



## **Research Report 19**

# **BUILDING A RESILIENT CITY TO WATER MEDIATED CLIMATE CHANGE: POLICY AND INSTITUTIONAL OPTIONS**

**By**

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## **Summary**

Climate change poses risk to residents of cities by increasing the likelihood of their exposure to adverse effects such as flood and seasonal change in water availability. However, little is known about the impact of these adverse effects and their possible measures to adapt to the anticipated effects. The paper aims to fill the existing knowledge gap by identifying policy and institutional options to minimize the anticipated water mediated climate change impacts in non-coastal cities of Africa. Addis Ababa city, the capital of Ethiopia and seat of the African Union, is used as a case study since it is the fastest growing city in the continent and a non-coastal city that depends heavily on the surrounding regions for its water source. Results from climate modelling study shows that the city will face increase in temperature and seasonal change in water availability. Using the result as input, a SWOT analysis was conducted on the existing sector policies and medium term development plan of the city. Essential policy and institutional gaps that may jeopardise the adaptation capacity of the city to water mediated climate change are analysed. Then the study identified most important strategic issues, prioritized and disaggregated by sector. To enhance adaptive capacity, both demand and supply side policy options are proposed, corresponding to the strategic issues, and institutional arrangements are suggested for effective implementation of the policy measures.

**Key words:** non-coastal city, water sector, climate change, adaptation, policy

## 1. Introduction

Most studies in developing countries focus on adaptation to the predicted adverse effects of climate change in rural areas, with little focus on urban centers. Cities are growing at a rapid rate and large numbers of people in cities are living in low quality housing and slum areas. They generally have little access to basic services such as water and sanitation, which increases their vulnerability to flooding and other extreme weather events. There is also a strong link between rural and urban communities, which are interdependent in terms of markets for goods and services and the more complex issues of nutrient balance and energy flows. If people are aware of and understand the possible impacts of climate change and how they may be affected, they can prepare themselves and in the process improve their adaptive capacity to other forms of shock. For these reasons, it is vital to conduct research on the impacts of climate change in urban areas in developing countries so that policy makers and urban development planners can make informed decisions about mitigating and adapting to climate change impacts.

This study focuses on urban areas and adaptation to climate change impacts on the water sector. The particular focus is on flood incidence, water supply and sanitation, and wastewater management. In this study, we refer to this as “water mediated climate change impacts”. Addis Ababa, capital city of Ethiopia, is treated as a case. The city’s political, geographical and socioeconomic context makes the city a useful exemplar for other cities in Africa. It is the political center of the country and a seat for the African Union. Politically, the city has its own administrative council, which is filled with elected representatives and has a constitutional right to decide policy, strategy and development plans.

A study on trends in climate variability for the city based on regional downscaling model shows that temperature will increase by an average of 0.37<sup>o</sup>c per decade, with no significant seasonal variations (Semu et al, 2012)<sup>1</sup>. The model projected that there will be an increase in average monthly temperature by 0.9 °c in coldest month in the next 30 years and 4<sup>o</sup>c in the hottest month in the next 90 years in the city. Similarly, precipitation will also be projected to increase in annual volume of rainfall but varies from season to season within the same

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<sup>1</sup> This study is also benefited from URAdapt project of the International Water Management Institute.

periods. The increase in temperature and the change in rainfall pattern are also perceived by residences of the most vulnerable parts of the city within the last three decades.

The change in these climate events will have potential impacts with important implications to the vulnerability of the city and its adaptation mechanisms. These impacts will be manifested in the form of flood and water availability for the city within the next 30 to 90 years. With regard to its impacts on water availability, the projected increase in precipitation will have both positive and negative impacts on the water availability for the city. The positive impact can be manifested in the form of availability of more water that can be used for different purposes for the city including for better and sustainable supply of water for domestic use of the city's residents. If the municipality is able to develop this potential benefit, it can also reduce the water shortage that may exist in its surface reservoirs due to reduction of rainfall in some months of the year as projected by the hazard analysis. However, this potential benefit can only be realized if the city has the financial, technical, managerial as well as institutional capacities to harvest and develop the projected increase in water availability to satisfy the ever increasing demand for water. Otherwise, it is likely that there will be less water in the reservoirs in the months of less precipitation, hence, shortage of water supply for domestic and other uses during these months. This situation will be exacerbated due to the rise in temperature, as predicted by the regional downscaling model that will induce increase in water consumption and less water in reservoir due to high rate of evaporation. The reduction in precipitation during the dry season in the city will also have a negative impact in the water flow of Akaki River that flows from north to south part of the city. This has negative implication on the livelihood of many farmers who are growing vegetables using the river's water within and downstream of the city since there will be less water to irrigate their crops resulting in crop failure.

The change in climate events will also have adverse effects to the city due to its impact on flood occurrence. The increase in precipitation means more water, which, if not used efficiently, can easily be turned into runoff. This increase in runoff will have implications on flooding and results in loss of lives and properties, unless and otherwise, the city will have a more robust drainage system that can manage the increased runoff. This increase in precipitation will also result in heavy storms, which will, in turn, damage houses, social services like schools, infrastructure like road, increases vector-born disease like malaria and diarrhea as well as affect livelihoods of the poor. Flood affects the livelihoods of poor people

specially those who engage in urban agriculture as their main means of survival since most urban agriculture is located in riversides. This effect can arise during seasons when there is an increase and reduction in precipitation. The change in climate events within the next 30 to 90 years will result in three different types of flooding including localized flooding due to inadequate drainage (street flooding); flooding from small streams whose catchment areas lie almost entirely within the built-up area; flooding from major rivers on banks whose urban areas are built.

These anticipated impacts will have important implications to the vulnerability of the city. The improperly managed urbanization rate (with rapid increase in population size and physical expansion), high level of poverty, low quality housing, low level of access to water supply and sanitation and inefficient wastewater management in the city are the socioeconomic features of the city that severely expose the city to the anticipated climate change impacts. The fact that there are variations among different communities in terms of access to social services and poverty levels implies that vulnerability and thus adaptation capacity varies across the different communities within a city. This suggests the need to consider the variation in the adaptation capacity of local community in designing adaptation programs at city level. In addition, its topographic structure and the route taken by the Akaki River as well as the existing drainage system, road network and sewerage system are the main physical features that expose the city to climate change impacts particularly to adverse effects of flood. The sources of water the city is getting currently and the fact that the city is expecting to get other sources of water costly exposes the whole of the city to the anticipated climate change impacts particularly to shortage of water.

This study therefore aims to provide evidence based information to policy makers so as to take appropriate adaptation measures to minimize the negative impacts and take the opportunities that may arise due to change in climate. It attempts to identify policy and institutional options that can be used as input to design strategy to build the resilience of the city to water mediated climate change.

## **2. Organization of the report**

The report is organized into six sections including this and the introduction sections. The following section discusses the methodology used by the study. It defines the conceptual framework in which the study used to identify key conceptual issues in addressing climate



change impact on the water supply system of a particular city in a developing country. It also outlines the different policy instruments as well as the data and analyses techniques. Section 4 presents the socioeconomic and environmental situations of Addis Ababa city that crucially determine the vulnerability of the city to water mediated climate change impacts. Section 5 presents the result from the SWOT analysis used to identify policy and institutional (adaptation) gaps that need to be filled in to build a climate resilient city. The last section outlines the policy and institutional options to fill the gap.

### **3. Methodology**

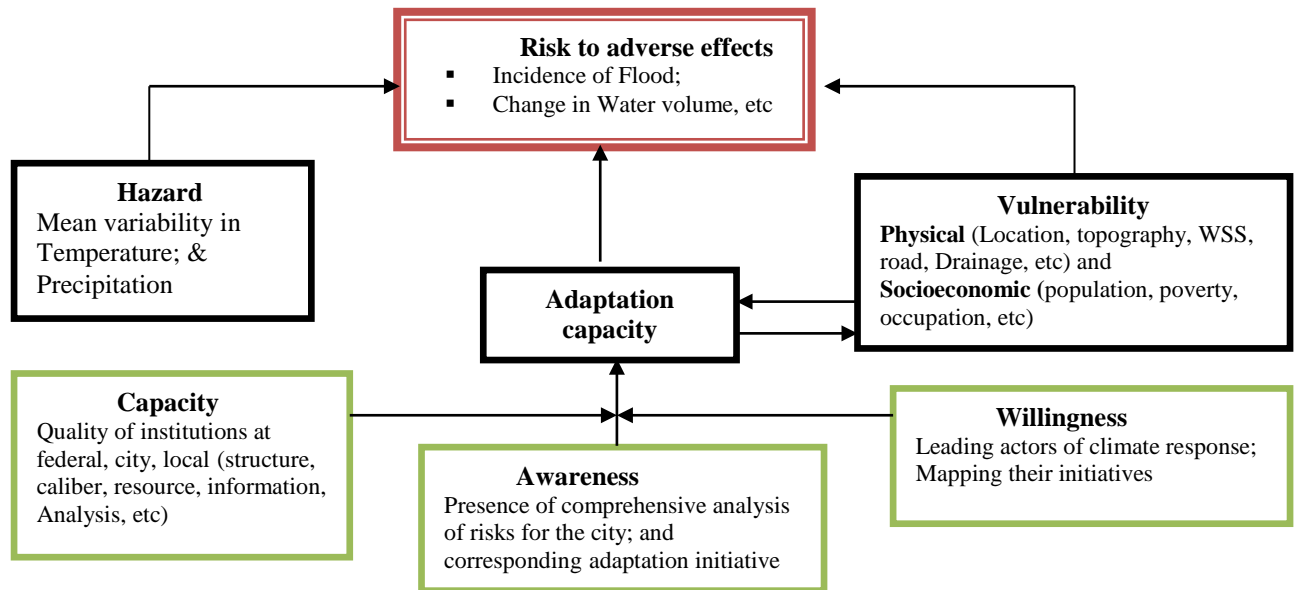
#### **3.1. Conceptual framework**

Following Shagun Mehrotra et al (2009), this study considers exposure to risks of adverse effects of climate change as a product of three aspects: hazard, vulnerability and adaptive capacity (Figure 1). The occurrence of adverse effects such as flood and change in water availability is determined by the level of hazards or variability in the predicted mean temperature and precipitation. Given this, the degree of potential damage from such phenomenon is determined by the level of vulnerability or exposure and sensitivity of the city to the expected adverse effects. This is determined by the physical and underlying socio-economic conditions of the city. It is a function of a host of city characteristics including location, topography as well as current and future population size and its composition, poverty levels, access to basic social services and infrastructure (quality of housing, road network, drainage, etc). The degree of damage can then be minimized if the existing adaptive capacity of the city is well understood. Such approach has advantages for identifying possible gaps, identifying adaptive options, and designing appropriate policies and strategies to adapt.

Shagun Mehrotra et al (2009) defines adaptive capacity as the institutional attributes of a society or city that determine the degree of its capability to respond to potential climate change impacts. It can be assessed by measuring the awareness of change agents and their ability and willingness to respond to climate induced changes. We measured ability as capacity of the city in terms of institutional structures, availability of resources, skills to access and analyze information related to policy making and implementation of climate change related responses. Awareness is measured in terms of the presence of a comprehensive analysis of climate change risks for the city and the corresponding adaptation initiatives. Similarly, the willingness of the different actors to respond to climate change

impacts is assessed using indicators that define their response in the form of tangible initiatives so far made to adapt to climate change impacts.

**FIGURE 1: Developing adaptation options for climate resilient city in Africa**



Adapted from Shagun Mehrotra et al (2009)

### 3.2. Policy instruments for adaptation

Though there is a wide recognition on the potential use of policy instruments for adaptation, there is relatively little literature on the use of economic instruments in the context of adaptation (IPCC, 2013). There are several typologies of policy instruments that are commonly known to address development problems, in general, and climate change impacts, in particular (IPCC, 2013; Agrawala and Fankhauser, 2008; Sterner, 2003). Agrawala and Fankhauser (2008) distinguished incentive-providing instruments relevant for key sectors such as insurance, water, health agriculture, etc. while the author suggested price signals or market based incentive for water and ecosystem, they identified regulatory measures and incentives for building standards and zone planning. On the other hand, Sterner (2003) classifies policy instruments into four major categories: using markets, creating markets, environmental regulation, and engaging the public. All are applicable to natural resource management<sup>2</sup>. While central government is important in formulation of policy instruments, the local state has also key role in identifying which policy instrument or mixture of

<sup>2</sup> See Sterner (2003) for detail classifications and their application in environmental and natural resource management.

instruments is more appropriate given the nature of goods or services to be managed within the context of climate change impact.

The choice of policy instrument depends on the objective of the decision to be made. Criteria include efficiency, distributional effect, effectiveness, incentive compatibility, administrative cost and political feasibility. Whatever the criteria, policy does not work in vacuum. Effective implementation of policy depends heavily on the institutional environment within which it works. Administrative structures and institutions can be seen as policy instruments in themselves. Certain conditions are relevant for the policy instruments to work as they are meant to. These include, but are not limited to, the structure and availability of information, preexistence of degree of inequality in distribution, and sociopolitical factors. While different policy instruments can be used to achieve the same target, some policy instruments may pose implementation challenges. Market-based policy instruments may require defining property rights and their legal context and seeking and obtaining stakeholder buy-in. For instance, there may be significant costs to implementing some pricing strategies, such as those requiring water metering, and a potentially significant administrative overhead.

Policy instruments for water demand management are promoted to attain a number of different objectives. They can be used to provide financial resources to cover all the costs of providing water, and to foster the economically efficient allocation of water – to move water from lower to higher value uses. They are also said to foster conservation and innovation, and provide signals to induce behavioral changes or they are used to promote technological advances while enlisting market forces to ensure the most economically efficient outcomes. Thus, decision makers need to clearly spell out the goal of their making decision so as to select the appropriate policy instrument. For example, cost recovery and efficient allocation are distinct objectives that may require different instruments. Pricing at average cost (where utilities break-even) allows utilities to recover their costs. Efficient resource allocation is, in theory, achieved when prices (or taxes) are set at the marginal cost by providing users with a signal about the value of the last amount of water used. The goal of efficient allocation can be reached no matter who pays for the fixed costs of water supply, even if they are subsidized. The conflict among the different uses and users of water needs to be also considered when designing an adaptation strategy for water sector. In such situation, possible policy instruments cited in the literature include the establishment of water markets or water pricing schemes (e.g., Alavian et al. 2009). Olmstead (2010), for instance, indicated that water

markets facilitate transfer from lower to higher-valued uses but pricing rules can also function through urban fees and real estate taxes. On the other hand, study by Medellin-Azuara et al. (2008) indicated that water markets and pricing improves climate change adaptation

Given the institutional arrangement, the socioeconomic aspect of a particular city or region crucially determines the choice of the policy instruments. In sub Saharan African context where poverty is still a development issue and access to basic social services is very low, adaptation policies need focus on minimizing the anticipated disaster and sustainable development that can easily be integrated into the overall development policies. Such policies believed to overcome the problem of uncertainty related to climate change. In their study, Bicknell et al. (2009) conclude that 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, the first priority for building city's adaptation capacity should be to remedy deficits in infrastructure and services. GWP/TAC (2007) suggests that resilience to flooding can be achieved by protective infrastructure as well as through land use planning or the combination of both. For instance, flood wall structures and flood diversion canals can also be used to protect houses and settlements from inundation and floods. In addition, appropriate land use management can reduce the vulnerability of communities to water-based natural disasters through planning that restricts settlements in risky areas.

On the other hand, to manage climate change and to sustain water resources, institutional settings must promote integrated approaches to optimizing outcomes in different sectors, including for water, food, climate, and energy (Bates et al. 2008). Thus, it is useful to find institutional mechanisms that are able to manage variability by prioritizing different water uses at times of water stress. Integrated Urban Water Management (IUWM) is a vital component of Integrated Water Resource Management (IWRM) and can make important contributions in the broader basin context in building adaptive capacity (Braga, 2001). IUWM can help optimize the links between urban water concerns and relevant activities beyond the urban boundaries, such as rural water supply, down-stream use, and agriculture (Reed 2006). 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). 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 periurban agriculture, especially in Africa (Muller 2007, 103). Arun Agrawa (2008) also affirmed that institutional partnerships are crucial to local adaptation practices. The author discussed climate change adaptations including enhancing local institutional capacities, improving institutional coordination across scales, focusing on territorial development strategies and mainstreaming adaptation to climate change into urban development planning. While Satterthwaite et al. (2007) suggest the need for the promotion of City Adaptation Programs of Action, Olendrof (2009) suggests promoting good urban governance and capacity development.

In promoting adaptation strategy for water mediated climate change impact in city, it is essential to recognize that water-related climate adaptation measures may include supply-side, infrastructure-based, hardpath solutions, in the form of more dams, water transfers, and flood levees. Alternatively, soft-path solutions, such as decentralized systems, demand management, and ecosystem-based measures, may meet many societal needs for water services with lower water consumption and fewer impacts on the environment (Gleick 2002, Kabat and Schaik 2003; Pittock 2009b).

### **3.3. Data sources and analysis techniques**

We used the conceptual framework given in section 3.1 to identify key indicators for measuring the vulnerability and adaptation capacity of the city. Identification of major actors related to climate change was done before generating the required data for measuring indicators of adaptation. Primary information was generated using key informant interviews and focus group discussions. To understand the awareness and willingness of local community actors and their responses to adverse effects, focus group discussions were held with members of the most vulnerable communities of the city. They were selected using specific criteria including access to basic social services, frequency of flood occurrence and poverty status. Similarly, to understand the awareness and willingness of actors related to climate change, key informant interviews were held with officials and experts in selected sector offices at municipal and district levels. Secondary information was collected from previous studies and sector reports to supplement the primary information.

A detailed review of existing policies, programs and plans was carried out on selected sectors directly related to adverse effects of climate change including flood and water availability. A

SWOT analysis was done to identify policy and institutional gaps at federal, municipal, local and community levels as it offers powerful insights into the issues affecting the city's adaptation capacity. The assessment of strengths describes the positive attributes, internal or within the control of the city while assessment of the weakness of the existing policy and institutions is important to identify the gaps that need to be filled to enhance the adaptive capacity of the city. Assessing the opportunities helps to identify where and how the city can benefit as it minimizes the adverse effects of water mediated climate change impacts. If opportunities are identified correctly, they are important inputs to design appropriate strategies that need to be implemented. Identifying the potential threats is essential for preparing contingency plans.

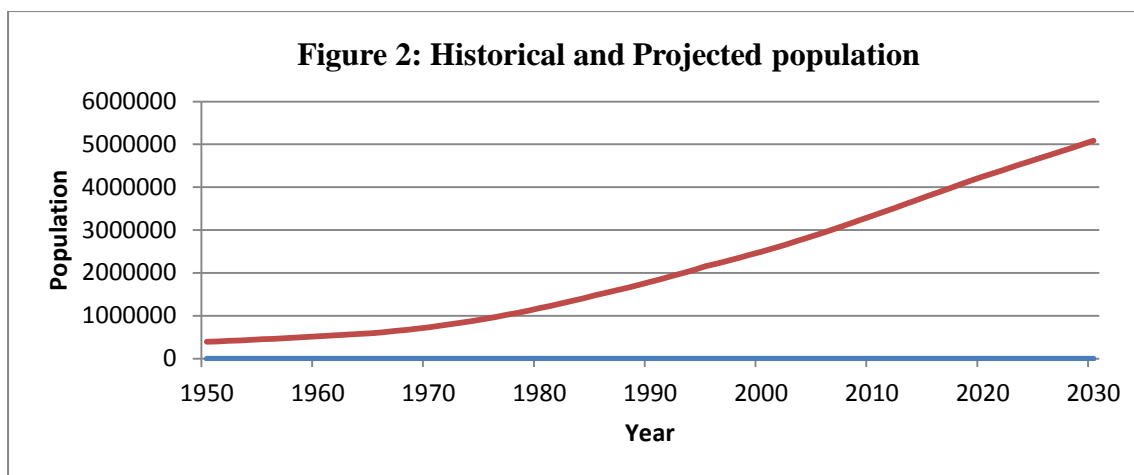
#### **4. Socioeconomic and Environmental situation of Addis Ababa**

The city has a total population of 2,738,248 (CSA, 2007). It is administratively subdivided into ten sub-cities. Urbanization, measured in terms of change in population number and physical expansion, has been very high over the past three decades (Table 1 and 2). The city has experienced a significant increase in population number within the last three decades. Addis Ababa took 90 years to reach a population of 1 million, but only 30 years to triple and exceed 3 million. In-migration contributed 46.9% to population growth in 1999 alone (CSA, 1999). Figure 2 shows the historical and projected population for the city for the period from 1950 to 2030. The city also expanded rapidly from 6,050 hectares of built area in 1975 to 14,672.7 hectares in 2000. The horizontal expansion of the city took place in all peripheral areas where both legal and squatter settlements were established. As shown in table 4, the expansion of the city has been faster after 1975, which also corresponds to the increase in population.

**Table 1: trends in population growth of Addis Ababa (1930 – 2007)**

<b>Year</b>	<b>Population size</b>	<b>Growth rate (%)</b>
1930	100,000	
1961	443,328	7.7
1967	683,530	3.5
1978	1,167,301	4.1
1984	1,423,111	1.8
1994	2,112,737	3.3
2000	2,495,000	1.53
2007	2,738,248	0.9

Source: Different publications of CSA



**Table 2: physical expansion of Addis Ababa (1886 – 2000)**

Period	Area covered (hectares)	Total built-up area (hectares)	Annual growth rate (%)
1886–1936	1863.13		
1937–1975	4186.87	6050	3.1
1976–1985	4788	10,838.00	6
1986–1995	2925.3	13,763.30	2.4
1996–2000	909.4	14,672.70	1.6

Source: ORAAMP (2001:17–18).

The uncontrolled and unmanaged urbanization has challenged the city in meeting the growing demand for basic social services including housing, water supply and sanitation as well as waste management. Before we look at the level of provision basic social services in the city, it is imperative to briefly examine the economic situations of the city in terms of overall production and revenue as well as poverty and employment situation.

The composition of the city's annual revenue shows that non tax revenue, direct tax and indirect tax accounts for 49%, 47% and 4% for the year 2009/10, respectively. The tax revenue mainly comes from the service sector, which takes the lion share of the city's gross production. It accounts about 75% of the city's GDP. From production side, Table 3 shows the city's gross domestic product in Ethiopian currency (Birr) for the period from 2005/06 to 2009/10. As it can be seen from the table, though the city's GDP generally increases in absolute terms for the stated period, there is no significant shift in terms of share of the three sectors. The city's GDP at constant factor cost increased from 12.4 million Birr in 2005 to 18.7 million Birr in 2009/10 (AACGFEB, 2010). Compared to the severity of the

socioeconomic problems of the city, the revenue still make up the total budget required for development.

**Table 3: Estimated Results of Addis Ababa City’s Gross Domestic Product (in million Birr) for the period between 2005/6 – 2009/10**

Sector	Period									
	2005/6		2006/7		2007/8		2008/9		2010/11	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Agriculture	50.3	0.003	60.2	0.003	78.6	0.003	100.3	0.003	144	0.003
Industry	3,319.40	0.23	4,260.9	0.24	5,569.4	0.25	7,103.4	0.25	10,264.0	0.25
Service	11,090.00	0.77	13,146.5	0.75	16,904.8	0.75	21,560.9	0.75	31,156.0	0.75
GDP at current factor cost	14,459.70	1.00	17,467.6	1.00	22,552.8		28,764.6	1.00	41,564.0	1.00

Sources: AACGFEDB (2010)

The poverty status of the people crucially determines their sensitivity towards climate change impacts and their ability to overcome the damage or revive from the adverse effects. In this regard, not only the amount of income residents of the city earn determines the extent or capacity of the city to overcome the adverse effects but also that the source of income crucially affects the capacity to permanently address and/or revive from the adverse effects. Formal and informal employments are major sources of income for the residents of the city. These include salary from public or other employment and self-employments, which account 42.8% and 40.6%, respectively (CSA, 2006). Recent empirical evidences show that the informal sector employs about 43% to 51% of the economically active labor force in the city (Medhanit Berhanu, 2010; MFI, 2002). Self-employment takes many forms including urban agriculture, trading, service provision, daily laborer, etc. The unemployment rate of the city for the year 2006 is estimated to reach about 28.6% and for the year 2009, 27.9% (CSA, 2006; 2009). See Table 4 for trends in unemployment rate in Addis Ababa by sex since 2003. Unemployment rate is higher for female than male residents of Addis Ababa.

**Table 4: unemployment rate for Addis Ababa city aged 10 and over by sex**

Year	Unemployment rate		
	Male	Female	Total
2003	21.2	43.7	32
2004	22.3	36.8	29.1
2005	22.8	40	31.4
2006	21.4	36.1	28.6
2009	18.4	38.3	27.9

Source: CSA report on 2009 urban unemployment survey



Similarly, Table 5 shows the trends in poverty status of Addis Ababa for the years between 1995/96 to 2004/05 from the survey conducted by the CSA. As can be shown from the table, at least 30% of the city's population was living under poverty, and this increased to 36% in 1999/2000, which later decreased to 32.5% in 2004/05. The poverty gap was 8.7% - 9.6% and 6.3%, in the respective years. Even though both the number of poor people and the gap among the poverty status of the residents of the people decreased in 2004/05 compared to 1999/2000, these figures indicate the magnitude of the economic problem in the city, and the extent of the vulnerability of the city's population to climate change impacts.

**Table 5: Trends in poverty incidence and gap in Addis Ababa (1995/96 – 2004/05)**

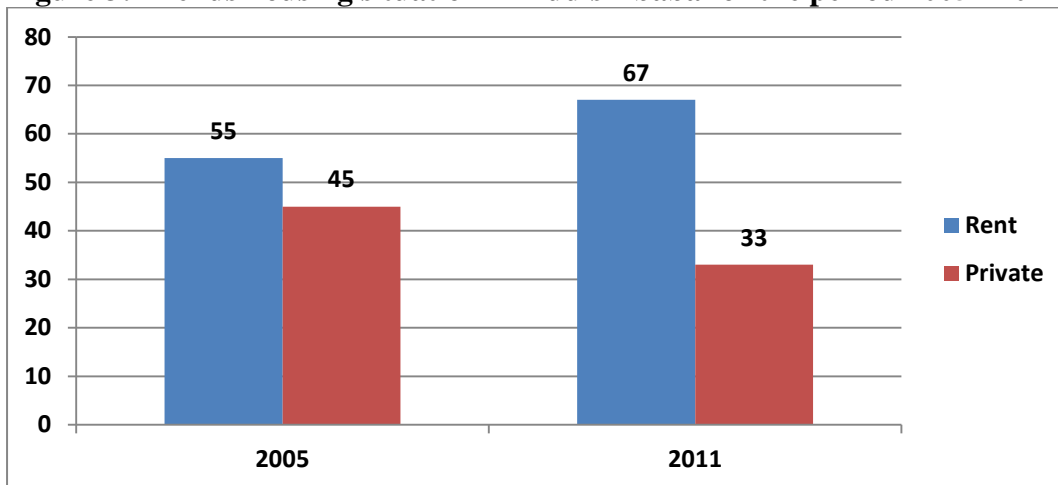
Year	Poverty incidence (%)	Poverty Gap (%)
1995/96	30.2	8.7
1999/2000	36.1	9.6
2004/05	32.5	6.3
Change (%) ('95/96 – 04/05)	7.7	(27.4)

Source: CSA (2005/06)

The narrow revenue base of the city coupled with the poverty status of its people and unemployment situations shows the extent and sensitivity of its people to the anticipated climate change impact. The vulnerability of the city can also be seen from its residences' access to basic social services. The housing situation of the city clearly shows the extent of slum development in the city, which is perhaps an indication of the increase in unmet demand in basic services with the high rate of urbanization which in turn makes the dwellers of the slum areas more vulnerable to adverse effects of climate change. As described above, horizontal expansion of the city took place in all peripheral areas of the city, where both legal and squatter settlements were established. Out of the total 94,135 housing units built in the city between 1984 and 1994, 15.7% (14,794 housing units) were built by squatters (ORAAMP, 2001:6). In 2000, the city had an estimated total of 60,000 housing units with squatter settlements, which accounted for 20% of the total housing stock of the city. State owned houses comprise 46% of the total housing stock. Of this number, 24.8% of houses are in a very poor condition requiring high maintenance or replacement. About 9% of these households do not have any toilet facilities, while 51% share communal toilets before 2000 (UN-Habitat, (2004); Solomon et al., 2004). To alleviate the housing problem, the city government prepared plan of action to construct condominium houses and transfer them on lottery bases since 2000. Though thousands of houses are constructed and transferred to residences of the city, there is still long way to go. Figure 3 and shows the recent housing

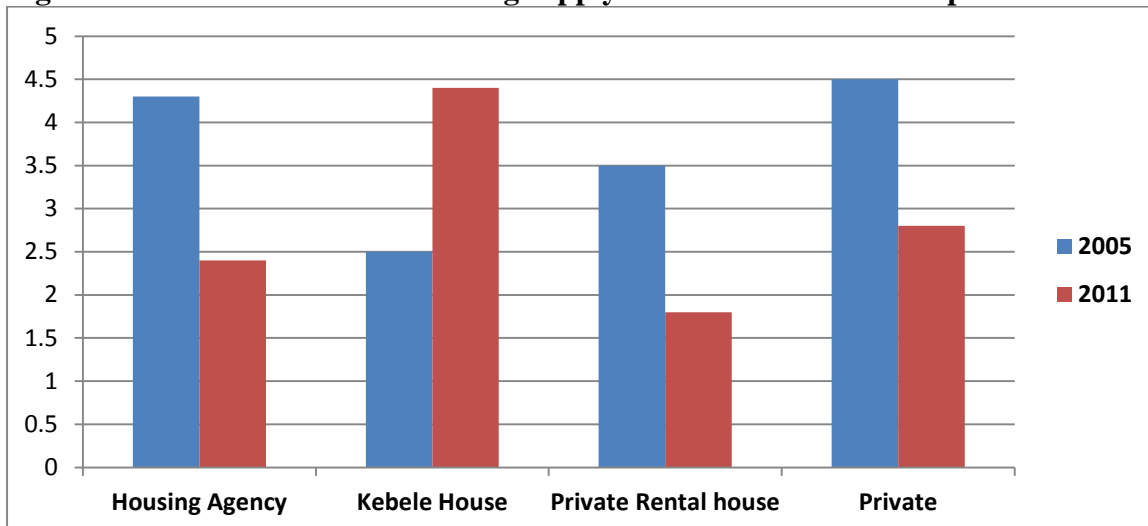
situation in the city. Besides, the houses are no climate friendly. The percentage of residences living in rented houses increased from 55% in 2005 to 67% in 2011 whereas those live in privately owned house decreased from 45% to 33% in the same period (figure 3). In terms of ownership, the rented houses are supplied by public agencies; kebele or private home owners (figure 4). While rented houses supplied by private sectors increased from 18% to 39% within the same period, publicly supplied houses substantially decreased.

**Figure 3: Trends housing situation in Addis Ababa for the period 2005 - 2011**



Source: CSA (HICE data, 2005 & 2011)

**Figure 4: Trends in source of housing supply in Addis Ababa for the period 2005 - 2011**

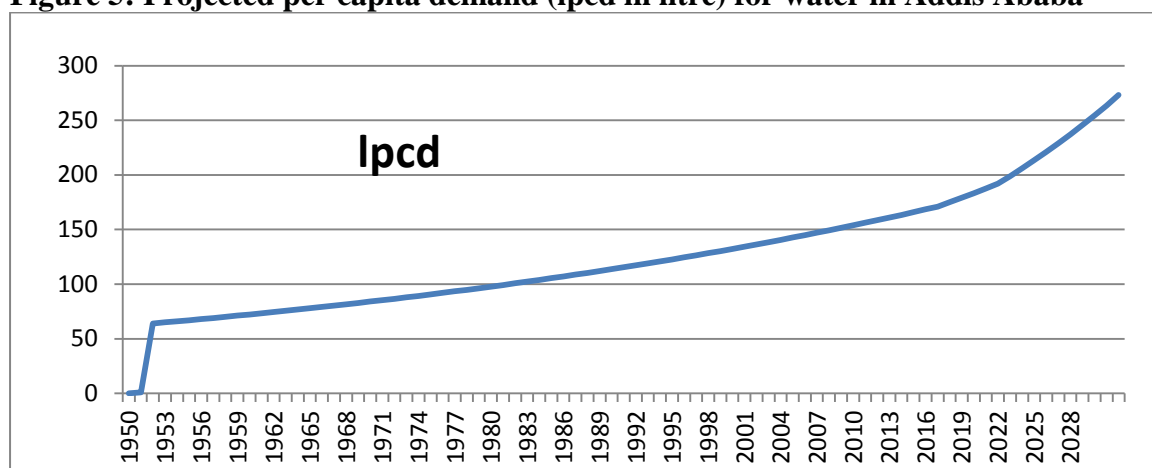


Source: CSA (HICE data, 2005 & 2011)

Access to safe drinking water and basic sanitation are essential for the achievement of the Millennium Development Goals (MDG), and is exposed to climate change impact. It is a fundamental requirement for effective primary health care, for increasing enrolment of boys

and girls in schools, and a pre-condition for success in the fight against poverty, hunger, child mortality and in achieving greater gender equality. On the other hand, as climate change affects the water availability for a particular region, it has important implications to improve access to safe water for the increasing water demand. The existing situation in Addis Ababa indicated that although 73% of the population has access to improved water supply, 29% experienced frequent water disruption. The average per capita consumption is about 52 litres and if a daily per capita demand of 110 litres is taken as per the city’s water supply office (Addi Ababa Water and Sanitation Authority) standard, the coverage is only about 48%. In addition to the low coverage, the non-revenue water is important as it reduces the amount reached to direct users. With a daily production of 300 thousand cubic meter, the monthly production is 9 million m<sup>3</sup> which implies non-revenue water of over 50%. This includes loss due to leakage, metering error and possible illegal connections. There are over 300 thousand customer connections in the eight branches with high customer density variation among the ten sub cities. Customer density is the highest in Arada where the density reaches 2,895 customers/km<sup>2</sup> while it is the lowest in Akaki where the density is 129 customers/km<sup>2</sup>. For the city, the average is 589 customer/km<sup>2</sup>. Given the city’s low coverage of safe water supply, it is planning to develop additional sources, mainly surface water sources, to meet the increased demand, which is also vulnerable to climate change impact due to increase in temperature. The projected demand for safe water supply for the city until the year 2030 is shown in figure 5 below. The forecast for per capita water demand, which increases substantially, considers the projected population growth.

**Figure 5: Projected per capita demand (lpcd in litre) for water in Addis Ababa**



The sanitation situation of the city is also important from building the resilience of the city’s water supply system to water mediated climate change impact. As it is now, the city has very

poor service. While 70% share dry pit latrines, only 15% use flush toilet facility, which is expected to increase when the planned housing program is completed. The rest use open fields to defecate. It is estimated that 10% of the city area is covered by a sewerage system. Table 6 shows solid waste generated and disposed of for Addis Ababa for the period 2003/4 and 2007/8. Of the total solid waste generated, only 20% to 50% are properly collected using municipality or private company vehicles. The remainder is dumped by local roadsides, open spaces and riverbanks (AASBPB, 2008). This has resulted in the accumulation of solid waste on open lands and especially in water ways and drains. Major challenges in solid waste management (SWM) include insufficient budget, absence of a cost recovery mechanism, lack of truck maintenance, absence of incentive systems, and low private sector involvement. Lack of promotion and education on waste reduction, recycling, composting and energy generation, rapid and unplanned city expansion and increase in the populations also contributed to the poor SWM in the city.

**Table 6: trends in solid waste generation and collection in Addis Ababa**

Description	Amount (m <sup>3</sup> )				
	2003/4	2004/5	2005/6	2006/7	2007/8 (only 9 months)
Amount of solid waste generated	760,244	789,134	819,121	850,247	882,557
Amount of solid waste collected and disposed of by the agency	531,258	475,266	493,868	529,189	352,018
Percentage of unattended waste	28%	34%	34%	20%	50%

Source: AASBPB (2008)

The city also has an inefficient wastewater management system. About 36 million cubic meters (MM<sup>3</sup>) of liquid waste is generated annually, of which domestic and industrial wastes constitute 70% and 30%, respectively (EPA, 2005). Not more than 1% of this wastewater is being treated by the existing two treatment plants (Kaliti and Kotebe Treatment plants). Nearly all the produced wastewater directly enters drains, rivers or streams flowing through the city without any kind of treatment.

Urban agriculture is a proven means of livelihoods and source of food for many households within and around the city. The main agricultural activities are crop production (field crops and vegetables), raising and keeping animals (particularly dairy cows and chickens), bee keeping and ornamental plants. This sector provides employment and food security and enhances nutrition at household level. Crops are grown on 10,586 ha of land. On average,

19,368.5 tonnes of crops were produced between 1998 and 2009/10. In addition, some farmers grow vegetables on 3,560 ha of land using wastewater irrigation. About 27,616.7 tones of vegetables were produced from wastewater irrigation farms in 2009/10. About 61% of all vegetables and 95% of leafy vegetables supplied to the city's central market comes from these farms (Weldesilassie, 2011). In the livestock production subsector, of the total 55 million litres of milk consumed by city residents, 70% comes from within city milk production (AAUAO, 2011). About 2,462 tons of meat and 1,000 tons of egg are also produced annually from the city's livestock farms owned by individuals and cooperatives. Despite its contribution, urban agriculture is practiced without any technical and institutional support. Water pollution is one of the major threats to this sector. Based on the city master plan, 21,046 ha of land is reserved for green areas for specific functions including parks, street gardens, playgrounds, sports fields, institutional vegetation, private gardens, and cemeteries. However, only 8,148 ha of land is currently covered with green areas due to encroachment by buildings and microenterprises. This encroachment contravenes the constitutional right of urban dwellers to live in an area with access to clean and environmentally friendly spaces.

These socioeconomic and physical infrastructures features of the city have important implications for climate change adaptation. The geographic location and topographic feature exposes the city to become vulnerable to natural disaster particularly to flood. The existing state of the drainage system, road network and sewerage system exposes most parts of the city to street and riverine flooding. While street flooding is common phenomenon, the city experienced riverine flooding that caused serious damage both in property and death of life in 1978, 1979 and 1994 (JICA, 1998 unpublished). However, the degree of sensitivity to anticipated climate changes varies from community to community within the city due to variations in topography, poverty levels, access to basic social services, quality of housing conditions and settlement patterns.

## **5. Policy and institutional gaps**

A review of selected sector policies and institutions helped identify gaps that need to be filled to build the adaptive capacity of the city to water mediated climate change impacts. This section presents the result from a SWOT analysis. The analysis is made on selected sector policies including environment, water, health, urban infrastructure, disaster prevention and

preparedness, early warning and agriculture. While the policy review shows the awareness and willingness of major actors, a review of the institutional setup shows gaps in capacity.

### **5.1. Policy gaps**

Climate change presents significant threats to the achievement of development plan such as the MDGs, which have time bound and quantified targets for addressing extreme poverty while promoting environmental sustainability. Accordingly, there is a worldwide recognition of the importance of considering development plans when addressing climate change impacts in any country. Cognizant of the threats posed by climate change and the need to respond accordingly and pursuant to its commitment to the conventions of UNFCCC, the Ethiopian government has swiftly embarked upon formulation of appropriate policy frameworks and related implementation modalities to fight climate change and minimize its impacts on the community. In this regard, there are some initiatives that reflect the commitment of the country to respond to climate change impacts in realizing the stated poverty eradication development goal.

From the perspective of the multi-sectoral impacts of climate change, the environmental policy of Ethiopia is worth considering. The policy was formulated in 1997 and considers climate change as a cross-cutting issue (EPA, 1997). The policy underlines the importance of incorporating rural-urban migration, human settlement and environmental health concerns into regional, district and local level planning and development activities and improved environmental sanitation to the federal and regional agendas for achieving sustainable urban development. The policy gives due attention to industrial water pollution. It states the need to adhere to the precautionary principle of minimizing and preventing discharges of substances, biological materials from industrial plants and personal or communal appliances or any other external sources and establish clear linkages between the control of pollution and other policy areas including water resources, agriculture, human settlements, health and disaster prevention and preparedness.

The agricultural and rural development policy explicitly points to climate change as an important component that needs to be considered in agricultural and rural development. The policy emphasizes a sustainable land management program as a tool to reduce rural vulnerabilities and building ecosystem resilience, environmental rehabilitation, watershed

development for environmental adaptation, harnessing the multiple benefits of water resources, and integrating disaster risk monitoring and early warning. This policy has important implications for rural communities within the watershed catchment of the city. However, the policy does not recognize the importance of urban and peri-urban agriculture for livelihoods. The disaster prevention and preparedness and early warning policy are important in relation to adaptation to flood risk due to climate change. The policy aims at reducing impacts of disasters through programs which generate employment, environmental rehabilitation and other drought-lessening activities. In addition to ensuring relief efforts to reinforce capabilities of the affected areas and people, it also aims at promoting self-reliance and contributes to sustainable economic growth and development. The policy emphasizes that public participation is central in planning, programming, implementing and evaluating relief programs and related measures.

The policy is more oriented to a multi-sectoral and multi-hazard Disaster Risk Management (DRM) approach rather than crisis management. Ethiopia has already prepared an adaptation plan in its effort to link climate change adaptation with disaster and risk management. The policy is important particularly in designing adaptation strategy to flood events due to climate change. The program gives due emphasis to improving use of weather information in decision-making, in which the National Metrological Agency (NMA) is mandated to generate weather information. The program also gives due emphasis to anticipated flood risk, particularly in urban areas. The program envisages initiatives for a more rapid flood early warning system and the construction of flood control measures as important interventions. Learning from NGO initiatives highlights that these measures can be effectively supported through community-based and community-managed disaster risk management measures where communities are involved in identifying and constructing flood control measures and managing low-tech early warning systems.

The Water Resource Management Policy of Ethiopia has direct relevance to address water mediated climate change impact in the city. It was formulated in 1999 (FDRE, 1999). The fundamental principles of the policy is that, Ethiopian citizens shall have access to sufficient water of acceptable quality to satisfy basic human needs and gives top priority to drinking water supply over other uses. The policy outlines equitable, sustainable and rational development of water resources potential. In pricing water use, it gives more weight to recovering the cost of acquiring than efficiency. It states that tariffs for drinking water should

be made based on partial cost recovery principles for rural communities and full cost recovery for urban water supply. The policy does not factor out climate change as a major variable affecting the amount, distribution and quality of water resources. It does suggest water harvesting and management measures, flood management and promotion of equitable water for multiple uses.

The guiding principle of the health policy is that more than 80% of the common diseases are infectious and communicable, which are mainly due to the poor standard of housing, the lack of potable water and inappropriate disposal of waste, and thus it gives due emphasis to health promotion and disease prevention (TGE, 1993). In relation to climate change adaptation, the policy prioritizes the prevention of environmental pollution with hazardous chemical wastes and the development of environmental health. The health sector prepared its program to adapt to anticipated climate change impacts. Among the anticipated adverse effects are effects through direct incidence of floods and storms, and indirectly through impacts on food supply and water resources. Climate sensitive diseases like malaria, diarrhea, infections associated with malnutrition, and non-communicable diseases are anticipated to increase due to climate change. The policy gives attention not only to the most vulnerable groups of society including women, children, elderly, disabled and poor people but also to people living in flood prone areas.

In relation to adaptation capacity to climate change, the science and technology policy does not address climate change issues explicitly. However, the policy is important in determining the use of green technology or water technologies used to improve water efficiency. In this regard, the policy addresses issues related to rational and efficient use of the natural resources and protection and conservation of the environment, both of which are closely related to climate change mitigation and adaptation measures. One of the strategies identified as priority area is to “Develop the capacity and the mechanism to search, choose, negotiate, procure, adapt and exchange technologies that are appropriate and environmentally sound to the Ethiopian socio-economic conditions” essential for acquiring technologies for climate change mitigation and adaptation measures. Another key policy relevant to build the resilience of the city to water mediated climate change is the urban development policy, which determines the infrastructure development of the city including building structure, drainage, sewerage system, etc. The guiding principles of the current policy include, strengthening sustainable links between rural, urban and across urban centers as well as



encouraging decentralization of urban centers. Poverty reduction is encouraged via opportunities to participate in development activities by way of institutionalizing sustainable development and urban governance, public mobilization and private sector participation. The policy does not directly refer to climate change or how to cope up with constraints of potential water supply, drainage and sanitation and other infrastructures.

While the above discussion indicates some policy documents of the country, there are also initiatives related to plans and programs designed to implement the different policies. The country prepared its NAPA in 2007 (EPA, 2007). The NAPA represented the first step in coordinating adaptation activities across government sectors, but was not intended to be a long-term strategy in itself. Ethiopia's NAPA projects are currently "on hold" whilst international adaptation funding mechanisms are under negotiation. More recently, a separate work program for action on adaptation to climate change has been developed by the Federal Environmental Protection Authority of Ethiopia. The program document interlinks climate change adaptation strongly with the economic and physical survival of the country and identifies key climate change adaptation measures and strategic priorities and intervention areas to address the adverse effects of climate change. The main objective of EPACC is to create the foundation for a carbon-neutral and climate-resilient path towards sustainable development in the country. The program states that most of the solutions to climate change will be implemented by inhabitants and farmers at local and district levels, thus the role of the federal institutions will be to initiate, facilitate and monitor activities with the exception of some cases that need the intervention of the concerned federal organs.

EPACC identifies twenty climate change risks and the institutions responsible for countering and mitigating each of the identified risks. The climate risks identified are broadly in the areas of human, animal and crop diseases, land degradation, loss of biodiversity, decline in agricultural production, dwindling water supply, social inequality, urban waste accumulation, and displacement due to environmental stress and insecurity. It identifies adaptation strategies and options in the various socioeconomic sectors including cloud seeding, crop and livestock insurance mechanisms, grain storage, societal reorganization, renewable energy, gender equality, factoring disability, climate change adaptation education, capacity building, research and development, and enhancing institutional capacity and the political momentum. Ethiopia is committed to building a Climate-Resilient Green Economy (CRGE) that aims to ensure economic development that pursues a low emissions path while building resilience to

adapt to climate change. The green economy strategy focuses primarily on emission intensive sectors, where the climate mitigation potential of Ethiopia resides -- energy, forestry, agriculture, soil based emission, livestock, cities, infrastructure, and health. Ethiopia has outlined a strategy to build a green economy. The climate resilience strategy, on the other hand, tries to address risk reduction by focusing on two aspects – integrated disaster risk reduction and management and sectoral and regional climate adaptation strategy and action plans. The GoE is currently in the process of developing the Climate Resilient component of its CRGE Strategy (EPA, 2011).

The CRGE is prepared based on four pillars and follows sectoral approach; the four pillars include improving crop and livestock production practices for higher food security and farmer income while reducing emissions; protecting and re-establishing forests for their economic and ecosystem services, including carbon stocks; expanding electricity generation from renewable sources of energy for domestic and regional markets; and leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings. The initiative is also prepared with the aim of offering important co-benefits including improved public health, through better air and water quality, and it would promote rural economic development by increasing soil fertility and food security. Though it shows the government's commitment, the CRGE mainly focuses on mitigation, but not adaptation.

Overall, the foregoing discussion shows there is a high level of awareness and willingness from agents who play a leading role in climate change at federal, city and local community levels. The result of the policy review and focus group discussions made with the local leaders and communities reveal some gaps in building a resilient city to water mediated climate change. This can be summarized as follows:

First, climate change is internalized indirectly in the existing environment, disaster prevention, preparedness and early warning policies. The health policy gives some consideration to preventing health problems associated with events such as floods, lack of access to water supply and sanitation services. Adaptation strategies and programs are prepared at city as well as federal levels.

Second, the goal of eradicating poverty contributes to the city's adaptation capacity. The medium-term plan focuses on pro-poor development, which is essential in building the

adaptation capacity of the most vulnerable segments of society. The plan gives priority to improving access to water supply and sanitation services, health, housing and employment. Climate change is integrated into the medium term plan. In addition, initiatives have been made in climate change adaptation programs such as EPACC which constitutes the adaptation program for the different sectors as well as regional states including Addis Ababa city adaptation program. The Climate Resilient Green Economy (CRGE), though focuses on mitigation, is also another initiative for addressing adverse effects of climate change. It addresses risk reduction by focusing on two aspects: integrated disaster risk reduction and management and sectoral and regional climate adaptation strategy and action plans.

Third, the focus group discussions revealed a strong willingness within the community to participate in and contribute to planning and implementation of adaptation programs to build resilience to water mediated climate change. There are important lessons from the local community that need to be encouraged. Currently, the most vulnerable communities have employed coping strategies for preventing adverse effects from floods such as risk insurance, reinforcing river banks, changing cropping patterns, cleaning drains, sheltering affected people in community based shelters and forming strong social networks.

However, there are policy gaps that may weaken the adaptive capacity of the city to water mediated climate change. First, the water resource management policy ignores the issue of efficiency in tariff setting as it only considers the full cost recovery of the investment and operation and maintenance costs in water service delivery. Second, there is no policy instrument that encourages the use of water efficient technologies. Third, there is no wastewater management policy per se and the existing wastewater treatment plants in the city have no policy mandate to sell or recycle treated wastewater. Fourth, there is no urban agriculture policy and strategy. This hinders the productivity of the sector and the use of safe wastewater irrigation despite the huge volume of wastewater production and the willingness of urban farmers to buy and practice safe wastewater irrigation. Fifth, the command-and-control policy of environmental pollution cannot be implemented due to the high transaction cost of enforcing the policy despite the existence of pollution regulation. In addition, though climate change is internalized at policy and strategy levels, it is not well articulated at the level of development plan. At least it is not clear whether or not the medium term plan of the city internalizes the cost associated with adverse effects of climate change. The city's adaptation program, which contains the most vulnerable sectors to climate change and the

corresponding adaptation mechanisms, does not contain the specific plans to be implemented for adaptation.

## **5.2. Institutional gaps**

A review of the institutional setup related to climate change impacts on water shows the ability of the city to plan and implement climate change adaptation programs. The review looks at indicators of institutional capacity, including institutional structure, plans and actual implementation, and availability of resources to identify strengths and weakness.

The constitution of the country states that Ethiopia is a Federal Democratic Republic with a parliamentary system (FDRE, 1995). The federal legislature is bi-cameral and is composed of the House of Peoples' Representatives (HPR) with 547 members and the House of the Federation (HF), which has 110 members representing 58 "nations and nationalities". The tenure of the two houses is 5 years. The country is composed of nine Regional States and two City Administrations councils. Members of the two parliaments, the House of Representatives and House of Federation are elected bodies from the people across all the regions and nationalities. The regional states and city administrations are subdivided into administrative Woredas/districts. These are further divided into Kebeles which is the smallest administrative unit in the governance system.

The highest governing body of each national regional state is the respective Regional Council, which is responsible for legislative functions. With the intention to promote decentralization and meaningful participation of the population in local development activities, public service delivery including health care has to a large extent fallen under the control of the regions. The regional councils define the region's policy and have all legislative, executive and judiciary powers regarding the region, except for those under the responsibility of the central government, such as defense, foreign affairs, and economic policy, etc.

The Addis Ababa City Administration is structured in a stratum where in the city council is the highest legislative body comprised of audit and inspection body, city government executive body and city government courts and judicial body. Under the city government executive body is the city mayor which constitutes the city manager, state functions bureaus (cabinet), the mayor's office and sub city executive body. The city manager is in charge of

municipal services like land development, solid waste disposal and reuse, emergency prevention and control, road construction, water construction and drainage, etc. Environment protection is under the mayor's office. The sub cities are further divided into woredas which are the last interfacing point between the administration and city dwellers (Proclamation 9th Year No. 86 FDRE, 2003).

The City Government is mandated, among others, to formulate and implement policies concerning the socioeconomic development of the city. It also organizes Sub-cities and woredas/districts, demarcates their borders, and allocates budgetary subsidy to them. The role and duties of the woreda administration, among others, is to encourage Wereda residents, Governmental and Non-Governmental Organizations for development being a center for direct participation of Wereda residents in development and a focal point of services delivery for those that can be delivered at Wereda level.

A detailed review of the institutional arrangement in terms of the power, function and governance system and implementation capacity of the federal system and the city of Addis Ababa can reveal at least the following key points relevant to building the resilience of the city to water mediated climate change.

First, the existing constitution, institutional arrangement as well as the organogram of the city administration reflects the capacity for the city to adapt to water mediated climate change. Second, the constitution and the water policy provide the city the right to use the water resources within and outside its boundary. Special arrangements can be developed with neighboring Oromiya Region for resource use and discharge of pollutants. Third, mandates are clearly identified at all levels including federal, city, sub-city and district levels. This facilitates efficiency in planning, implementation, monitoring and evaluation of adaptation programs on water mediated climate change impact. Fourth, the city is governed by democratically elected officials; the city prepares its own sectoral policies, strategies and development programs; it allocates budget to development programs, implements and follows up implementations. The city has its own institutional structure that stretches from city to district levels to implement policy and development plans approved by the city council. For instance, the city has an environmental protection authority that formulates and coordinates climate change related programs, controls river pollution, conducts environmental impact assessments; and a water supply and sewerage authority to plan and implement water supply

and sewerage activities. Finally, the existing coping strategies of the local community to adverse effects of climate change such as flood can strengthen the adaptation capacity, through enhancing community participation, if their coping strategies are considered in designing adaptation programs.

There are, however, important gaps in the institutional structure in sectoral offices that play a vital role in water mediated climate change impacts.

1. Despite the policy and legislation allowing it, there are no clear institutional arrangements between Addis and Oromiya except that the city and the Oromiya regional state agreed to establish a regional office for its realization.
2. There is low private participation in waste management, as in recycling of wastes.
3. Even though there is an early warning system at city and sub city levels, there is none at district level where there is close communication between the government and community. Institutional structure at local level is important to involve local people in planning and implementation of anticipated adverse effects of flooding. For instance, currently the local community uses their social network as a form of insurance to minimize the risks associated with loss of houses and property during events of flooding and heavy rains.
4. There is low institutional implementation capacity within different organizations in the city. This is reflected in planning, implementation of targets, low enforcement of existing policy and low motivation of district officials and low coordination capacity.
5. There is no clear understanding in integrating development plans with climate change adaptation plans.
6. It seems that there is a very loose coordination among the different sector offices of the city. For example, it is a common phenomenon to see the destruction of the built-up infrastructure for telecommunication, water supply and road which are built by the respective offices due to lack of coordination in planning and implementation.
7. The focus group discussion revealed that there is low motivation among district officials in coordinating local people's initiatives.
8. There is shortage of manpower in sector offices as well as low level of skill, which resulted in low implementation capacity of development plans.
9. There is very low enforcement capacity of existing policy and regulation (e.g. industrial water pollution policy); low revenue collection capacity (at city level); narrow revenue

base and little awareness within local communities about water mediated climate change impact.

In addition to these strengths and weaknesses, there are opportunities for the city to build its adaptive capacity. First, the existing constitution is an opportunity that gives right to the city to use the water resources outside its boundary as well as the right to arrange special institutional arrangements with neighboring Oromiya state where almost all sources for the city water supply originate. Second, the international community provides financing for climate change adaptation programs. Third, it is likely that climate change will bring with it more water in the form of unexpected increase of precipitation. Fourth, the anticipated better economic performance from the medium term Growth and Transformation Plan will also bring opportunity in the form of increases in per capita income and improved living standards. Fifth, strong motivation among the climate change leaders of the country also builds the resilience of the city to water mediated climate change since it brings with it more initiatives and priorities of adaptation programs. However, these opportunities are uncertain due to the low level of implementation capacity of the city; the low level of revenue collection; the low level of development in terms of access to basic social services such as water supply and sanitation, health, solid waste management, education, etc., coverage; and uncertainty in climate change impacts.

## **6. Policy implications**

This study assessed the existing adaptive capacity of the city to water mediated climate change impacts, giving due emphasis to water supply and sanitation, wastewater management as well as risk to flood as one of the most potential adverse effects from climate change. Based on the assessment, the following conclusions can be made and are presented in four key strategic issues.

1. Water demand management. Concerns include the current situation of low water supply coverage, inequitable distribution of water supply, inefficient use of water by residential and industrial consumers, and the expected increase in both marginal and absolute water demand due to the increase in population, living standards and increase in temperature due to climate change.

2. Water supply management. The three major concerns are shortage of water supply, shortage of investment finance to expand the water supply through source development, and water loss due to poor service delivery and leaking pipes.
3. Flood vulnerability. Here the concern is how to design an efficient risk management scheme while addressing the rapid expansion of the city and the resulting increase in built-up area that changes the land use pattern and reduces infiltration. The increase in built-up area has significantly contributed to high flood incidence and reduces ground water recharge. A related issue is the reduction in human wellbeing due to the absence of green areas and the increase in environmental pollution.
4. Wastewater management practices. Currently, the city has a very low level of wastewater treatment due to the low capacity of the treatment plant, inadequate sewer lines, and policy gaps in generating revenue. The current practice of wastewater irrigation within and around the city is unsafe due to the lack of appropriate urban agriculture policy and strategies resulting in a health risk to farmers and consumers. This situation puts the livelihoods of urban farmers at risk. Furthermore, the increase in the incidence of flooding as a result of climate change will expose urban farmers to loss of farm land and consumers to food shortages.

These four key strategic issues can be addressed through formulating appropriate policy and institutional arrangement. In this regard, the following policy options and institutional issues are identified corresponding to each of the four strategic issues.

1. Demand side policy is required to improve access through modifying consumer behavior towards a more efficient use of water. Options range from water pricing with efficiency objectives to creation of awareness on water conservation. However, the options may vary depending on the type of consumer. For instance, water pricing is appropriate for residential water consumers only for short time spans as consumers adjust their behavior. For industrial use, water pricing is appropriate as their objective is the maximization of profit. The underlying point is that water pricing should be used to achieve efficient water use. This requires adjusting the current water supply and sanitation policy from cost recovery to efficiency as the major criteria in setting tariffs. Policy that incentivizes consumers who use water saving technologies is essential, regardless of the type of consumer.

Provision of information through education on water conservation is also important. In this case, use of water recycling for services other than domestic use is advisable. Efficiency can



also be realized through delivering improved services and designing appropriate tariffs. This requires understanding the perceptions of consumers and their preferences by conducting research with the aim of delivering improved services and estimating their willingness to pay for such services.

2. From the supply side management perspective, one option is improving access to water through developing alternative water sources. As the city gets its water from Oromiya Region, it is essential to implement good institutional arrangements and ensure that high level officials are well informed about constitutional rights and have the power to make decisions. The focus of these arrangements should be on how to improve access to water supply through developing alternative water sources that ensure people in downstream communities can live in a healthy environment.

Similarly, the city council must improve revenue collection and widen the revenue base to improve its financial capacity for investment in new water source development. Policy options include provision of training to employees, developing better incentive schemes through improved human resource management, and raising awareness among tax payers about the benefits of a better supply system.

3. Adaptive capacity to flood vulnerability can be improved through institutional capacity to implement the city's plan for green areas. This requires provision of property rights to the private sector to manage parks and collect revenue. The adverse effects of floods can also be addressed through urban agriculture policy and strategy that encourages safe wastewater irrigation.

It is essential to strengthen the organizational structure of Addis Ababa fire, emergency prevention and control offices to sub cities and districts, particularly in those areas most exposed to flooding. This will improve community participation in prevention and help reduce adverse effects through the provision of early warning information and integrate coping mechanisms adapted to local situations. Social insurance schemes in flood prone areas in consultation with local people are also an option for vulnerable communities.

4. Improvements are needed to existing wastewater management practices. This could be realized by designing a policy that addresses both the supply (polluters) as well as demand

side (users and treatment schemes). From the polluter's side, the current command and control policy does not work due to high transaction costs. It can be changed to an incentive-based policy through effluent charges or sewer discharge fees, or to subsidizing industries for using abatement technology through access to credit or pricing for technology. From the users' side, formulating urban agriculture policy that considers safe use of wastewater for irrigation minimizes the health risks to consumers and farmers.

Improving the treatment capacity of the existing public plants is vital. In the short term, this can be done through the provision of policy and institutional rights to the existing plants to sell treated wastewater to farmers, and collect and use these revenues to build capacity as farmers are willing to pay. In the long run, technological improvement is needed which requires further research.

## References

- AACG, (2006), Addis Ababa City Government Five Year Strategic Plan Draft (2006-2011), Addis Ababa
- AACGFEDB (Addis Ababa City Government Finance and Economic Development Bureau (2010), Urban Development Indicators, August 2002 E.C., Addis Ababa Ethiopia
- AASBPDA (Addis Ababa Sanitation, Beautification and Park's Development Agency) (2008). Assessment Report on the Packages of Solid Waste Pre Collector Institutions. AASBPDA, Addis Ababa
- AAUAO (Addis Ababa Urban Agriculture Office) (2011), performance report of the livestock department of the office.
- Agrawala, S. (ed.) (2008): Bridge over troubled waters: linking climate change and development, Paris: OECD
- Agrawala, S. and S. Fankhauser (eds.), 2008: Economic aspects of adaptation to climate change. *Costs, Benefits and Policy Instruments*, Paris, OECD9264046038/978-9264046030
- Alavian, V., H.M. Qaddumi, E. Dickson, S. M. Diez, A.V. Danilenko, R. F. Hirji, G. Puz, C. Pizarro, M. Jacobsen, B. Blankespoor, 2009: *Water and Climate Change: Understanding the Risks and Making Climate-Smart Investment Decisions*. World Bank: Washington, DC.
- Bates, B. C., Z. W. Kundzewicz, S. Wu, and J. P. Palutik of, editors. 2008. *Climate change and water*. Technical Paper of the Intergovernmental Panel on Climate Change (IPCC). IPCC Secretariat, Geneva, Switzerland.
- Bicknell, J. / D. Dodman / D. Satterthwaite (2009): *Adapting cities to climate change: understanding and addressing the development challenges*, London: Earthscan
- Braga, B. P. F. (2001) Integrated urban water resources management: a challenge into the 21st century, in: *International Journal of Water Resources Development* 17 (4), 581–599
- CSA (Central Statistical Authority) (2008), summary and statistical report of 2007 population and housing census: population size by sex and age, Federal Democratic Republic of Ethiopia Population Census Commission, December 2008, Addis Ababa Ethiopia
- CSA (2007), Population and Housing Census result, Artistic press, Addis Ababa Ethiopia
- CSA (2004) welfare Monitoring Survey 2004, Analytical report, Federal Democratic republic of Ethiopia June 2004 Addis Ababa, Ethiopia
- CSA (1999) *The 1994 Population and Housing Census of Ethiopia: Results for Addis Ababa*. Addis Ababa.
- EPA (Environmental Protection Authority) (2011), Climate Resilient Green Economy, Addis Ababa, Ethiopia
- EPA (2007), National Adaptation Program of Action, Environmental Protection Authority, Addis Ababa, Ethiopia
- FDRE (Federal democratic Republic of Ethiopia) (2003) FEDERAL NEGARIT GAZETA Proclamation No. 361/2003 Addis Ababa City Government Revised Charter Proclamation 9th Year No. 86 ADDIS ABABA 24 III July 2003

- FDRE (1999), Water management policy, ministry of water resources, Addis Ababa, Ethiopia
- FDRE (1997), *Environmental Policy of Ethiopia*. Environmental Protection Authority, Federal Democratic Republic of Ethiopia, Addis Ababa.
- FDRE (1995), *The Constitution of the Federal Democratic Republic of Ethiopia*; Proclamation No 1/1995, Federal Democratic Republic of Ethiopia, Addis Ababa
- Gleick, P. H. 2002. Water management: Soft water paths. *Nature* **418**(6896):373–373
- GWP / TAC (Global Water Partnership / Technical Advisory Committee) (2000): Integrated Water Resources Management, Global Water Partnership and Technical Advisory Committee, Stockholm (TAC Background Papers 4)
- IPCC (2013). Climate Change-Economics of Adaptation. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change
- IPCC (Intergovernmental Panel on Climate Change) (2007): Summary for policymakers, in: M. Parry et al.(eds.), *Climate change 2007: impacts, adaptation and vulnerability: contribution of working group II to the fourth assessment report of the IPCC*, Cambridge: Cambridge University Press, 7–22
- Kabat, P., and H. Schaik. 2003. *Climate changes the water rules: how water managers can cope with today's climate variability and tomorrow's climate change*. Dialogue on Water and Climate, Delft, The Netherlands. [online] URL: <http://www.waterandclimate.org/?id=CPWCresources340>.
- Medellín-Azuara, J., J. Harou, M. Olivares, K. Madani, J. Lund, R. Howitt, S. Tanaka, M. Jenkins, and T. Zhu. Adaptability and adaptations of California's water supply system to dry climate warming. *Climatic Change*, **87** (Suppl 1):S75–S90, 2008.
- Medhanit Berhanu (2010), Housing Re-development in Addis Ababa Mixed-use, Mixed Income Cross Subsidized Re-development
- Muller, M. (2007): Adapting to climate change: water management for urban resilience, in: *Environment and Urbanization* 19 (1), 99–113
- Olmstead, Sheila M., 2010: The economics of managing scarce water resources. *Review of Environmental Economics and Policy*, **4**(2): 179-198.
- ORAAMP (Office for the Revision of Addis Ababa Master Plan), 2001, Housing Components: Improvement and development strategy, Addis Ababa Ethiopia.
- ORAAMP, (2002). Executive Summary, Addis Ababa in action: progress through partnership. City Development Plan (2001-2010). Office for Addis Ababa Master Plan Revision Project.
- ORAAMP (Office for the Revision of the Addis Ababa Master Plan). 1999. *Addis Ababa and its Planning Practice*. Addis Ababa.
- ORAAMP. 2000. *Policy Environment Assessment for Urban Planning in Addis Ababa*. Addis Ababa.
- ORAAMP. 2001. *Land Use and City Structure Studies of Addis Ababa and the Metropolitan Areas*. Addis Ababa.

Pielke, R. et al. (2007): Climate change 2007: lifting the taboo on adaptation, in: *Nature* 445 (7128), 597–598

Pittock, J. 2009b. Lessons for climate change adaptation from better management of rivers. *Climate and Development* 1(3):194–211.

Reed, J. A. (2006): Urban water and sanitation services: an IWRM approach, Global Water Partnership and Technical Advisory Committee, Stockholm: GWP / TAC (TAC Background Papers 11)

Satterthwaite, D. et al. (2007): Adapting to climate change in urban areas: the possibilities and constraints in low and middle income nations, London: IIED (Human Settlements Discussion Paper 1)

Semu Ayalew M, Getahun Habtamu, \* Geremew Sahilu Gebrie Liqa Raschid-Sally (2012) Impacts of expansion of built environment on the flooding regime of Addis Ababa city, unpublished URAdapt project report

Shagun Mehrotra; Claudia E. Natenzon; Ademola Omojola; Regina Folorunsho; Joseph Gilbride; Cynthia Rosenzweig (2009), FRAMEWORK FOR CITY CLIMATE RISK ASSESSMENT, Fifth Urban Research Symposium

Showers, K. B. (2002): Water scarcity and urban Africa: an overview of urban-rural water linkages, in: *World Development* 30 (4), 621–648

Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge, UK: Cambridge University Press

Transitional Government of Ethiopia (TGE) (1993b), Health Policy of Ethiopia. Transitional Government of Ethiopia, Addis Ababa, Ethiopia

UN-Habitat (2004) Cities and citizens Series, Urban Inequality Report: Addis Ababa

Weldesilassie, A., E. Boelee, and S. Dabbert. “Wastewater Use in Crop Production: Impact Productivity and Policy Implication.” Discussion pap., Dept. of Production Theory and Resour. Econ., University of Hohenheim, Stuttgart, Germany, 2008

Weldesilassie, Alebel B, (2008), Economic Analysis and policy Implications of Impacts of Wastewater Use in Agriculture, unpublished PhD dissertation, Hohenheim University, Germany