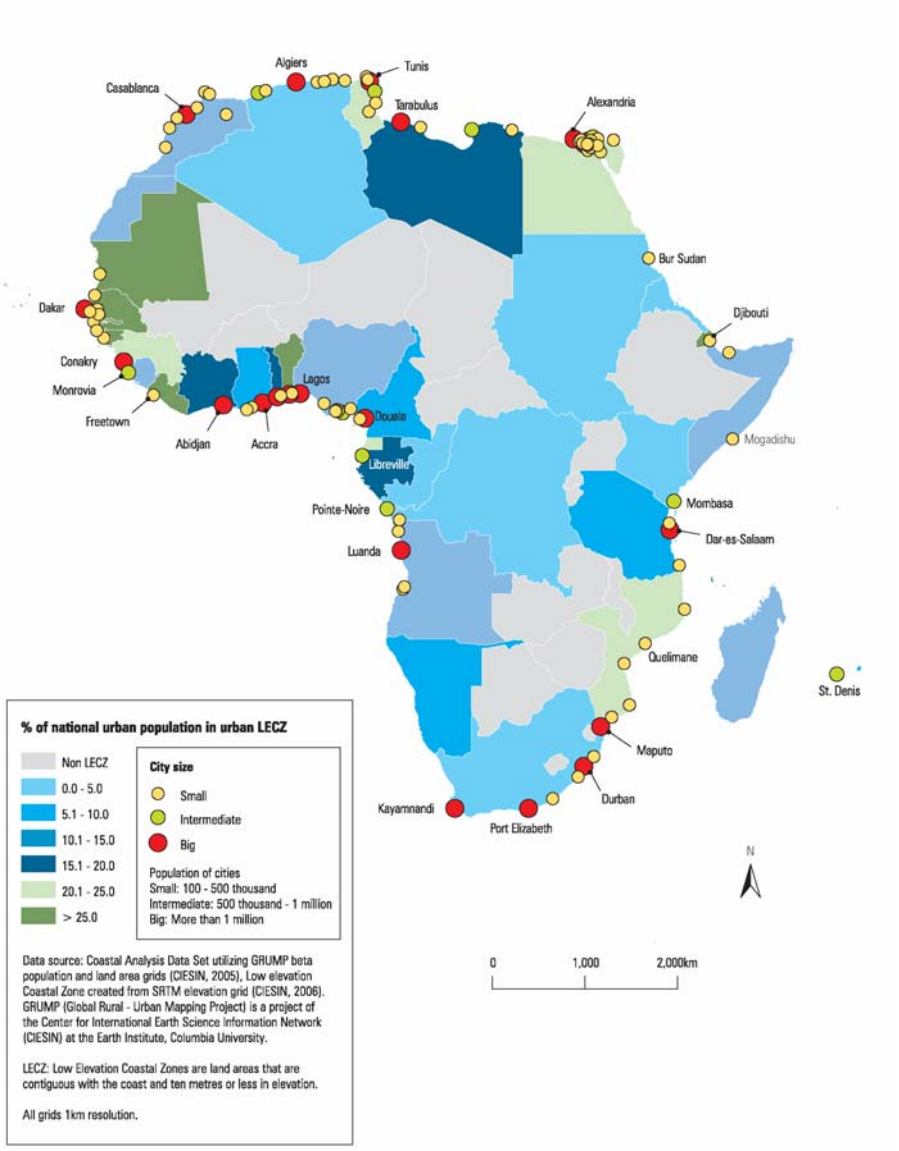
3.5 Particular impacts from sea level rise

Many of Africa's largest cities, such as Lagos, Cairo, Alexandria, Abidjan, and Cape Town, are located on fragile coasts or river deltas. Populations in these locations are highly vulnerable to sea level rise, flooding, and other extreme weather events, along with coastal erosion and increasing salt levels in coastal groundwater tables. Moreover, the economic, social, and political infrastructure in many African countries is concentrated in coastal areas, magnifying the importance of protecting these sites.

Many cities in the coastal zone already face a considerable risk of high tides, rainstorms and storm surges; but perhaps the greatest threat they face is a combination of both: storm surges and high tides. In many cities, wetlands are drained to open valuable land for urban developments or the land is occupied with informal settlements, with the effect that important buffers against tidal floods are removed. Sea-level rise will not only increase this risk, but is also likely to undermine building foundations. Such processes will be exacerbated through rapid urbanization and excessive abstraction of ground water in cities, often leading to subsidence and salt water entering valuable groundwater sources. Moreover, these areas face an increased risk of coastal erosion that destroys infrastructure, housing and tourism facilities, such as in the residential region of Akpakpa in Benin (Boko et al. 2007, 440).

Africa's largest population centres, and much of its economic infrastructure, lie in the coastal zone and river deltas. McGranahan / Balk / Anderson have undertaken the first global review of population and urban settlement patterns in the Low Elevation Coastal Zone (LECZ), which they define "*as the contiguous area along the coast that is less than 10 meters above sea level"* (2007, 17). The zone covers only 2 per cent of the world's land area but contains 10 per cent of the world's population and 13 per cent of the world's urban population. Major coastal Sub-Saharan African cities that could be severely affected by the impact of rising sea levels include Abidjan, Accra, Cape Town, Dakar, Dar es

Figure 3: African cities at risk due to sea-level rise



Source: UN-HABITAT Global Urban Observatory 2008, cited in UN-Habitat (2008a, 21)

Salaam, Djibouti, Durban, Freetown, Lagos, Libreville, Lomé, Luanda, Maputo, Mombasa, and Port Louis (UN-Habitat 2008b).

Although Africa is the only region in the world with as little as one per cent of its land and one of the lowest population shares in the zone, the region has as much as 12 per cent of its urban population in the LECZ (McGranahan / Balk / Anderson 2007, 24). Especially for Africa, colonialism and the expansion of international trade contributed to the coastal location of many contemporary cities. With the contemporary expansion of international trade and China's ongoing economic boom with its trade-related coast-ward orientation[3] it

3 Although pre-eminence of ocean shipping has declined, with air freight growing in relative importance, ocean shipping still dominates in terms of ton-kilometers shipped (McGranahan / Balk / Anderson 2007, 19).

is highly likely that further urbanization will dominate in coastal areas in Africa as well (McGranahan / Balk / Anderson 2007, 19). Moreover, it has been noted that for Africa there are higher shares of its LECZ population living in cities of 100,000 to 5 million people, and the highest urban growth will take place in these secondary and tertiary settlements, i.e. towns with less than 500,000 inhabitants (UN-Habitat 2008a). Smaller cities tend to have less financial and human capital available for adaptation, with strong implications for the question of vulnerability in these cities. Figure 3 classifies small, intermediate and big cities and draws on the national urban population within the urban LECZ that is at an increased risk of sea-level rise.

The most important region to consider here is West Africa with 40 per cent of the overall population living in coastal cities. It is projected that the 500 km of coastline between Accra and the Niger delta will become a continuous urban megalopolis of more than 50 million inhabitants by 2020, with large portions of the population within the LECZ (Boko et al. 2007, 450). Banjul and Lagos appear to be among the cities that are most at risk from sea-level rise and storm surges, with high concentration of poor populations in potentially hazardous areas that may be especially vulnerable to climate changes. However, there is a significant lack of local data, and it is difficult to determine the scale of risks (Satterthwaite et al. 2007, 19). Box 1 provides a collection of examples with cities at particular risk from floods and/or sea-level rise compiled by Satterthwaite et al. (2007).

4 Climate change and the urban environment: understanding the vulnerability of cities in Sub-Saharan Africa

4.1 Vulnerability and the urban environment

The IPCC defines *vulnerability* within the latest assessment report as *"the degree, to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, the sensitivity and adaptive capacity of that system"* (Parry et al. 2007, 6). Therefore, it can be understood *"as a characteristic of a system and as a function of exposure, sensitivity and* adaptive capacity*"* (Adger 2006, 273). The adaptive capacity of a system depends on certain parameters and is defined as *"the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences"*. Hence, *adaptation* to climate change and climate variability is the *"adjustment of human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities"* (McCarthy et al. 2001). However, high adaptive capacity does not necessarily mean that it is translated into action (Adger et al. 2007, 719). Thus, adaptation is a function of the local context and knowledge about it; the local capacity, and the willingness to act to reduce vulnerabilities (cf. Satterthwaite et al. 2007, 55). Another important concept in this context is the concept of *resilience*. It refers to the magnitude of disturbance that can be absorbed before a system changes to a radically different state as well as the capacity to self-organize and the capacity for adaptation to emerging circumstances.

It is necessary to distinguish between adaptation to changes caused by climate change and adaptation to other environmental changes such as land subsidence through rapid urbanization and excessive groundwater extraction. The United Nations (UN) Framework Convention on Climate Change (UNFCCC) treats adaptation in the narrowest sense – *"as actions taken in response to climate changes resulting from anthropogenic greenhouse-gas emissions"* (Pielke et al. 2007). This contrasts with a broader definition by decision makers and researchers who focus on sustainable development and disaster mitigation, taking into account those changes which are not caused by climate change. This analytical distinction is critical in the context of global climate policy, although – in reality – impacts from climate change cannot easily be separated from other environmental changes. This problem will be outlined in the following.

To understand the vulnerability of cities and their inhabitants, one must consider the diverse and dynamic character of such human systems and the complexity of multiple interrelated factors. This is in particular true for the analysis of hazards and vulnerabilities linked to climate change that must be seen in its interaction with a *"complex 'bundle' of environmental, economic, social and political stressors that influence these"* (Satterthwaite et al. 2007, 12; see also Adger 2006, 273; Adger et al. 2005; de Sherbinin / Schiller / Pulsipher 2007; Wilbanks et al. 2007, 361). Therefore, one approach for the analysis of urban vulnerability is to look at the *urban environment* that significantly reflects the economic, social, institutional, and cultural context of a city.

The urban environment is highly influenced and shaped through a whole range of interconnected factors, in particular human activities and structures; the wastes, emissions and environmental impacts generated by those human activities; and the competence and accountability of institutions that manage these (Hardoy / Mitlin / Satterthwaite 2004, 12). In this paper the "environment" is used *"to refer to all that is external to humans, including those environmental factors created or influenced by human activities"* (Hardoy / Mitlin / Satterthwaite 2004, 12). The "urban environment" can be understood as the *"physical environment in urban areas, with its complex mix of natural elements (including air, water, land, climate, flora, and fauna), the built environment, i.e. a physical environment constructed or modified for human habitation and activity encompassing buildings, infrastructure and urban open spaces"* (Hardoy / Mitlin / Satterthwaite 2004, 12).

Especially in the developing world, urban environmental changes are taking place very rapidly, and it is a great challenge to model and predict changes in this highly dynamic and complex system, with its diverse influencing factors that are located on different scales. This is already true in the absence of climate change, and climate change now creates an additional complex dimension of uncertainty.

Urban environments significantly differ from the rural context: *First*, with regard to the spatial concentration of hazards and stressors that can be reinforced through climate change (e. g. industries, wastes) as well as to the sheer concentration of population and infrastructure that often mean a greater loss of life and a greater damage of physical capital[4]. *Second*, with regard to the number of hazards, as for example the range of

4 Cities make up only 1 per cent of the land area of the Earth, but concentrate more than half of the world's population and the majority of its physical capital (buildings, infrastructure) (Pelling 2003, 22).

infectious and parasitic diseases that can spread rapidly amongst concentrated populations[5] as well as potentially dangerous industrial processes and industrial wastes, etc. (Bull-Kamanga et al. 2003, 196). *Third*, cities are highly susceptible to sudden supply shortages due to significant dependence on goods from the hinterland such as water, food, raw materials, and electricity; and *fourth*, city development and expansion through sealing of land (buildings and infrastructure) often erode natural defences or buffers (e. g. wetlands) and increase flooding risks from rainfall (Satterthwaite et al. 2007, 12). *Fifth*, with respect to the scale of impact, i.e. catastrophic shocks that are confined locally at first run may impact a whole region in the long run due to the economic (e. g. urban-rural remittances) or infrastructural (e. g. major sea port) importance of a city. *Last of all*, urban areas pose particular challenges owing to the mix of and possible synergies between hazards, as for example industrial accidents or floods contaminating water supplies (Bull-Kamanga et al. 2003, 196).

In urban Africa, rapid urbanization, accompanied by a lack of housing and infrastructure, fragmentation, social-economic disparities, loss of governability, as well as environmental degradation currently constitute some of the most striking problems in most of the cities (cf. El-Shakhs 1997, 504; Kraas / Nitschke 2006; Scholz 2005). Besides holding the potential of considerable conflict, such problems increase the susceptibility and sensitivity of a human system and can be serious enough that any significant additional stress could be the trigger for serious disruptive events and impacts (Wilbanks et al. 2007, 373). Table 2 lists the major characteristics of cities in Africa that contribute to an increased vulnerability of a city and its inhabitants to climate change related impacts and extreme weather events.

Accordingly, cities turn out to be, as James Mitchell states it, *"crucibles of hazards"* (1999) that face multiple risks and vulnerabilities for very large populations. Stresses and perturbations that emanate from the natural environment synergistically coalesce with those arising from the society (e. g. the co-occurrence of drought and economic depression synergistically enlarges the vulnerability due to the reduced capability to develop or maintain pre-emptive coping measures) (de Sherbinin / Schiller / Pulsipher 2007, 41).

Moreover, to a great extent, the vulnerability of urban populations to disasters is not 'natural', but is constructed and amplified by the economic, social and political system, and thus changes in these systems can greatly reduce vulnerabilities (Adger et al. 2005; Bull-Kamanga et al. 2003, 196; Hardoy / Mitlin / Satterthwaite 2004, 157). Therefore, much of the human cost of extreme weather events in urban areas *"comes not from the 'hazard' or the 'disaster-event' but from the inadequacies in provisions to protect urban populations (or particular sections of the population) from it"* (Satterthwaite et al. 2007, 9; see also Revi 2008, 211).

5 The outbreak of the Severe Acute Respiratory Syndrome (SARS) and its international spread, highlights the vulnerability of large urban agglomerations to newly emerging diseases, in a globalized world (CDC 2003; Krafft / Wolf / Aggarwall 2003).

Table 2: Characteristics of urban areas in Sub-Saharan Africa relevant for understanding vulnerability to climate change and extreme weather events
Concentration of population, infrastructure, wastes, industries as well as concentrated labour markets and income-earning opportunities for mostly non-agricultural activities
Official **land and housing markets** that **price out most or all low-income groups**. As a result large sections of the urban population depend on informal or illegal land and housing outside the official system of land-use controls and building standards that are meant to reduce risks
Related to the above, large sections of the population live in **informal settlements** facing **adverse living conditions** such as extreme population density (often single room households), lacking health and safety standards and without any regulatory framework to protect tenants
High-density housing and the concentration of solid and liquid wastes, often accompanied with absent or insufficient sewers, drains and waste-collection services. Measures to prevent or reduce disaster risks as well as disaster response are curtailed due to the density of housing and infrastructure
Large, **impermeable surfaces** and concentrations of buildings which **disrupt natural drainage** channels and accelerate runoff with absent provision of storm and surface drainage
Improvements of the living conditions in informal settlements through upgrading (e. g. water supply, sanitation, cementing of foot paths and lanes, etc.) generally **increases the land and housing prices** with the result of market-driven **displacement of lower income groups** and emergence of new informal settlements often situated more marginal (UN-Habitat 2007, 126)
Patterns of urban form and buildings that do not take current and future hazards into account, which generate increased scales and levels of risk from floods, landslides, fires and industrial accidents
Industrialization, inadequate planning and poor design generating secondary or "natech" risks, where **natural hazards trigger technological disasters**
Susceptibility to changes in the **region around cities** that cause or exacerbate risks (e. g. poor watershed management, often a particular problem for city governments as the **watershed** usually lies outside their jurisdiction)
City governments and urban economies unable to cope with **sudden movements of people** into a city in response to crises elsewhere (linked to extreme weather events nearby, or to conflict)
Source: based on Bull-Kamanga et al. (2003, 197); Moser (1998, 150); Satterthwaite et al. (2007, 12)

4.2 Climate change-related risks and vulnerabilities: differentials by location and certain segments of the population

There are great differences of urban vulnerability between countries, especially between the developed countries and those of the developing world. In a wealthy, well-managed city, disaster risks in relation to injuries and deaths are much reduced by considerable investment in housing and infrastructure, and economic and financial losses are much reduced by insurance. In contrast, large death tolls are much more common in poorly managed cities (Hardoy / Mitlin / Satterthwaite 2004, 159), where a lack of financial resources, rapid and uncontrolled urbanization, the weakness and incapacities of governments as well as historical and cultural aspects can be identified as major determinants of increased vulnerability independently of any natural or man-made hazard. Climate related disasters generally cause higher total monetary damage in industrialized areas, but higher total human damages in less-developed areas for developed countries, and monetary damage in developing countries may represent a larger share of their GDP. For instance, during 1985 and 1999 the world's wealthiest nations suffered 57.3 % of their measured economic losses due to disasters, which is about 2.5 % of their GDP. In contrast, the world's poorest countries suffered only 24.4 % of the economic toll of disasters, but this represented 13.4 % of their combined GDP (Wilbanks et al. 2007, 374).

Moreover – scaling down to the local level – exposure to climate-related risk is not equally distributed within a city. Rather, there are great differentials in city population by location (e. g. settlements in dangerous locations lacking a protective infrastructure) and income level (Satterthwaite et al. 2007, 45 ff.). It is generally the lower-income groups that bear most of the risks associated with climate variability and change in cities[6]. These groups generally bear the highest costs with respect to ill-health, injury or premature death as a result of environmental problems in cities.

Generally, households with low incomes are least able to afford accommodations that protect them from environmental hazards with respect to both, shape and location. Due to the often poor provision of public transport and in order to keep commuting costs (time and money) down, many people prefer to reside close to their workplaces, i.e. often near the city centres where formal housing is unaffordable. Moreover, there is an enormous lack of investment in housing and infrastructure as well as inadequate policies governing land and property administration and security of tenure (Tibaijuka 2004, 7). As a consequence low-income households often have to put up with informal or illegal housing status, poor quality, overcrowded settlements, insufficient access to water supply, inadequate provision of sanitation, waste collection and drains, and also with regard to the level of risk from natural disasters (Hardoy / Mitlin / Satterthwaite 2004, 149 f.). People may be aware of the existing health and disaster risks. However, investments in the environmental quality of a "minimum standard" accommodation may still be seen as less important for the survival than other investments (Hardoy / Mitlin / Satterthwaite 2004, 169).

Particularly in low- and middle-income nations, rapid urbanization often takes place in relatively high-risk areas (Wilbanks et al. 2007, 359). In Sub-Saharan Africa this trend is likely to continue, especially if poverty further increases in cities and as a result exacerbates the growth of slums. There is a wide gap between housing needs and the housing supply in most of the African countries. In Nigeria, for example, there is a backlog of 4 million needed new urban housing units compared to a formal housing supply of 10.000 actual new units per annum (Tibaijuka 2004, 7). There are no specific estimates regarding an *"urbanization of poverty"* in Africa, but other *"statistics indicate that the locus of absolute poverty is moving from rural to urban areas"* (Tibaijuka 2004, 9).

At the household and individual level, there are great individual differentials of vulnerability to multiple environmental hazards among urban dwellers, with children (including the unborn children of pregnant women), elderly people, and disabled and powerless persons ranking first. This is especially true for environmental health risks that are often significantly exacerbated by climate variability and change (cf. Confalonieri et al. 2007, 393). Additionally, there are those people who are socially or linguistically isolated, such as indigenous people or recent immigrants who are highly dependent on public support (Wilbanks et al. 2007, 374).

Age-related risk factors most of all include *"weak body defenses, susceptibility to particular chemicals and, for younger children in particular, inadequate or a completely lacking understanding of how to avoid hazards"* (Hardoy / Mitlin / Satterthwaite 2004,

6 This is not to say that vulnerability can be used as a synonym for poverty: *"It means not lack or want, but defenselessness, insecurity, and exposure to risk, shocks and stress"* (Chambers 1989, 1).

161). Hardoy et al. depict in detail how the urban environment in low-income countries in general, and low-income urban settlements in particular, poses significant risks of intestinal diseases, vector-borne diseases, and respiratory diseases, with young children among the highest risk group (2004; see also Confalonieri et al. 2007). With regard to disaster events such as flooding, those citizens with lowered ability to escape floodwaters and their consequences (such as children, the elderly, and the infirm) are also at higher risk of adverse effects (Confalonieri et al. 2007, 412; see also Bartlett 2008).

Moreover, women are generally more affected by environmental problems than men, resulting from the particular social and economic roles that women have to play. Generally women and children are responsible for procuring water and gathering firewood, and they are usually more affected by problems related to the overcrowded household conditions, the lack of an energy supply, and indoor air pollution in the context of their daily work. Moreover, women are often responsible for disposing of household wastes and even human excreta when there is no regular waste collection service as well as inadequate sanitation. Pregnancy and childbirth also contribute to the higher levels of environmental risk since the mother and the unborn child are particularly sensitive to adverse environmental conditions: *"the risk for a mother of dying during pregnancy or childbirth in a poor urban district can be 1000 times higher or more than for a mother from a wealthy household living in a healthy environment with good quality health services and antenatal and post-natal care"* (Hardoy / Mitlin / Satterthwaite 2004, 167).

4.3 Opportunities for urban areas and cities in the context of adaptation to climate change

There are important potential opportunities and advantages of urbanization that may not only positively affect the adaptive capacity of urban inhabitants in the long run, but also help to mitigate climate change[7].

As shown above, it is crucial to consider the environmental conditions in order to develop an understanding of vulnerability to climate change in cities, since this significantly influences not only the risk, exposure and susceptibility to hazards, but also the adaptive capacity on different levels, i.e. households, neighbourhoods, on the city level, and, in some cases, on regional levels. Human settlements and activities exist in the most extreme environments on earth. This shows that *"the capacity to adapt to known conditions, given economic and human resources and access to knowledge, is considerable"* (Wilbanks et al. 2007, 378).

However, especially cities in developing countries will face rapid future changes with respect to social-economic and political conditions as well as environmental changes, including the climate (cf. Johnston / Taylor / Watts 2005; Kraas / Nitschke 2006). These

7 In most nations, a high (and growing) proportion of greenhouse gas emissions is released within cities. However, many sources claim that cities are responsible for 75–80 per cent of global greenhouse gas emissions. Statistics drawn from the IPCC's Fourth Assessment show that this figure highly underestimates the contribution from agriculture and deforestation as well as from heavy industries, fossil-fuelled power stations, and high-consumption households that are not located in cities (Satterthwaite 2008b).

cumulative and often synergic dynamics are difficult to predict for adequate adaptation. New risks will emerge or risk levels of already existing hazards and stressors will rise or fall. Therefore, effective adaptation is more likely to those changes that emerge gradually. However, climate change is likely to exacerbate also risks from extreme weather events, which represent a major threat for those who are not prepared to it.

As already shown, there are many reasons why cities – and megacities in particular – are often perceived as major risk areas burdened by numerous disadvantages, with their high concentration of people, physical capital, industries, wastes, etc. But at the same time, this concentration also provides many potential opportunities, particularly through economies of scale and proximity, that should not be neglected. For instance, cities allow considerably lower per capita cost for measures that reduce risks from extreme weather events through e. g. efficient hazard prevention or adequate health care systems. It is also more feasible to respond rapidly and effectively when a disaster is imminent or happens. Moreover, there is generally a higher capacity among city dwellers to invest in such measures as compared to the rural population, provided there is enough awareness of the risk. (Kraas / Nitschke 2006; Moser 1998, 20 f.; Satterthwaite et al. 2007, 11; see also World Bank 2009). Table 3 provides an overview of the potential opportunities and advantages of urbanization.

Nevertheless, benefits from agglomeration can easily tip over to diseconomies of scale through e. g. infrastructure overload, environmental pollution and degradation, and/or rapidly rising land prices (El-Shakhs 1997, 504). Diseconomies of scale in cities, however, are often associated with the absence of effective governance. In most of the countries in Sub-Saharan Africa, cities and urban centres face radical spatial, social and political structural changes and in this context governmental structures are already highly stressed, with the consequence that many processes take place in an unregulated fashion and informally or illegally (e. g. informal housing, the informal economic sector, informal negotiation processes between various stakeholders) (Kraas 2007a). In this context, climate change as an added stressor could lead to a lower threshold of failure of the system of governance (medium confidence) (Wilbanks et al. 2007, 375; cf. Muller 2007, 108).

5 Adaptation in cities of Sub-Saharan Africa

As shown in the previous chapters, urban areas in Africa have a high and growing proportion of their population with high levels of vulnerability to environment and climate related impacts.

Many of these vulnerabilities are not necessarily climate-induced but can be related to other factors such as rapid population growth along coasts or in areas with limited water supplies. Hurricane Katrina has shown how climate-related vulnerability largely originates in unsustainable patterns of development combined with socioeconomic inequity. Moreover, Pielke et al. (2007) state that *"virtually every impact projected to result from increasing greenhouse-gas concentrations – from rising storm damage to declining biodiversity – already exists as a major concern"*. Thus, most projected impacts of

Table 3: Advantages and benefits derived through economies of scale, proximity, and agglomeration in cities and urban centres	
1. Infrastructure and services	– Higher efficiency and lower unit costs (provision of water, energy, electricity, communication and transport, waste collection, education, emergency services, and health systems) – Shorter transportation distances
2. Reducing risks from natural disasters	– Lower per capita cost of risk reduction measures (e. g. through better watershed management or drainage to reduce the scale of floods) – More effective disaster risk prevention (use of early warning systems, evacuation) – Greater capacity of city dwellers to help to pay for such measures
3. Efficient resource use, water reuse or recycling	– More efficient resource use and possible closure of material, water, and energy flows (through proximity of so many consumers) – Density offers greater scope for recycling or directly reusing of waste water – Cities allow the efficient use or storage of rainwater
4. Land	– Decreased land consumption (per capita, through high-rise construction, optimized land-use patterns, efficient land-use planning[8] – Sustainable urban agriculture and green space – Cities concentrate demand for fresh fruit, vegetables, fish and dairy products (potential for production in peri-urban areas with various benefits associated)
5. Reduced fossil fuel use	– Potential for limiting the use of motor vehicles (reduced greenhouse gas emissions and air pollution) – Reduced travel distances and greater use of public transport – Industrial concentration allows cheaper regulations on reducing GHG emissions and pollution control
6. Funding environmental management	– Concentration of households and enterprises allow easier collection of taxes as well as charges for public services and measures for adaptation to climate change impacts
7. Governance	– Better availability of information, better communication, better international connectivity – Dynamic environment for the development and strengthening of civil society institutions – Improved participation in political decision making and multi-stakeholder participation – Facilitation of community-municipal authority partnerships (co-production[9])
8. Greenhouse Gas (GHG) Emissions	– Better opportunities for cost-effective climate change mitigation measures – High potential for reduction of fossil fuel and motor vehicle use (see above)
Source: based on Hardoy / Mitlin / Satterthwaite (2004, 20 ff.); Kraas / Nitschke (2006, 22)	

8 Hardoy / Mitlin / Satterthwaite (2004) argue that the world's current urban population would fit into an area of 200.000 square kilometers (roughly the size of Senegal) at densities similar to those of high-class, much valued inner city residential areas as e. g. Chelsea in London.

9 For the concept of co-production see Ostrom (1996).

anthropogenic climate change are *"marginal increases on already huge losses"* (Pielke et al. 2007) and therefore, it is cumbersome to use a too-narrow definition for adaptation to climate change such as that provided e. g. by UNFCCC (see Chapter 4). This raises the question of how to separate these various factors and change processes that contribute to an increased risk of susceptibility to natural disasters in urban areas (such as rapid, unplanned urbanization, and/or excessive groundwater withdrawal) from those originating from anthropogenic climate change. For instance, non-climate factors are by far the most important drivers of increased risk to tropical disease such as malaria. One study found that the global population at risk from malaria would increase by 100 % by 2080, whereas the effect of climate change would increase the risk of malaria by at most 7 % (Goklany / King 2004).

This and other examples (see Pielke et al. 2007) point to the limitations of mitigation for reducing vulnerabilities in developing countries and Sub-Saharan Africa in particular. Pielke et al. (2007) conclude that policy-makers need to *"give more urgent consideration to broader adaptation policies – such as improved management of coastal zones and water resources – that will enhance societal resilience to future climate impacts regardless of their cause"*. Broader adaptation policies focusing on sustainable development and disaster mitigation are also more easily integrated into overall development policies and help to overcome the problem of uncertainties of the projected climate changes (see also Klein 2001). Moreover, addressing overall development goals under consideration of current and future climate impacts, is more likely to clear up worries that adaptation to climate change will draw resources from other priority areas. Against the background of rapidly growing cities that lack the most basic infrastructures it is otherwise difficult to see how action on climate change can be regarded as a priority area.

In this context, one might ask what the necessary and sufficient conditions for adaptation are and whether adaptation can ever be complete. Mohammed and Etkin (2003, 90) state that *"no country is so completely adapted to its climate as to reduce damage to zero"*. At the same time, in many developing countries' cities, the adaptive capacity may be minimal if there is evidence of repeated losses due to environment and climate-related disasters. Bicknell et al. (Bicknell / Dodman / Satterthwaite 2009) conclude in their recently published book on adaptation in cities with focus on developing countries that the first priority for adaptation should be to remedy deficits in infrastructure and services. This is especially true in the context of Sub-Saharan Africa, where at least half of the population lacks access to piped water, sewers, drains, health care or emergency services. They also highlight the fact that there are very large overlaps between good adaptation, poverty reduction and good city governance (Bicknell / Dodman / Satterthwaite 2009), thus supporting the approach of a broader and more integrated adaptation policy in cities.

It has been noted that adaptation to climate change and extreme weather events will bring considerable cumulative benefits, and that the sooner action is taken the lower the unit costs will be (Reid / Satterthwaite 2007). For most urban areas in Africa, it can be very cost-effective to implement adaptation measures early on because of the projected dynamic growth of the cities and urban centres that is still to come. This is especially true for the future provision of infrastructures with a long, economically feasible service life that can be adapted to future climatic conditions and variability. Moreover, current development processes that may irreversibly constrain future adaptation to impacts of

climate change can and should be redirected to sustainable paths of urban development (cf. Adger et al. 2007, 721).

Recent estimates of the costs of adaptation to climate change in low and middle-income countries range from US$ 10-40 billion (World Bank 2006) over US$ 50 billion (Oxfam International 2007) to US$ 86 billion (UNDP 2008) per annum. For cities, the costs of adaptation will account for a significant proportion of these estimates basically *"because of the expense required to adapt (or, in the case of many low- and middle-income countries, to build new and resilient) infrastructure and services for densely populated areas"* (Ayers 2009).

These costs are certainly high, but – especially in the case of developing countries' cities – adaptation measures will be integral to the process of achieving the social goals established in the Millennium Declaration (cf. Muller 2007, 111). Climate change is likely to compromise any progress of economic and social development and therefore, adaptation needs to be integrated into all sectors of the development process. For this purpose, however, local governments, communities, NGOs and CBOs, the private sector and households can and should act together to remove or lessen most of the existing environmental hazards. Government agencies, and especially local governments, are most important for "shaping the operating environment that influences the capacity for households and businesses to build adaptive capacity and undertake adaptive action" (Satterthwaite et al. 2007, 51). Also, community organizations and local NGOs often incur an important role in this respect when it comes to informal or illegal settlements where government agencies are usually reluctant to provide infrastructure and services (Satterthwaite et al. 2007, 51). This also has implications regarding the fact that both constraints on and opportunities for adaptation depend heavily on the local context, and it becomes clear that the adaptive capacity is uneven across and within societies (see also chapter 4).

As already discussed above, mitigation is not going to unfold quickly enough to avoid most impacts; so adaptation will be necessary. However, the IPCC AR4 states that *"climate change adaptation processes and actions face significant limitations, especially in vulnerable nations and communities"* (Adger et al. 2007, 720). Most efforts to adapt to the impacts of climate change will become increasingly ineffective if greenhouse gas emissions are not kept within safe limits. For this purpose a new post-Kyoto agreement with considerable reduction commitments is indispensable. Otherwise, adaptation can do little to protect natural resources and cities, urban centres and villages from the impacts of climate change. Clearly then, both mitigation as well as adaptation are needed and can even be regarded as complementary (Wilbanks / Sathaye 2007).

Another reason for limitations in adaptation is the fact that most city governments in Sub-Saharan Africa lack the competence and capacity to adapt, and that there are huge infrastructure backlogs (Reid / Satterthwaite 2007). Several studies show that the capacity to adapt can depend on a range of factors such as wealth, technology, education, information, skills, infrastructure, access to resources, and various psychological factors (Boko et al. 2007, 452; Brooks / Adger / Kelly 2005).

Certainly, adaptation requires knowledge and the capacity to understand existing vulnerabilities and possible future changes. Knowledge and information are essential for

any adaptation strategy, be it on the local, municipal, regional or national level. Therefore it is necessary to find ways to assess current and future risks as well as vulnerabilities and also to disseminate this knowledge to various actors on multiple levels.

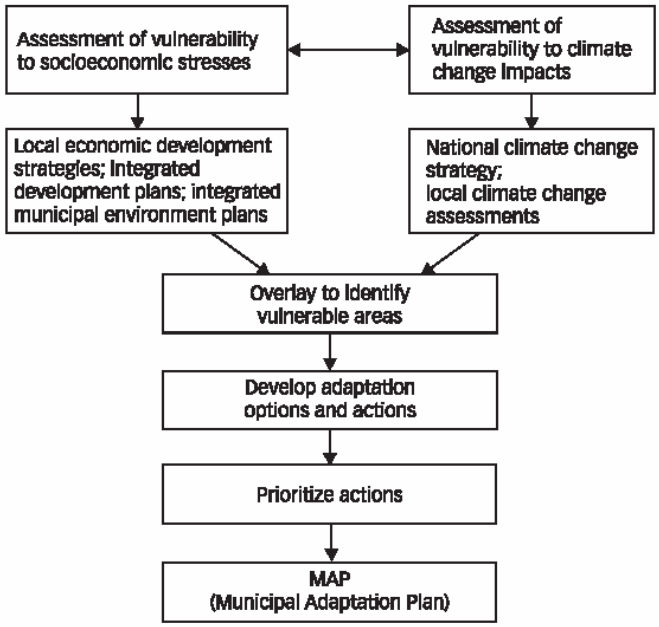
In the following, this paper outlines important steps and strategies for adaptation across scales, starting at the municipal level. Important aspects of sustainable adaptation strategies additionally include adjusted and integrated urban planning, integrated water resource management, as well as early warning systems and disaster risk management. These aspects have to be embedded in a national strategy of institutional development for climate change adaptation and good governance both on the municipal (good urban governance) as well as the national scale.

5.1 Assessment of risks and community based adaptation

The assessment of current and future risks and vulnerabilities at the local level is necessary in order to prioritize the most urgent local adaptation activities and identify the required local human and financial resources. This should be undertaken under consideration of the complexity of urban risks across all sectors and by considering spatial and social aspects of vulnerability, since different locations and certain segments of populated areas are likely to show different degrees of vulnerability.

The following steps are based on ideas from Mukheibir and Ziervogel, who presented an overarching framework for adaptation planning for the city of Cape Town (2007). As a starting point, current climate trends and future projections for the geographical region are

Figure 4: The process for developing a Municipal Adaptation Plan (MAP)



Source: Mukheibir / Ziervogel (2007, 146)

to be assessed in combination with an appraisal of vulnerabilities to existing hazards and future climate change impacts. This first step can already be seen as a challenge since most of the cities will not have collected and analyzed such information before and would have to develop this assessment from scratch. An important tool for capturing and processing such information are Geo-Information Systems (GIS), which make it possible to include risk mapping, including areas with substandard or lacking infrastructure and those areas affected by sea-level rise and flooding. In a second step, development plans are reviewed and strategic priorities investigated. All information collected in this process can be integrated into the GIS for future spatial interrogation and other participatory and quantitative assessments for further analysis. With the help of these various overlays, certain hotspots can then be identified upon which adaptation activities should be focused. The assessment and integration of all relevant information facilitates the development of a comprehensive Municipal Adaptation Plan (MAP) (Mukheibir / Ziervogel 2007, 146). Figure 4 shows some of the major steps that are necessary to build such a comprehensive plan for adaptation.

On the one hand, risks and vulnerabilities for all aspects of climate change are shaped by local contexts. Effective adaptation therefore needs strong local knowledge and strong local adaptive capacity and can be best assumed as a bottom-up process (Satterthwaite et al. 2007, 74). On the other hand, it becomes clear that adaptation demands a certain degree of competence, capacity and willingness from city governments to act, especially when it comes to the issue of inclusive planning that considers the most vulnerable groups in informal or illegal settlements. This is rather difficult to see without support from higher levels of government and international support (Satterthwaite et al. 2007, 75). Therefore national governments need to ensure that local administrations have the required knowledge and information, funding and expertise to draw on for developing and implementing effective adaptation measures.

One example can be given with regard to the density of weather stations in Africa, which is eight times lower than the minimum level recommended by the World Meteorological Organization. Other constraints lie not only in monitoring the climate and forecasting changes, but also in the lack of systematic data records of disaster events, including small disasters and hazardous events stemming from everyday risks (Satterthwaite et al. 2007, 68). These may affect only a few people at a time, but cumulatively kill or injure more people than large disasters do. Bull-Kamanga et al. point out the need for “good empirical data on the scale, nature and impacts of disasters (including small disasters) in particular cities or smaller urban centres” (Bull-Kamanga et al. 2003, 201 f.). Such data are necessary for identifying and understanding the risks at district, city and city-region levels and providing layered information from the community up to the global level (Bull-Kamanga et al. 2003, 201 f.). Moreover, assessing the risks from climate change impacts and vulnerabilities also helps to make better linkages between environmental considerations and urban health and health equity (Campbell-Lendrum / Corvalán 2007, 114).

Certainly, contextual knowledge and information is a prerequisite for any adaptation strategy. However, how can such an integrative approach of comprehensive risk assessment and adaptation planning be implemented in cities of Sub-Saharan Africa, where limited financial resources, bad governance, and lack of communication between

and among scientists, politicians, planners, emergency services and the public represent major constraints? This question will be answered in the following sections.

Adaptation as a bottom-up process implies enhancing the adaptive capacity of local communities by responding to environmental and climate-related risks. Community-Based Adaptation (CBA) is an innovative approach that recognizes the contribution of local capacity for adaptation. It has strong links to other more established development activities that have track records, such as community-based development and disaster planning – with the difference that it includes changing climate risks in the assessment process (Jones / Rahman 2007). Thus, it can be viewed "simply as an additional (though fairly new) layer of community-based development activities, practices, research and policies" (Braga 2001). CBA is a very recent approach, but a number of early lessons have already been learned from a few CBA activities done around the world so far. It offers a set of tools that seem promising also for the urban context, although only a few case studies are available which focus on urban areas. Positive experience exists from a study that is based on Participatory Vulnerability Analysis (PVA). With a focus on flooding, it was conducted with slum dwellers in six African cities that are most likely to be hit hard by the impacts from climate change: Nairobi (Kenya), Kampala (Uganda), West Africa Lagos (Nigeria), Accra (Ghana), Freetown (Sierra Leone) and Southern Africa Maputo (Mozambique). It highlights the importance of involving the affected local communities in cases where problems are essentially internal to a specific community, because then that community should also manage them (Actionaid 2007, 16). Some of the case studies illustrate the readiness of local governments to act provided they have the necessary information and resources. They show that informed action at the local level is possible if local initiatives to reduce vulnerability and increase community participation are facilitated by training, capacity building and resource transfers. The authors state that the required outside support could be sustained through a "network of organizations engaged in economic, social, political and scientific action and inter-organizational learning" (Actionaid 2007, 19).

Jones / Rahman (2007) have summarized the main experiences gathered with CBA based on conclusions drawn at a recent CBA workshop in Dhaka. CBA works at a community level and it can be applied in any community[10]. It is an approach that seeks to strengthen the communities' ability to make their own choices and to increase the range of possible choices in the future. The authors state that it is important to embed adaptation in a wider developmental framework and that CBA strategies should be seen as a complement to the methods and tools from the development and disaster risk research community. Therefore, they suggest that climate adaptation should be incorporated into the activities of disaster risk reduction and community development and that it is useful to translate the differing technical languages of the climate adaptation, development and disaster communities for purposes of mutual understanding (Jones / Rahman 2007, 18).

10 The community should not be understood as a single, close-knit, homogeneous group, often implicitly assumed in the term 'community'. There are certainly difficulties with the term, but in this context it can be simply defined as a group of people that are directly linked to each other through a common identity, activity or interest with links to the climate (Jones / Rahman 2007, 18).

Box 2: Early warning systems

Early warning systems are a critical tool for adaptation to various impacts of climate change. They can be efficiently used to alert the population and relevant authorities, not only as in the case of hot periods and heat waves, but also in case of infectious disease outbreaks such as malaria and meningitis (Cuevas et al. 2007; Thomson / Connor 2001). Early warning systems however, must be coupled with specific intervention plans and should be evaluated in their functioning in order to be effective in the case of any targeted impact that is to occur (Confalonieri et al. 2007, 416). Moreover, early warning should be combined with measures for increasing disaster preparedness at the community level, including trainings on evacuation procedures (and the identification of safe places for those evacuated).

CBA can also play a role in the development of early warning systems, that currently often lack effectiveness in reaching marginal population groups which often face the highest risks (Satterthwaite et al. 2007, 66) (see Box 2).

Jones / Rahman (2007) also describe a road map for fitting CBA assessments into broader development processes. This separates CBA projects into three stages: In the first stage climate-related vulnerability is addressed by adapting to current climate risks within a development context. These risks are often linked to other human activities, and therefore this stage has a good deal in common with other disaster risk reduction or development projects. Stage two can be seen as a reflexive phase where adaptation may continue but ongoing changes are monitored and adaptation progress can be quantified. The third stage investigates how risks may change and how such risks can be managed over time. Moreover, development options under climate change are assessed to give local communities a greater choice in their future. It is therefore necessary that communities learn to understand alternative path-ways. The introduced CBA road map presents communities with an opportunity to find innovative locally adjusted approaches that may lead to sustainable outcomes. However, in actual practice there may be critical political, financial, and social barriers that hamper the process of community-based adaptation (Jones / Rahman 2007). In a briefing paper about the CBA approach Reid and Huq (2007) draw on major practical experiences and lessons learned from the field. These include gaining the trust of the community, communicating the concept of climate change, identifying the appropriate adaptation measures, taking into consideration the relevance of the project with respect to climate change, facilitating learning through practice, and promoting experience and knowledge sharing (see Box 3).

In summary, CBA is a relatively new approach, especially in the urban context, but it can draw from the experience gathered in participatory methodologies (see e. g. Garrett / Downen 2002 on Rapid Urban Appraisal), and it is likely that this approach will gain popularity in future. CBA could also be an answer for overcoming many of the existing constraints to adaptation in urban areas of the developing world, because it works with limited financial resources, offers a bottom-up approach, and facilitates communication between government bodies, NGOs, CBOs and the public.

5.2 Adjusted urban water resource management

Water is growing in importance for more and more countries in their struggle for economic and social development and is one of the most critical aspects for climate

Box 3: Lessons learned from the field about the CBA approach
First, it is a critical step to gain the trust of vulnerable communities. This usually means spending a long time with the community; but if trusted local intermediaries (e. g. local Non-Governmental Organizations (NGOs), CBOs or government bodies) are available, they can be helpful in facilitating dialogue with the communities themselves.
Second, it is challenging to communicate the concept of climate change to vulnerable communities. It is necessary to use a community's own language and terms that are understood. This means not only translating scientific texts into local language, but also giving up on the written word altogether and using traditional means and other creative means of communication such as drama, video, multi-media, art, storytelling etc.
Third, identifying the appropriate adaptation measures requires initial learning about the community's indigenous capacities, knowledge and practices for coping with climate hazards in the past. Only this can be the basis for developing new practices and technologies for the future.
Fourth, it should be noted that differentiating a CBA project from any standard development project requires a deeper look into the input given to the intervention. For instance – a project that promotes rain-water harvesting in drought conditions might not look like a stand-alone response to climate change. The important difference should be the knowledge and understanding gained about climate change risks that communities obtain through the process of CBA. It should be noted, however, that the few existing CBA projects are so new that they have hardly been tested for resilience to climate variability let alone to climate change.
Fifth, one important feature of the lessons from CBA so far is that learning itself requires practice. It is not possible to learn the theory of CBA in a university or training workshop and then apply it in the field – the learning comes from the practice itself. Adaptation is a classic case of learning-by-doing or 'action-research'.
Sixth, the theory and practice of CBA are in their infancy but both are likely to grow very rapidly. It is important now to allow as many pilot activities to be carried out as possible and to share the experience and knowledge gained from them. This is a major challenge of networking in real time between practitioners, policymakers, researchers and funders – and the communities at risk.
Source: Reid / Huq 2007

change adaptation, especially in Sub-Saharan Africa. Economic and population growth as well as changing consumption patterns, particularly in cities, increase water demands in various sectors (food production, industry, agriculture, direct consumption) and lead to ever-growing levels of water pollution and environmental degradation.

As shown in Chapter 4.2, climate changes will significantly add to the scarcity of water in many African countries and exacerbate competition over this scarce resource. It has been stated that *"if our global energy habits are the focus for mitigation, the way we use and manage our water must become the focus for adaptation"* (GWP / TAC 2007, 1). Such problems increasingly require institutional arrangements that facilitate equitable allocation and conflict resolution and recognize the complex interdependency between human and environmental systems.

Integrated Water Resource Management (IWRM) is a framework that assists countries in tackling the problems related to water scarcity in a cost-effective and sustainable way. It is defined as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP / TAC 2000, 22). Taking IWRM as a starting point, it is the catchment

or watershed that represents the basic hydrological unit of analysis and management. Water has to be understood as a finite and vulnerable resource, and cities usually have a significant impact on the availability and quality of water in a catchment. Therefore, Integrated Urban Water Management (IUWM) as a vital component of IWRM can make important contributions in the broader basin context. As a matter of fact, IUWM must also optimize the interlinkages between urban water concerns and relevant activities beyond the urban boundaries, such as rural water supply, down-stream use, and agriculture (Reed 2006).

IWRM and IUWM suggest a combination of "hard" infrastructural, and "soft" institutional measures that need to holistically include aspects of environmental sustainability, economic efficiency, and social equity into the different water management objectives. One of the major constraints is the lack of local capacity to make the right choices with regard to the technology to be used and the institutional forms for building and managing it. For instance, Muller (2007, 105 f.) draws on the example of Johannesburg, South Africa, where the city and national government have to make decisions about the sources from which water is to be taken in the long-term future. All of the available options are very expensive and prone to conflict. Factors that will affect the decision include, among others, differences in operating costs and political considerations. However, any calculation may be meaningless if the hydrological forecasts on which they are based are not reliable or comparable. The example illustrates why many practitioners argue that it is not yet possible for water managers, in low-income countries in particular, to take climate change into account in their designs.

Moreover, in most of the cities in Sub-Saharan Africa, negative impacts of climate variability and change will exacerbate and add to the very large deficiencies that already exist in urban water provision and waste water management. Here, it is much less water scarcity that creates the inadequacies in the provision of urban water supply; rather it is a result of poor management (Satterthwaite et al. 2007, 85). New innovative strategies have to be found that take local conditions into consideration and also take into account all stakeholders' needs. To extend the piped supply to those presently without such service and to improve existing supplies, informal options, including the informal private sector (water vendors, kiosks and small-scale piped suppliers) and partnerships between government agencies, private enterprises, CBOs and local NGOs have to be considered where conventional methods do not work. Moreover, available "hard" infrastructural measures for water management should be flexibly adjusted to the local context. Hard measures can include traditional systems such as household water cisterns or the water tank (typical in many Indian towns) for the management of water resource variability; as well as river "training", flood wall structures, and flood diversion canals to protect houses and settlements from inundation and floods.

Among the most important large scale measures are dams that capture and control river flows to store peak flood flows and retain water for periods of scarcity. Therefore, dams are important for managing the impact of climate variability on water resources inasmuch as they avert the disasters caused by floods and droughts. Moreover, dams are important sources of hydroelectric energy with a large future potential for the developing world (GWP / TAC 2007, 6). Furthermore, canals, tunnels and pipelines provide important possibilities of linked supply systems with multiple sources that help to reduce variability and enhance supply security with large economies of scale. In addition, sufficient

wastewater disposal and storm water drainage systems are vital facilities for protecting settlements from extreme weather events. Other technologies such as wastewater recycling or the desalination of brackish water augur well for tackling future water-related problems, but these measures are still very costly.

All the large-scale measures mentioned above have in common that their useful life span is often "*measured in hundreds of years, investments that are made today will still be operating under the new climates of the 22nd century and need to be designed for the future as well as for the present*" (GWP / TAC 2007, 6). Another important message is "that there are no simple technical fixes" (ibid.) and that the "soft", institutional management systems are equally important, if not more so, for tackling the impacts of climate change and variability on water resources.

IWRM offers a set of soft tools that are often cheaper and should be seen as a critically important complement to any infrastructural measures. For instance, appropriate land use management can substantially reduce the vulnerability of communities to water-based natural disasters through planning that restricts settlements in risky areas. Thus resilience after flooding can be achieved by protective infrastructure as well as through land use planning or the combination of both (GWP / TAC 2007).

Moreover, IWRM approaches often emphasize the importance of managing water demands through the promotion of a culture of conservation as an alternative to increasing supplies (cf. GWP / TAC 2007). However, with respect to most cities in low- and middle-income nations there is a great need to expand the supply, especially for those areas that offer no access to water and sanitation such as many slum settlements. For Sub-Saharan Africa, of the 295 million urban residents, 254 million are reported to already have "improved" water supplies, although these services are often not functioning effectively. Here it is assumed that a manageable 15 per cent increase in the amount of water supplied would be required to reach 100 per cent. However, it is projected that urban growth will significantly increase the required water volumes by as much as 60 per cent between 2000 and 2015 (Muller 2007, 103).

Surely, demand management is an important answer to the expected urban growth and it should be applied especially in periods of supply stress. Here it is useful to find institutional mechanisms that are able to manage variability by prioritizing different water uses at times of water stress. However, any incentives and regulations that aim to reduce demand and to achieve more efficient domestic water use have to be carefully managed with regard to possible social impacts (GWP / TAC 2007, 7). For instance, the design of cities with denser housing rather than larger gardens may be effective in reducing water use, but it might challenge domestic food security that often depends on urban and peri-urban agriculture, especially in Africa (Muller 2007, 103). The example also shows that it is essential to involve all stakeholders, not only those who directly engage in water supply, sanitation services, and storm water management, but also those who are responsible indirectly, such as stakeholders in solid waste management, and also all regulating authorities, householders, industrialists, labour unions, environmentalists, downstream users, and recreation groups. Hereby it is useful to adopt a combination of top-down regulatory responsibility and concomitantly involve local stakeholders and user groups from the bottom up.

In conclusion, water resource management cannot be based on a single-factor analysis. Rather, an integrated, holistic approach in planning and implementation is required in order to facilitate ecologically sustainable, equitable and integrated policies and projects. Showers states that *"urban planners and government officials must appreciate that the boundaries drawn on a map have little relationship to an urban area's true boundaries, which are defined more correctly by water extraction and disposal"* (2002, 645). This has direct implications for IUWRM because any decision about urban water and sanitation *"must encompass their bioregional consequences, with analysis extended in space and time to include urban–landscape interactions"* (Showers 2002, 645).

5.3 Adjusted and integrated urban planning

Satterthwaite (2008a) highlights four critical aspects of adaptation to the impacts of climate change: long term protection, pre-disaster damage limitation, immediate post-disaster response, and rebuilding. Therefore, an integration of adaptation measures into urban planning is of significant importance. It is challenging for larger and well-established cities to adjust existing buildings, infrastructure and land-use patterns to the new or heightened risks of climate change and growing variability. However, long-term policies and planning can spread necessary costs over longer time periods and can make use of possible synergies between the reduction of climate change risks and other environmental risks that are typical for urban areas in the developing world. In addition, as most of the urban growth for Africa is expected to come in the next few decades there is a window of opportunity for channelling the projected new urban growth into more sustainable pathways and away from high risk sites. Therefore, climate change risks and international concern for mainstreaming adaptation into development could also trigger enhanced planning of urban development in the future (Satterthwaite et al. 2007).

One of the most challenging issues with respect to adaptation to climate change in Africa's urban areas is to meet the needs of lower-income groups. Improvements in building and infrastructure standards as well as land-use restrictions as e. g. in flood-prone areas may increase land and housing prices and limit the availability of cheaper accommodation for the urban poor. In addition, urban governments often have an antagonistic relationship to most low-income groups not only due to the often informal or illegal character of the settlements in which high proportions of the urban poor live. Often, a vision of a 'modern' city landscape conflicts with the requirements of an inclusive city in a developing countries' context. Moreover, many urban regulation standards in Sub-Saharan Africa are relics from colonial rule and were originally instituted for those areas of the colonial city that were inhabited by "non-natives". Today they still function to serve the interests of those who in power (Satterthwaite et al. 2007). Du Plessis shows how such rules are used to evict and dispossess poorer groups to "serve the public good" or to make a city "more efficient" (Du Plessis 2005, 126) thus increasing their vulnerability. This is also supported by Satterthwaite et al. who argue that:

> *"For any growing city, what is worse than expanding 'squatter settlements' is government authorities preventing squatter settlements – which will mean poor families doubling and tripling up within the existing housing stock. (…) Official urban policies so often increase poor people's vulnerability to environmental hazards and climate shocks, rather than reducing them – and so they are best conceived as maladaptation"* (Satterthwaite et al. 2007, 4 f.).

However, urban sprawl and the rise of informal settlements in high-risk areas such as flood plains need even more attention due to the risks of climate change impacts. There are certain tools available for limiting the processes of unplanned urban growth.

One such strategy lies in the promotion of mixed land use, i.e. the mix of residential, employment, leisure, health care and education within one locality, combined with measures to ensure land availability for low-income households so that these groups are not forced to build their homes within high-risk areas. A key issue here is to prevent the displacement of all poor groups from areas that are newly developed or undergoing redevelopment, such as inner city areas or new towns. To ensure better and more secure housing conditions also for the poor, a more supportive public framework is needed to increase the supply and reduce the cost for housing. Given the right scale of such a pro-poor housing agenda, this has also downward effect on land prices (Hardoy / Mitlin / Satterthwaite 2004, 170).

Mixed land use also makes it possible to preserve a city's cultural heritage and to provide sufficient space for trees, greenery, and other open spaces as e. g. for urban agriculture. Trees within urban areas have important environmental benefits as noise-barriers, windbreaks and due to their capacity to mitigate heat-island effects in cities. The same is true for green spaces that can also serve for recreation, facilitate water infiltration and reduce surface runoff (Hardoy / Mitlin / Satterthwaite 2004, 290; Haughton 1999, 53).

Attention should also be put on a more integrative type of transport planning that reduces the demand for motorized transport and particularly considers the importance of pedestrians and cyclists. The role of non-motorized transport gains particular weight within mixed use communities where low-density sprawl is prevented and distances are reduced to a minimum (Hardoy / Mitlin / Satterthwaite 2004, 290).

The special case of coastal cities

As outlined in Chapter 4.5, urban populations residing in coastal areas face a particular risk from climate change and sea-level rise. Often, only parts of the city area are located within the LECZ, and the risks of many human settlements could be reduced if people and enterprises could be encouraged to move away from the most risk-prone coastal locations, which would also reduce the pressures that human settlements place on coastal ecosystems. However, in most cases much of the further urban growth is likely to take place within the coastal zone, and the driving forces are still poorly understood. It will be a great challenge to at least turn around these flows, and doing so is likely to be slow and/or costly. Moreover, the experience after the Indian Ocean tsunami in 2004 has illustrated how difficult it is to institute more restrictive coastal settlement policies without undermining the lives and livelihoods of the most vulnerable residents (McGranahan / Balk / Anderson 2007, 20). Again, it becomes clear that strategies for adaptation to the risks of climate change have to be inclusive considering the multiple and differing interests of all involved actors. Therefore, a decentralized decision-making process has to be facilitated to allow an equitable urban development that takes the necessity for adaptation into account. The most striking problem here is related to the inequitable allocation of land to the urban poor, who are thus often forced to settle informally on unserviced and environmentally hazardous land such as flood plains.

McGranahan / Balk / Anderson (2007, 35) state that *"measures that support more efficient and equitable resolution of existing land issues are likely to provide a better basis for addressing the land issues brought on by climate change"*. They conclude their study by noting the importance of "the three Ms": mitigation, migration and modification, all of which have a long lead-time. Since it is too late to rely solely on a reduction in greenhouse gas emissions to mitigate climate change, which remains a clear imperative, migration away from the zone at risk will be necessary but costly and hard to implement, so that coastal settlements will also need to be modified to protect their residents (McGranahan / Balk / Anderson 2007, 17).

Some scholars argue that urban planning and regulation for better safety and increased sustainability in cities can only take place once the problems of poor infrastructure, housing, health and communications are resolved. This bleak view, however, offers few perspectives, given the unlikelihood of sufficient economic development amongst the urban areas of Sub-Saharan Africa (Pelling 2003, 37). Indeed, most of the current approaches in urban development and planning are rather rigid and technically oriented (cf. Zérah 2005, 129) and are often not able to recognize the demands and requirements of the urban population (cf. Kraas / Nitschke 2006, 28). Therefore, new approaches of urban governance are required to better integrate the various actors and to extend the degree of civil society participation (Kraas / Nitschke 2006, 28).

5.4 Institution development and good urban governance

Development policy has traditionally focused on the role of the state to regulate the market and the civil society. This narrow perspective has changed in the 1990s towards a rather integrative approach that considers a wide variety of institutions and actors as important components that are *"working together on a formal and informal basis to produce policy outcomes"* (Hubbard et al. 2002, 175). With this perceptional change the concept of governance as a synonym for government has been superseded, and the scope was extended *"beyond the formal institutional structures of authority and decision-making associated with government"* (Hubbard et al. 2002, 175). It can be defined as *"the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences"* (UNDP 1997, 2).

Especially in the large cities of the developing countries, which are characterized by processes of functional re-organization and fragmentation and an increasing loss of governability, it is necessary to find new strategies of a more integrative urban administration (Coy / Kraas 2003, 39 ff.). Therefore, the concept of (good) urban governance was developed to explicitly cover the processes of governance in urban administration and planning. (Good) urban governance is the *"sum of the many ways individuals and institutions – public and private – plan and manage the common affairs of the city. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action can be taken. It includes formal institutions as well as informal arrangements and the social capital of citizens"* (UN-Habitat cited in Hust / Mann 2005, 8). This rather normative definition aims at a more efficient and more

integrative government administration that is accountable to its clients and provides legal security to all its citizens (cf. Nuscheler 2005, 625).

Cities in high-income nations have infrastructures and services that protect the majority of city population from environmental hazards or crisis and help them cope in the case of illness or injury through health care and emergency services. They can draw on a range of local organizations; often have insurance for homes and possessions; buildings and the infrastructure have been constructed and maintained according to much higher standards; and powers and resources available to city and municipal governments are also much larger as compared to those of cities in developing countries. Another important aspect is the accountability of local and national governments that are supervised by elected politicians and the civil society (Satterthwaite et al. 2007, 54).

Most of these aspects not only serve the everyday needs of city inhabitants but are also fundamental elements of adaptive capacity. The character of socially and politically well-functioning cities outlined above, which is already a reality in most of the high-income countries, displays the ideal and normative character of the concept of good urban governance. The long history of colonial rule in Africa has strongly worked against successful local governance. Governments' ability to enforce rules and regulations is too often insufficient, plans are not respected, projects are frequently abandoned or radically changed, and often the state itself does not function democratically but rather with favouritism, nepotism, biased allocation of resources, distorted priorities, and stifling of local initiative and innovation. Moreover, exogenous factors such as oil price fluctuations, fluctuations in the world economy and structural adjustment policies have contributed to the severity of urban problems (El-Shakhs 1997, 506; Satterthwaite 2008a, 12).

It has been shown in the previous chapters that the problems confronting urban areas in Africa are huge, complex and therefore difficult to address due to the lack of financial and human capacities. However, Muller argues that without action to make cities more resilient to the impacts of climate change, the costs of climate change-related disasters will almost certainly be greater than the costs of prevention through appropriate adaptation measures. *"At the extreme, if disasters place unsustainable financial burdens on urban societies, this could lead to the collapse of public services, and climate change will have created 'failed cities'"*[11] (2007, 108).

However difficult it is to specify the necessary types of adaptation intervention due to the varying local contexts, it is indispensable to integrate the full range of urban government divisions and departments across different levels into the adaptation process. As shown above, resilient systems incorporate diverse mechanisms for living with, and learning from, change and unexpected shocks. This requires multilevel integration of all actors across sectors and institutions *"to enhance the capacity to cope with uncertainty and surprise by mobilizing diverse sources of resilience"* (Adger et al. 2005, 1036). Moreover,

11 There are several examples of how city governments have simply collapsed or retrenched on their responsibilities. Here it is interesting to note that cities sustain themselves even in the absence of government. Piermay shows how the state apparatus and the city's managerial structures have completely broken down in Kinshasa after the major political crisis in 1991. It is interesting here, how a city of by that time almost four million people could sustain itself and its residents without any formal administration (1997)

cooperation and exchange of knowledge and experience between various institutions (such as CBOs, NGOs, and the private sector) and levels (communities, municipalities[12], national government, and International cooperation) are essential to keep monetary and transaction costs at a minimum.

Here, it is also useful to look at experience and knowledge gained from the field of research into urban disaster mitigation. Pelling suggests searching for solutions and answers outside of those institutions that are currently seen as being the main players and instead looking in more detail at actors from the civil society and private sector (2003, 37). It has been stated elsewhere already that the processes of vast urban growth and expansion, informal construction activities through various actors, the increasing informality of control and the *"future of informal and semi-formal housing production in the context of socio-spatial fragmentation"* demand new approaches in planning and governance (Kraas 2007b, 21). Therefore it is critical to also incorporate informal and non-state actors into the planning process and rather shift towards the broader context of community planning without neglecting financial and technical support from the public sector (Pelling / High 2005, 38).

Satterthwaite (2008a) also states that successful adaptation through local governments requires an understanding of how adaptation measures can be integrated into the general administrative and planning process. Many of the measures represent quite minor

Table 4: Different local contexts through which national governments and international agencies can pursue "good governance" for adaptation

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

Source: Satterthwaite et al. (2007, 55)

12 Many larger cities are formed by more than one municipality with serious constraints on inter-municipal cooperation (for instance because they are governed by different political parties) and with great variation in the extent of functions managed at a higher (metropolitan or provincial) level (Satterthwaite 2008a, 15).

adjustments in current practices (e. g. adjustments of building codes, land-use management, and infrastructure standards), but even such minor changes in sum build greater resilience without high costs (Satterthwaite 2008a, 15).

Finally, there is a great variation of competence and capacities among different local and national governments. Table 4 illustrates this and shows how local governments influence what is possible and how local adaptation processes should be supported by external agencies (see also chapter 6).

6 New challenges for development policy

6.1 Mainstreaming adaptation to climate change into urban development planning

Most of the cities in Africa are among those that face the greatest risks from climate change, due to their lack of a protective infrastructure, the lack of funds to take needed action, and the presence of bad governance. This complex situation clearly deserves and requires international support not only due to the fact that climate change is closely associated with the past and present lifestyles of high-income groups in high-income nations. It has been stated already in the previous chapters that adaptation is less costly and more successful when total greenhouse gas emissions are kept within safe limits through an effective international Post-Kyoto emission reduction strategy. Therefore it is crucial that the governments of the developed world contribute to adaptation as well as mitigation. Furthermore, it is critical that the climate change adaptation policy agenda will not be paralleled or be in competition for resources with ongoing and traditional development and poverty alleviation programs. Rather, responses to climate change should be implemented and mainstreamed within the overall development process.

Agrawala (2005) describes the significant challenges and barriers that have to be overcome for a successful mainstreaming of adaptation (see also Agrawala 2004; Huq et al. 2003; Klein 2006). *First*, there are certain structural barriers within governments and donor agencies that are likely to impede adaptation mainstreaming. For instance, many development projects are often funded over shorter time periods, while climate risk reduction measures require long time horizons. It is also challenging to integrate several competing cross-sectoral agendas such as adaptation, gender, and governance into the core development activities. Moreover, there is no equally shared understanding of climate change within governments and donor agencies, rather it is segmented. *Second*, there is still a great lack of available information on climate change that is relevant for development-related decisions and not all relevant information can be projected. For instance, climate extremes, which are often critical for many development-related decisions, are much more difficult to project than mean trends. Moreover, downscaling of climate change projections is still a problem due to the lack of data. *Third*, there are possible trade-offs between climate and development objectives through e. g. the complication of operating procedures with additional requirements or considerations, or the raising of costs. Moreover, short-term economic benefits crowd out longer-term considerations such as climate change (Agrawala 2005).

To tackle these implementation problems it is crucial to build up, support and strengthen the systems and structures that encourage and support locally driven adaptation. Satterthwaite et al. state that *"unless adaptation is seen by national and city governments to be complementary to development agendas, it will not get considered"* (2007, 73).

One important instrument that facilitates implementation and mainstreaming of adaptation is represented by the National Adaptation Programs of Action (NAPAs) that specifically target the Least Developed Countries (LDC) under the United Nations Framework Convention on Climate Change (UNFCCC). The NAPAs provide an important way to prioritize urgent adaptation needs for LDCs. They draw on existing information and community-level input to identify adaptation projects required now in order to enable these countries to cope with the immediate impacts of climate change. As of October 2008, 29 of the 33 LDCs in Sub-Saharan Africa had submitted their NAPA to the UN Framework Convention on Climate Change (UNFCCC)[13].

However, there is an inherent bias in the NAPA process towards less emphasis on the urban poor than on the rural poor, and there is a lack of community-based adaptation plans, reflecting the fact that most LDCs do not have ministries with a focus on urban issues. Moreover, NAPA guidelines promote urgent action rather than strategic development planning, with the result that many NAPA projects are rather sectoral in focus. This neglects the importance of *"structural and institutional reforms required to mainstream climate change into national policy and planning and also support the needed adaptation capacity within local governments"* (Satterthwaite et al. 2007, 73). Especially for cities, there is a great need of strengthening local capacities for planning and acting, because risks and vulnerabilities for all aspects of climate change are shaped by local contexts.

For these reasons, Satterthwaite et al. suggest (2007, 74) that NAPAs be downscaled to city and local levels through the promotion of City Adaptation Programs of Action (CAPAs) and smaller scale Local Adaptation Programs of Action (LAPAs) – especially for the settlements and areas most at risk. Such a bottom-up approach may facilitate participation on a local scale and enhance the process of locally adjusted adaptation. It has been stated that locally driven adaptive measures are most likely to succeed inasmuch as they respond to existing local needs, and contribute to other development goals (McGranahan / Balk / Anderson 2007, 35 f.).

Especially with respect to disaster risk management, adaptation in cities requires locally adjusted planning both to reduce risk and to have in place appropriate responses when disasters occur. Therefore, an institutional and organizational framework is needed that provides the basis for integrating adaptation to climate change into urban planning (Satterthwaite et al. 2007, 65). A more decentralized institutionalization of adaptation programs can also facilitate the process of learning and innovation regarding how public policies and investments can work best with community-based adaptation. This can

13 NAPAs have been submitted by Benin, Burkina Faso, Burundi, Cape Verde, the Central African Republic, Comoros, Democratic Republic of Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Sudan, Tanzania, Uganda, and Zambia.

provide a broad basis for improved practical experience on the basis of which NAPAs can be much improved (Satterthwaite et al. 2007, 74).

6.2 Beyond the rural-urban divide: a new paradigm for regional development

Urban areas have long been neglected in the German and international development communities. Although more than half of the world's population lives in cities, German development policy has not set an urban focus until today, and there is no overarching concept for tackling urban development problems. To be sure, there are certain individual projects with sectoral approaches to urban development, for instance in the energy sector; but a coherent approach is not yet in existence, nor has one been targeted up to now by the *Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung* (BMZ) (Nitschke / Ouan / Peters 2007, 83). At the international level, UN-Habitat – the United Nations agency for human settlements – struggled almost alone among multi-lateral organizations until 1996 and had only little impact with meagre support and an unfocused mandate. In 1996, however, the second United Nations Conference on Human Settlements (Habitat II) was held in Istanbul, with 171 countries adopting its political document, known as the Habitat Agenda, that contains over 100 commitments and 600 recommendations for preventing and ameliorating problems stemming from massive urban growth, especially among cities of the developing world (UN-Habitat 1996). In 2000, another international milestone for urban development was set by the international community with the millennium development goals that highlight the problems of urbanization by specifically targeting slum dwellers (goal 7, target 11).

The neglect of urban areas in development policy is not only a result of the fact that large portions of the developing world have long been predominantly rural. It is also due to the assumption - stemming from an urban bias paradigm - that urban populations are privileged over rural populations, for instance with regard to public service provision. Especially for Africa, however, there is not much evidence in support of this claim. It has been shown that prevailing methods for comparing the scale and depth of poverty between urban and rural areas have been insufficient (Bolnick et al. 2006, 15 ff.; Corbridge / Jones 2005). Moreover, the fact that urban centres concentrate public service provision does not necessarily mean that these services are also accessible to the inhabitants: *"low-income urban dwellers may live 50 meters from a sewer and 100 meters from a hospital and secondary school but with as little possibility of using them as a rural dweller who lives 20 kilometres from the nearest sewer, hospital or secondary school"* (Bolnick et al. 2006, 16).

It is beyond the scope of this study to elaborate on the continuing debate about urban bias (see e. g. Corbridge / Jones 2005). This is also not to say that a radical shift towards an urban focus in development cooperation should be attained. Rather, it is to suggest that problems in rural and urban areas should be addressed with equal priority in order to endorse an inclusive regional development, since there are important interdependencies and equalizing currents between both of them (Nitschke / Ouan / Peters 2007, 84). This is also highlighted in the new World Development Report 2009, which emphasizes the importance of cities and admits that economic growth will always be spatially unbalanced (World Bank 2009).

Adaptation to the risks of climate change in Sub-Saharan Africa has been shown to be very important in urban areas, and there is a great need for international support. But urban areas cannot be understood separately from their rural hinterlands, rather there is a need for a better understanding of urban and rural areas as a continuum with consideration of their complex interdependencies (Ellis / Harris 2004). These linkages are crucial for an integrative adaptation process that has to take into account the important dependencies and interactions that are likely to be affected by climate variability and change (see chapter 3.4).

Thus, one important challenge for (German) development policy is to reorient its focus towards a more effective regional development, i.e. an inclusion of urban development as a focal point, so that rural and urban issues can be dealt with in an integrated manner.

Moreover, sectoral approaches and singular projects are not an answer to the increasing problems that rapid urban growth will bring. Against the background of global climatic and environmental change this argument gains even more weight. Successful mitigation of and adaptation to climate change in developing countries are intimately connected with finding new, sustainable paths of urban development by taking into account the complex interrelation between rural and urban areas (including environmentally induced rural-to-urban migration), as well as between various sectors.

6.3 Promoting good urban governance and capacity development

In most of the cities in Sub-Saharan Africa, administration and planning on the city level is rarely part of an integrated overall development plan. It is rather based on sectoral approaches with an inflexible orientation to infrastructure and land use planning. Often, such planning does not meet the major needs and demands of the inhabitants. Moreover, larger cities are often fragmented with respect to administrative boundaries, a fact which poses major challenges to coordinated action and planning. In this context, local administrative bodies have to compete for scarce financial resources and they often face very limited powers. Such a narrow scope of action in turn often leads to the refusal of higher levels of government to allocate the power and resources needed to adequately address local needs.

The failures or limitations in local urban governments are also linked to the failure of national governments and international agencies to support urban policies and urban local governance systems. Satterthwaite et al. clearly point out the major constraints that are inherent in most national and international ambitions that strive for good governance and enhanced adaptive capacity:

> *"Within international development assistance, there may be a growing recognition of the importance of supporting "good governance" but this rarely focuses on the importance of good local governance. Even if it does, the institutional structures of most international agencies limit their capacity to support this. Meanwhile, the international agencies that are leading the discussions on how to support adaptation to climate change do not understand the political and institutional constraints on successful local adaptation. There is also a tendency to assume that as long as new funding sources for adaptation are identified, adaptation can take place."* (Satterthwaite et al. 2007, viii)

To conclude, the greatest challenge for future development policy with respect to adaptation and urban development will be associated with the problems of local governance. These problems can only be addressed through comprehensive capacity-building programs which target the facilitation of local self-government. Such a campaign should envision *"the inclusive city as a place where everyone, including the urban poor, and among them women, can contribute productively and enjoy the benefits of urban life"* (Tibaijuka 2004, 14).

The first step towards good urban governance is to require governments and administrative bodies at a number of levels to accept the basic tenets of the concept, including transparency, accountability, gender balance, and civil society participation. This also includes the willingness to further promote the process of decentralization with financial, technical, and institutional support in order to encourage local authorities to work more co-ordinately and more effectively (Satterthwaite et al. 2007, 65).

Decentralization is vital for enhancing the adaptive capacity of cities, and local communities. National governments cannot be sufficiently responsive to the problems of rapid urbanization as well as to the impacts of climate variability and change. Their role is better suited to the level of policy, standard setting, oversight, and assessment. Local authorities, on the other hand, are closer to their constituents and they can be seen as a decision-making platform that has to ensure inclusive resource allocations in the general interest of all their citizens (Tibaijuka 2004). This must certainly also include the resolution of urban land issues that drive people to settle informally in hazardous environments such as floodplains (McGranahan / Balk / Anderson 2007, 20).

With respect to the latter, long term security of tenure has been stated to be a key to slum upgrading and community stabilization. Improved community stability in turn helps city authorities to attract donor, corporate and individual investment in pro-poor housing, infrastructure and adaptation measures. Moreover, it enhances the adaptive capacity of communities, facilitates the process of participative urban planning and significantly enhances adaptive capacities. The long term aim should be *"to stop local authorities from getting locked into a vicious cycle of evicting the poor from one place only to find them squatting in another location"* (Tibaijuka 2004, 15).

Against the background of the extent and complexity of problems that already exist and that are likely to be exacerbated by climate change, it becomes clear that there is a great need for innovative new approaches that go beyond traditional top-down solutions. It is necessary to facilitate research that focuses not only on scientific analysis, but also, and more importantly, on the formulation of concrete priorities and recommendations for action. Moreover, capacity development in urban planning and adaptation should promote a process and problem-oriented perspective away from a rather sectoral view that is not capable of taking into account the complexity of the various processes and problems (Kraas / Nitschke 2006, 27).

Capacity development is also crucial in terms of promoting the exchange of experience regarding adaptation practices, as for example in the implementation of early warning systems or disaster control. An important instrument for an exchange of experiences that also facilitates the dissemination of knowledge and information on climate change can be seen in the strengthening and extension of local government partnerships. Moreover, it can

be useful to promote the development of a database on local urban coping strategies that is comparable with the more general database provided on the UNFCCC webpage. This may facilitate the transfer of long-standing coping strategies/mechanisms, knowledge and experience from communities that have had to adapt to specific hazards or climatic conditions to communities that may just be starting to experience such conditions as a result of climate change.

7 Conclusion

This study has highlighted the immediate necessity of adaptation in the context of urban areas in Sub-Saharan Africa. It has drawn the complex linkages between the urban environment and the urban residents' exposure to a broad range of man-made and natural risks and hazards that already exist without climate change and are most likely to be exacerbated by it. Rapid and often uncontrolled urbanization, poor infrastructure supply, dominance of informal settlements, and the lack of good urban governance are key factors in determining this exposure. Moreover, these factors will most probably be negatively affected through the impacts of climate change. It has also been shown that there are great differentials in terms of location, income level, age and gender and that the urban poor bear the brunt of climate and environmental impacts in cities and urban areas. Rapid onset disaster events such as floods and storms, shortages of water and food, increased strength of tropical storms, coastal inundation, and changes in the spread of disease vectors will all lead to greater risks to health and life. However, many of these problems do in fact already exist today and have been well known in the development and disaster management community for decades (see e. g. Pelling 2003). Therefore, adaptation to climate change has to build on this knowledge and expertise.

Moreover, there are important areas of overlap between adaptation to climate change and other forms of disaster management and measures for addressing local environmental health issues, such as improved water, sanitation, waste disposal and drainage systems (McGranahan / Balk / Anderson 2007, 20). With a focus on the urban poor, a first priority for adapting cities to climate change is to resolve the major deficits in infrastructure and services, since in most urban areas in Sub-Saharan Africa at least half of the population lacks piped water, sewers, drains, health care or emergency services (Bicknell / Dodman / Satterthwaite 2009). A key issue here is for city governments to work with their citizens and community organizations in identifying and reducing the infrastructure and service deficits as well as the resulting risks. Such a partnership reduces the costs of adaptation and is better able to identify locally adjusted adaptation options with greater effectiveness (Bicknell / Dodman / Satterthwaite 2009).

On the municipal and regional level, adjusted and integrated urban planning has to be prioritized under consideration of current risks and future demographic and climate projections, both being ideally based on a local assessment. A strong focus has to be given to the provision of adequate and affordable housing for the poor in safe sites with mixed land use, including residential, employment, leisure, health care and education within one locality. The provision of parks and other open spaces such as land for urban agriculture should be considered for such areas in order to improve the microclimate of the city and contribute to the accommodation of floodwaters.

Hand in hand with urban planning goes Integrated Urban Water Resource Management (IUWRM), that combines technological and institutional measures in order to holistically enhance the environmental, social, and economic sustainability of water management even beyond the administrative boundaries of the city. Therefore, IURWM can contribute to solving some of the problems associated with the important linkages between urban and rural areas. Water scarcity has often been identified as an important driver of climate-related displacement and migration (see e. g. Warner et al. 2009), and integrated water resource management is best suited to also increase the resilience of rural communities and their livelihoods, so that the push factors for rural-to-urban migration can be reduced.

However, it has also been stated that urban areas hold a significant source of income for many rural households in Sub-Saharan Africa. Generally, in urban areas there is a considerable demand for products, services, and labour that reaches far beyond the city boundaries. Therefore, cities and urban areas offer a great opportunity for rural households to diversify their livelihood basis and therewith increase their adaptive capacity. Rural-to-urban migration represents one such option besides trade and seasonal labour migration. From this perspective, some of these linkages between the rural and the urban can be seen also as an important basis for adaptation in rural areas. Therefore, a key issue here is that policies should contribute to create an environment that facilitates rural-urban interactions, and this includes rural-to-urban migration.

Urban (local) governance represents another critical aspect of successful and sustainable adaptation to climate change in urban areas. This is crucial especially in terms of pushing forward a more inclusive approach with respect to the large portions of the urban poor, who mostly live in informal settlements. The poor are the present and future victims of impacts that result from climate change and other syndromes such as rising food prices, the financial crisis, energy shortages, as well as demographic changes. These impacts and the processes behind have to be managed in a highly coordinated manner. To conclude, good adaptation requires new strategies for poverty reduction and good city governance as a means of increasing the adaptive capacity of the people. This includes the requirement that city governments have to work together *with* those living in 'slums' and informal settlements, *not against* them.

What are the conclusions of this study for development policy? *First*, there is a significant deficit of funds to address the complex issue of adaptation, especially in urban areas. This shortfall should be complemented through additional funding, be it bi- or multilateral. This is not only a moral duty, but in case of adaptation a historical obligation as well. Moreover, to make adaptation work, it is a necessary precondition to keep total greenhouse gas emissions within safe limits through an effective continuation of the Kyoto protocol in 2012. Additions to existing funds must be assured as well as the mainstreaming of adaptation into existing development projects.

Second, a key challenge for development policy is to overcome the bias towards rural development. Problems in rural and urban areas should be addressed with equal priority in order to endorse inclusive regional development, taking into consideration as well the complex interdependencies on a continuum as an integrative adaptation process. At the same time – and this is especially true for urban areas – development policy should adopt a more people-, process-, and problem-oriented approach that focuses on the complex interrelationships between various sectors and moves away from rather sectoral

approaches. On a multi-lateral level, the NAPA process has also been criticized in terms of placing less emphasis on the urban poor. NAPAs should be downscaled to local levels, including cities, through the promotion of smaller scale Local Adaptation Programs of Action (LAPAs) and City Adaptation Programs of Action (CAPAs) (Satterthwaite et al. 2007).

Third, capacity building for adaptation and good (local) governance has to be an integral part of the development process towards adaptation in urban areas. This also includes raising awareness of the complexity of problems and processes which have relevance with respect to climate and environmental risks and hazards. One suggestion here is to build comprehensive capacities by targeting the facilitation of local self-government. Another important strategy is to build knowledge concerning the effects of long-term security of tenure for the vast number of informal settlements. This has significant implications for slum upgrading, building of social capital, and community stabilization. This in turn helps city authorities to attract both corporate and individual donor investment in pro-poor housing, infrastructure and adaptation measures. In the long run, it enhances the adaptive capacity of communities, facilitates the process of participative urban planning, and significantly enhances adaptive capacities.

Finally, a vision is needed of an inclusive city that provides everyone with an equally secure place for contributing productively and enjoying the great benefits of urban life (Tibaijuka 2004, 14).

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