

*Review*

# Climate change vulnerability and adaptability in an urban context: A case study of Addis Ababa, Ethiopia

Logan Cochrane\* and Peter Costolanski

Addis Ababa, Ethiopia

Accepted 01 July, 2013

---

This paper explores the nature of vulnerability to climate change and examines the adaptation strategies of the residents of Addis Ababa, Ethiopia. Data were collected through qualitative interviews to understand the perceptions and coping mechanisms of households and then contextualized within the existing local, national and international research. The findings reveal positive adaptations to climate change in some areas but also non-existent or maladaptive changes in other areas that have increased vulnerability. The study prioritized vulnerabilities based upon the data collected. Of the areas examined, food (in)security emerged as the greatest immediate and long-term vulnerability for the target population.

**Keywords:** Addis Ababa, adaptability, climate change, Ethiopia, vulnerability

---

## INTRODUCTION

The ability to change is highly localized. In order to engage in strategic planning for climate change, policy-makers and other authorities must understand the unique dynamics of the particular context in question. Necessary measures will vary according to locale; thus local conditions must drive the implementation of particular solutions. Research has been conducted in several rural Ethiopian sites in order to understand these local dynamics, and while aggregate modeling and estimation provide some general information, more specific geographical and societal studies are required (Wilbanks et al., 2007). Additionally, little scholarly attention has been paid to the effects of climate change in an urban, developing world context (Satterthwaite et al., 2007).

This study aims to fill a portion of that gap by outlining and prioritizing the climate-related vulnerabilities faced by

the residents of Addis Ababa, Ethiopia in order to facilitate the creation of appropriate policies. Through narrative-based qualitative interviews conducted with residents of Addis Ababa and experts across Ethiopia and by using existing data, this paper highlights the current and potential climate-induced adaptations for this urban environment.

This paper brings together macro-level climate change data in Ethiopia with a micro-level analysis of how those changes are impacting everyday lives in Addis Ababa. The following section provides an overview of the challenges that climate change poses, and the third section, "Vulnerability and Adaptation," presents the framework within which the current study was conducted, the terms and approaches taken. This is followed by an examination of the ways in which climate change and

urbanization are linked, in order to contextualize the data presented in this report. A brief background of Ethiopia is presented in the fifth section, after which is a description of the methodology used. Section seven presents the comments provided by respondents, groups them into seven sub-sections related to climate change and respondents' well-being – temperature, rainfall, environment, electricity, food, sanitation and water – and discusses the adaptations that respondents have been forced to make due to changing their changing environment. The final section then summarizes the main findings and highlights issues for further study.

## Climate Change

Climate change refers to long-term modifications to climate, whether due to natural occurrences or human activity (Intergovernmental Panel on Climate Change (IPCC), 2007). The global climate is warming, as demonstrated by increases in air and ocean temperatures, increased ice and snow melt and rising average sea levels. The risk of extreme weather events is also rising (Adger et al., 2007); all these trends are expected to continue.

Climate change is, in turn, affecting multiple spheres of society. The most immediate impacts are environmental, resulting in increased desertification, drought and floods, shifts in arable land and water stress. As natural resources deteriorate, populations are subjected to increasing stress that can result in property ownership and rights disputes; conflicts over land; migration due to drought or rising sea levels, desertification and resource scarcity and increased urbanization; and declining economic performance as agriculture and horticulture face greater challenges and marine resources are depleted. These, in turn, can manifest themselves in increased social and political instability.

Vulnerability to a changing climate is highest amongst developing countries, yet paradoxically and tragically, these same countries have contributed little of the greenhouse gases (GHGs) that have accumulated in the atmosphere and brought about recent climate change. The high degree of vulnerability in these countries is a product of high reliance upon agriculture (for basic needs, livelihoods and exports) and low adaptive capacity (caused by high levels of poverty and lack of access to adequate education, health care, social safety nets, information, technology and infrastructure).

Ethiopia provides an example of how climate change can manifest itself. At present the majority of citizens are rural farmers who follow traditional practices to raise livestock and crops, relying upon rainfall and relocating seasonally. Climate change is already altering these practices as freshwater resources dwindle, desertification spreads and productive cropland shrinks. As their

pastoral lives become more and more challenging, these rural farmers may abandon their traditional livelihoods and move to urban centers seeking an alternate means of survival, but once there, they face high unemployment and a system already strained by rural-urban migration. This has led to conflicts between established residents and migrants, sometimes igniting past tensions and sometimes fueling new ones.

Urban areas pose challenges unknown in rural environments, and some of the most adverse impacts are expected to be felt in urban areas (Adger et al., 2003; World Bank, 2008). Furthermore, the interdependent nature of the rural-urban relationship will enhance vulnerabilities in both areas. The risks posed in urban areas are magnified due to the dense concentration of hazards and their possible immediate effect upon a large and concentrated population. These include the potentially swift spread of infectious diseases, water contamination, water shortages, electricity blackouts, poor sanitation, a lack of emergency services, and underdeveloped infrastructure.

Over the next two decades, the population of Ethiopia is predicted to double to approximately 145 million. All these factors combine to present a menacing picture of a future that includes widespread environmental stress, hunger, homelessness and unemployment. In order to counter these developments, engagement must be proactive and effective, and policymakers must understand the context to formulate appropriate measures.

## Vulnerability and adaptation

For the purposes of this paper, a population's vulnerability is understood as its susceptibility to a decline in its social and economic well-being (Kelly and Adger, 2000). Adaptation is the process used by individuals, communities and countries in anticipating or interacting with changing circumstances, particularly measures taken to mitigate challenges to well-being. In this study, the concept is used to identify constructive reactions to vulnerabilities connected to climate change in the urban environment. By contrast, reactions that inadvertently exacerbate vulnerabilities or bring about significant undesirable outcomes are termed "maladaptive" (Barnett and O'Neill, 2010).

Societies have been affected by environmental change throughout history, but due to the severity and rapidity of current climate change, traditional responses are becoming less effective (Pradhan et al., 2012). The specific challenges of ongoing climate change pose new risks, many of which require societal preparation, such as efforts to cope with drought, heat waves, sea level rise and more intense and frequent extreme weather events (Adger et al., 2007). The capacity to adapt, as identified by Brookset al. (2005), is associated with a wide variety

of supporting mechanisms across society, such as governance, civil and political rights and literacy. Consequently, certain vulnerabilities can be exacerbated due to socio-cultural and economic factors, or adaptations may be enhanced by these same factors. The key is to identify both strengths and vulnerabilities to inform adaptive and mitigating strategies.

The concentration of population in urban areas magnifies vulnerabilities as poverty interacts with diminishing municipal services and climate change, with its attendant environmental disruptions such as declining rainfall, rising temperatures and water and food scarcity. Independently, these vulnerabilities can be severe, yet as they interact their impacts are magnified (United Nations Human Settlements Programme (UNHABITAT), 2011; Wilbanks et al., 2007). When insecurity of food, power and water supplies are further strained by climate change, the result may be deterioration of livelihood stability, sanitary conditions, and human health, while the ability to respond to such challenges simultaneously declines. Due to this tangled web of causes and effects, measures to counter the impacts of climate change on urban residents may only indirectly involve the environment. Individual and community interventions to support adaptations may therefore address infrastructure, provision of basic services, disaster preparedness, water and waste management, affordable housing, renewable energy options, insurance and healthcare (Khattri et al., 2010).

Poverty alleviation is a key component of the adaptation process, as those who are currently vulnerable due to poverty have fewer resources upon which they can rely. Furthermore, preventative measures to support those at risk from falling into poverty must be in place to ensure climate change does not push more people into poverty (Krishna, 2009). Adaptation to climate change needs to be understood within this wider development context (Olhoff and Schaer, 2010).

### Urbanization

Global populations are shifting from rural to urban centers, with a majority of people now living in urban areas (United Nations Department of Economic and Social Affairs (UNDESA), 2009a) and 70% expected by 2050 (Asian Cities Climate Change Resilience Network, 2009). This trend is clear regardless of the morphological, functional, administrative and other criteria used to define what constitutes an urban area. Although rural to urban migration in Ethiopia has been significant, less than 20% of the population currently lives in urban areas. However, it is estimated that one-third of the population will be urban by 2040 (Evans, 2012). Urbanization is largely focused in the capital, Addis Ababa, one of Africa's largest cities (UNDESA, 2009c). The 1994 census

reported slightly more than 2 million residents in the city, while the 2007 census found that the population had expanded to more than 4.5 million, a figure that has surely only increased during the last half-decade. Climate change is expected to be a significant factor in rural to urban migration, as rural areas become uninhabitable or less able to provide livelihoods (Ferris, 2012). UNHABITAT (2011) states that as urbanization increases, understanding the unique challenges climate change poses to the urban environment will be vital.

The impact of climate change will fall first and most heavily upon the poor, whose weak or non-existent support systems and limited ability to adapt place them at greatest risk. Additionally, the negative effects of climate change upon the urban poor will have significant ripple effects in the national and global spheres. However, in many cases governments and practitioners have not fully understood these risks (Moser and Satterthwaite, 2008). As every urban area is unique, it is inappropriate to make generalizations regarding vulnerabilities and potential responses. Rather, vulnerabilities and mitigation and adaptation strategies need to be specifically designed for the unique needs of each context.

### Ethiopia

The population of Ethiopia is approximately 83 million, making it the 13<sup>th</sup> most populous country in the world and the second most populous in Africa (UNDESA, 2009b; Central Intelligence Agency (CIA), 2012). With a current growth rate of 3.18% and a significant proportion (46.3%) of the population under the age of 15 (United Nations Population Fund (UNFPA), 2008; CIA, 2012), the population is expected to continue to grow rapidly and is projected to reach 119 million by 2030 and 145 million by 2050 (Evans, 2012).

At just over 1.1 million square kilometers, Ethiopia is the world's 27<sup>th</sup> largest country by land area (CIA, 2012). Highlands dominate the central portion of the country, which features a moderate climate and receives significant rainfall during the summer months. These plateaus gradually slope downward to the lowlands, steppes, and semi-arid deserts of the more peripheral regions; these are typically significantly hotter and drier.

The rural areas of Ethiopia are largely home to subsistence-based farmers. Agricultural productivity is limited as less than one percent of smallholder farmers utilize irrigation, and farming remains largely rain-fed (Central Statistical Agency of Ethiopia (CSA), 2009). Additionally, productivity per household is decreasing as the average household landholding is declining due to population growth and the subdividing of farms within families (Africa Climate Change Resilience Alliance (ACCRA), 2011).

This rapid population growth is one of the leading

causes of the country's myriad problems. Unemployment is approximately 20.5% (Evans, 2012); approximately two-thirds of the population earns less than US\$2 per day; and gross domestic product (GDP) per capita in 2010 was a mere US\$358, the seventh lowest level globally (Evans, 2012). The overall national literacy rate is only 47%, with the rate for women (38%) significantly lower than that for men (56%); by contrast, 87% of Addis Ababa residents are literate, although gender-based inequality is still evident (81% for women versus 94% for men) (CSA, 2012). Malnutrition remains a major challenge: 35% of children are moderately underweight while 14% are severely underweight, and 51% of children suffer from moderate stunting and 28% from severe stunting (Evans, 2012). It is generally thought that children in rural areas are disadvantaged in comparison with their urban counterparts; however, this is often not the case due to widespread urban poverty and overburdened municipal services (Bartlett, 2008).

Ethiopia's overall vulnerability to climate change was ranked 10<sup>th</sup> of 233 countries (Center for Global Development (CGD), 2012) and climate change is considered a significant threat to the development of the country (ACCRA, 2011). Climate has played a primary role in recent disasters, with seven major droughts and six major floods experienced in the last three decades (World Bank, 2010). As a result, Ethiopia's development and growth potential have been held back by climate variability, uncertainty and change (Dinku et al., 2011), all of which are expected to increase in the future. Ongoing deforestation, degradation of land, soil erosion, biodiversity loss, desertification, water and air pollution and increased water stress have already intensified environmental strain.

Mean annual temperature increased consistently between 1960 and 2006, rising 1.3°C. In addition, hot days have become more frequent, while cold days have become more infrequent (McSweeney, New and Lizcano, 2007). Fifteen different climate models all predict temperatures will continue to increase, differing only in the extent and speed, whereas mean annual rainfall projections differ widely (World Bank, 2012).

On the national level, the Ethiopian government reports that climate change is increasing food insecurity, further degrading land due to heavy rainfall, and causing floods that have damaged infrastructure. Furthermore, outbreaks of disease are more common (Federal Democratic Republic of Ethiopia, 2007). Drought is listed by the government as the greatest hazard resulting from climate change (Federal Democratic Republic of Ethiopia, 2007) and some regions are experiencing significant declines in annual rainfall (ACCRA, 2011). As rural agriculture is largely rain-fed and accounts for 47% of GDP, the economy may be greatly affected by climate change (World Bank, 2010).

One study of climate change and its impact on Ethiopia was undertaken by ACCRA in three rural sites. Each site

demonstrated the potential of participatory adaptation development interventions and stressed the impact that climate change is already having in these areas (ACCRA, 2011). A second report focused on pastoralists and agropastoralists in Ethiopia, because of their extreme vulnerability to climate change (Naess et al., 2010). These studies concluded that livelihood promotion should be combined with disaster risk reduction and social protection mechanisms so that communities can meet their needs in the face of change. Both studies highlight rural residents' recognition that the environment is changing and the need to address these new challenges. ACCRA (2011) found that many projects are not utilizing existing data and techniques to assess and fully understand vulnerabilities.

Finally, gender inequalities tend to restrict women's employment to sectors sensitive to climate change, such as subsistence farming, making gender an important consideration in studying vulnerabilities in times of climate change (Skinner, 2011). Likewise, the effects of climate change will not equally affect people sharing urban environments: gender, age, ethnicity and wealth all affect the extent of socio-cultural and institutional vulnerabilities.

## METHODS

This study aims to understand vulnerability and adaptability, focusing upon the perspectives of those living in the study area. This participatory vulnerability and adaptability analysis resulted in a prioritization of vulnerabilities based upon the lived experience of those within the study area and an examination of the actual and potential processes of adaptation (Bennett and Roberts, 2004; Herman, 2010).

Compared with other data gathering methodologies, interviewing in qualitative research provides several advantages: it is a flexible approach that does not typically require extended on-site stays; it is less structured than interviewing for quantitative research (Bryman, 2008); and it facilitates the discovery of unforeseen results. This stands in contrast to interviewing for quantitative research, which seeks to understand the perspective of a target group or population. However, such qualitative research may result in a time-consuming data collection process, and it is potentially less objective, as the interviewer can direct conversation, and even opinion, with tone, body language, word choice and other socio-cultural cues. This approach can enhance, or call into question, macro-level statistics by explaining micro-level processes (Brock, 1999).

Formal interviews were conducted with twelve community members in Addis Ababa, representing different socio-economic, ethnic and gender groups. Interviewees were selected based on a set of predetermined criteria, which included being at or above the age of sixty, in order to enable historical comparisons and analyses (Krishna, 2009). The selection process sought equal representation from male and female participants. Although no formal requirements were set for ethnic and socio-economic representation, an effort was made to ensure that diversity existed among the interviewees. Differences, particularly those resulting from varying socio-economic status, were evident: some interviewees struggled to pay for basic needs such as food and water, while others were able to afford relatively new and expensive items, such as solar technologies.

The narratives indicate trends experienced across different segments of the city. The analysis presented below seeks to present the commonly experienced and expressed context, and when unique contributions or situations are highlighted, they are noted as such. Local interviewers were employed to reduce power imbalances in the interviewing process and to reduce linguistic barriers. Both a male and female interviewer assisted with the interviewing process to reduce the potential role of gender imbalances. All interviews took place in Addis Ababa. They were anonymous, pre-arranged, audio-recorded, transcribed and translated. This procedure was followed by informal interviews with representatives from twenty-five bodies, including the Ethiopian government, non-governmental organizations, universities, United Nations agencies and journalists.<sup>1</sup>

## ANALYSIS AND DISCUSSION

This section is devoted to interviews conducted with residents of Addis Ababa. It has been divided into seven parts according to dimensions of urban life that the authors anticipated might be directly impacted by a combination of ongoing climate change, rural-to-urban migration and attendant strains upon municipal infrastructure. The sections are: temperature, rainfall, environment, energy, food, water and sanitation. The numbers enclosed by parentheses following each quotation correspond to a particular respondent, with each assigned a number of one through twelve.

One important observation that ought to be made at the outset is that many Ethiopians do not feel they can speak freely on all issues due to the prosecution and imprisonment of journalists and politicians who have expressed critical opinions about the government. Residents are generally unwilling to speak on the record about politics, even if protected by anonymity and when their attitudes do not reflect directly on the country's current rulers. Some of the responses when questions seemed to touch on politics included:

"I don't know. I don't struggle with the government. You are exposing me?" (1)

"I have a reservation with the questions because they seem politicized." (4)

"Let's not talk about it." (12)

As such, topics directly related to the government were avoided, and participants were informed that they could skip any question(s) and stop the interview at any time.

<sup>1</sup>The authors communicated with members and/or representatives of the Ethiopian Agricultural Transformation Agency, the Ministry of Agriculture, the Ministry of Health, the Environmental Protection Authority, Harari Environmental Protection Authority, Oxfam, USAID, One Acre Fund, World Learning International, Fair and Sustainable Ethiopia, African Forest Forum, Ethiopian Institute of Agricultural Research, Addis Ababa University, Hossana Health Science College, Unity University, Ethiopian Civil Service University, Bahir Dar University, Axum University, New York University, the United Nations Economic Commission for Africa, UN-HABITAT, the World Food Program, the World Bank and *The Guardian* and *Horn of Africa* newspapers.

## Temperature

The consensus amongst the interviewees was that the temperature of Addis Ababa has increased. Indeed, mean annual temperatures have risen; the frequency of hot days has increased by 20% and hot nights by 37.5%, while the number of cold days has decreased by 6% and cold nights by 11% (McSweeney et al., 2007). Temperatures are expected to continue to increase throughout the coming century, with projections ranging between 1.5 and 5.1°C, with increasing hot days/nights and decreasing cold days/nights (McSweeney et al., 2007). One participant stated:

"Yes, it has increased. Formerly it was cold in Addis and low temperature. Step by step it changed to moderate temperature. Currently, it has desert-like weather." (10)

Interviewees attributed this temperature change to several causes:

"There is change in climate. The temperature of the city is increasing. Though I don't know the reason why it is increasing. Maybe it is because of deforestation." (11)  
 "Earlier, the residents were very small in number and the city was treed and circled with trees. So the temperature was colder. But during the *Derg* regime (in power from 1974 to 1987), people started to cut down trees and the government became less strict in controlling such things. So both the farmer and the jobless started to cut down trees for selling. Hence, the forests started to become open lands. That is where the hot temperature stemmed from." (12)

The loss of green space is tied to the increase in population, which, as previously noted, has dramatically increased. Some respondents linked this rapid population growth and its attendant changes, such as a boom in construction and the urban heat island effect, to temperature:

"It is very warm now. It is because of population growth which resulted in congestion." (1)

"In the past, we were not measuring it but as I have heard, now sometimes it reaches 28°C. But from what I feel, it seems a bit warm these days. This is due to the construction of big buildings, deforestation, and air pollution." (6)

Kifle (2003) has, in fact, found that urban heat due to population growth is correlated with increases in minimum and maximum temperature trends in Addis Ababa. Although this research has been used to argue that any temperature changes observed are localized and due to the urban heat island effect, rising temperatures are seen throughout Ethiopia and across the globe. The urban heat island effect is therefore a compounding

factor in rising temperatures in urban settings.

The causes of temperature increase include global changes, such as those related to climate change, and local changes, such as the loss of flora, increases in population, pollution, road cover and buildings. The change in temperature was spoken of as more of a nuisance rather than posing any serious challenges to life or health. Nevertheless, although overheating has not been a major issue for residents of Addis Ababa in the past, increasing temperatures and more frequent very hot days may impact public health, particularly for children and the elderly. Additionally, although malaria is non-existent in the city due to its moderate temperatures and high elevation, future temperature increases may expand the areas in which malaria and other tropical diseases are prevalent (Bartlett, 2008). Potential adaptive mechanisms, from the individual to the state, include ground water cooling, green infrastructure, shading, increase of evaporative cooling, reflective building materials and improved ventilation and insulation (Shaw et al., 2007).

## Rainfall

Rainfall is seasonal in Ethiopia, driven largely by the Inter-Tropical Convergence Zone (ITCZ). ITCZ movements vary due to changes in the Indian Ocean sea-surface temperature (McSweeney et al., 2007). As a result, the length and timing of rainy seasons throughout Ethiopia fluctuate. Additionally, the El Niño Southern Oscillation (ENSO) is associated with reduced rainfall during the main June to September rainy season in central Ethiopia, where Addis Ababa is located, which can result in drought and famine (McSweeney et al., 2007). Some rainfall projections for the coming century indicate increases in annual rainfall in parts of Ethiopia, particularly the southern regions (McSweeney et al., 2007). Studies indicate that rainfall in Ethiopia between 1898 and 2002 fluctuated, but few trends and no statistically significant changes were observed (Conway et al., 2004).

Addis Ababa receives the majority of its rainfall between June and September, with average precipitation in other months ranging from 10 to 100 mm (British Broadcasting Corporation (BBC), 2012). Interview participants noted that rainfall patterns have changed, with the rainy season both shorter and drier. This can be understood variously, as there have been no statistically significant changes in rainfall pattern. It may be that the periods recalled by interviewees are significantly different or that the decrease in rainfall is associated with the decline of natural waterways and an increase of storm drainage services in the city. Participants might also be influenced by reports regarding changes in rainfall in other parts of the country, alluded to in the second

quotation below. Whatever the reason, the majority of the participants felt rainfall had decreased:

“Earlier, we used to have a long rainy season. Now it rains very rarely. We cannot even say it rains. Earlier, if it started showering during night, it might continue till midday. So the days were cold and dark. Now, it is not the case.” (1)

“Both the season and amount of rainfall decreased. The small rainy season which used to stay from February/March to May is now shifted to the next rainy season which is called Meher [autumn].” (6)

The suspected causes of rainfall change were similar to that of temperature change, namely a decline of vegetation and an increase in pollution:

“There is a significant change in the amount of rainfall as well. It is decreasing (...) The reason is climate change. There are no plants that protect the place. The area is changed into desert. So it is changed in to lowland. Earlier this season was rainy but now it is difficult to get rain.” (2)

National television stations are some of the main sources of information regarding climate change, as they have actively promoted tree planting. Ethiopia has been recognized for its massive reforestation campaign: the United Nations and Ethiopian Ministry of Agriculture state that 1.4 billion trees had been planted in Ethiopia as of 2009 (United Nations Environmental Programme (UNEP), 2009). The role of trees was cited by interviewees as a cause for many problems, which demonstrates widespread awareness of that media campaign but also the limited acceptance of other aspects or impacts of climate change.

Certain regions of Ethiopia, specifically the semi-arid regions, have experienced decreased rainfall (International Institute for Environment and Development (IIED), 2007). This has in turn affected agriculture and horticulture, both of which are relied upon by residents of Addis Ababa. Agriculture is the largest consumer of fresh water; therefore rural agricultural development efforts need to facilitate both more efficient uses of available water and higher crop yields from available water sources (Menter, 2012).

## Environment

Although the interviewees demonstrated a keen awareness of a variety of environmental issues, they largely focused on deforestation:

“The forest should be protected (...) We are burned. We are exposed. Trees can do a lot of things. Animals cannot

get grass to eat. If there is no animal, what would be the fate of mankind?" (1)

"When trees are cut, climate changes and villages turn to desert. We should avoid deforestation. We need to keep on planting trees (...) The trees were deforested and suffered. But recently people are trying to replace the trees. That is why the weather is not good. Now it's encouraging that plantation of new trees are conducted everywhere ." (10)

Despite the crucial role that the environment plays in all spheres of life, it was not mentioned as a major vulnerability by interviewees. This is likely due to the disconnection many urban residents have with the environment: water is piped to the home and food purchased at shops. The limited concern for wider environmental issues suggests an important role for education and the need to raise public awareness. Other areas of general concern include air pollution, river pollution, drinking water contamination and soil contamination. These each impact other sectors; for example, air and water pollution affect human and animal health, drinking water contamination increases treatment costs, soil contamination affects crop fertility and so forth.

Measures to address these problems will not be enacted unless those concerns are shared by a significant portion of society. Examples of how participatory climate-change adaptation might take place include: developing rain calendars, using video, behavior-change communication, community mapping and integration of environmental education in schools (IIED, 2009). Government policy and markets, however, may play a greater role in nudging communities to make positive changes (Pradhan et al., 2012).

## Energy

Within the last half-century, residents of Addis Ababa have seen great changes in predominant energy sources: lighting has been predominantly provided by firewood, then kerosene, and now electricity, while the predominant cooking fuel has shifted from firewood, charcoal and other biomass to a combination of organic sources, kerosene and electricity. The declining use of kerosene for light is due to its rising cost and the increasing availability of electricity. The shift from fire to electricity for cooking, heating and lighting has brought significant benefits to urban residents. Indoor air quality has improved, thus improving health, and the quality of life has risen as various electrical appliances have been introduced into households. This change has a number of causes, notably the rapid expansion of the electric grid over the past five years and various socio-cultural, economic and legal pressures that pushed residents to stop using firewood and other biomass and use

electricity.

The changes in fuel use were described thus:

"We used small kerosene lamps and firelight itself. In the evenings we used to eat dinner by burning tree leaves. It is much better now (...) in the past, there was no electric power at all. However big a feast you had, you treated your guests by burning tree leaves." (1)

Nevertheless, inconsistent electrical supply and resulting brownouts and blackouts have forced some reversal of this trend, as people have had to switch back to wood to satisfy their needs. High demand and a strained electrical distribution system are likely to continue; thus the shift to electricity is expected to be gradual (Evans, 2012). Most interviewees consider the challenges of supplying adequate electricity to be temporary and have found alternatives in the meantime:

"It is insignificant. If they cut [the power] today, you know for sure it will come tomorrow." (1)

"Even though it goes frequently, it returns soon or by the next day." (9)

However, some were concerned that electrical shortages are becoming more frequent:

"Now, if it goes you need to wait for a day or two. Even today, the light went around 4:00 P.M. and came back at around 7:00 P.M. It is going from bad to worse." (4)

Others recognize the problem and are actively seeking to change the situation:

"We are appealing the case to the concerned [municipal] body. They have told us that the electric cables are too old and need to be changed." (3)

Electrical shortages are attributed to population growth and urban expansion:

"The problem has increased with the increase in the population. Population increase results in shortages of everything. You can't help it." (7)

"There are so many factories and everybody is using electricity. They can't distribute it equally." (2)

Some pointed out that the shortages could be better managed if the grid were better maintained and upgraded to meet demand. That, along with the issue of good governance, was raised by one participant:

"There is some electricity cut problem in our surrounding. This came from the load on the old transformer. It bursts out easily and they don't come and maintain it on time. They need to replace it with a new and better one so that

it can resist (...) In principle, the *Kebele* [local government] is there to address the problems of the residents not to take salary. So they are responsible to forward issues like this one to the attention of the concerned body. However, the truth is they are engaged in other political issues. So even if we forward the petition to the concerned body there is no immediate response. I am sure it will continue like this for an additional year or so. They don't listen to us." (12)

As many residents in Addis Ababa already face regular electrical outages, some have begun to use renewable technologies such as solar power, while others have returned to methods of the past, such as using candles.

"We use candles. A couple of minutes ago, even you and I were using a candle when the power went. That is it. I also have a solar torch. I prefer the torch unless I forget. Candles are expensive." (4)

"When it [the electricity] goes, we use torches and solar bulbs. I like it. My son bought it for me." (1)

"Due to the technology, there are various options like solar equipment. So it may even solve the problem. We can buy them as our capacity permits...The people are not yet used to it. But it is being advertised. So when the electricity problem grows, it will be a must to shift to solar energy." (2)

Others, however, were not aware of solar-powered options, or they identified cost as a major barrier for the adoption of these technologies:

"I haven't seen people using solar panels widely here in Addis at the household level. But we have installed for a church in the countryside, which cost 30,000 birr. Now the church is using it." (11)

"No, how on earth? That is for the rich. I can't afford more than 10 or 20 birr. We don't use it." (6)

Institutional solutions to concerns such as grid maintenance and upgrades may appear absent to some at the local level, but most are aware of the macro-level developments to address the power shortage problem: a series of large hydroelectric dams. When international funding options went dry for the Renaissance Dam, the Ethiopian government turned to its citizens for the necessary capital via a government-issued bond, which received significant support. There is great optimism due to these dams and therefore a degree of tolerance toward the current electrical outages:

"So far, no improvement, but as an Ethiopian, I envision that in the future, when the dams are constructed, these types of problems will be solved." (2)

"That is why we are joining our hands for the construction of the Grand Renaissance Dam. Our vision is that once

the country is able to satisfy its own needs, it may even sell the surplus to other countries. So, the power should be increased. Plus, Ethiopia has the water potential to produce from 20,000 and 30,000 megawatts not even 10,000." (4)

Residents of Addis Ababa and citizens of Ethiopia need to be empowered and supported to make more sustainable decisions. For example, solar energy may be unaffordable for most, but governmental policies can support shifts in energy use. This can be seen in the government's decision (through the state-owned Ethiopian Electric Power Company) to promote the use of energy saving compact fluorescent light bulbs. Costs were shared by international donors, the government and the consumer, but ultimately all parties benefited. This can also be done with other alternatives. In the public sphere, energy use can be regulated and incentives can help the country meet its long-term energy objectives through greater efficiency and more sustainable energy sources (United Nations Secretary-General's High-level Panel on Global Sustainability 2012, UNHABITAT 2011). Westley et al. (2011), however, warn that analysis of all forms of changes must be evaluated so as to prevent a reinforcement of unsustainable practices, whether on the individual, national or global level.

## Food

Agriculture and horticulture are crucial contributors to the Ethiopian economy, accounting for nearly half of GDP, over 90% of exports and 83% of employment (United States Agency for International Development (USAID), 2010). Despite the size of the sector and significant increases in agricultural production, over 25 million Ethiopians go hungry annually, and over a quarter of them are chronically food insecure (United States Agency for International Development (USAID), 2010). Although agricultural output potential is high, foodstuffs also account for a significant portion of imports (Evans, 2012).

The lack of food security, due to changes in accessibility and demand, is compounded by high inflation and increasing agricultural exports. The Ethiopian government has actively supported foreign investment in agriculture, which is largely export-orientated and has relocated smallholder farmers in the process (Cochrane, 2011). The result has been skyrocketing prices for food. Between 2008 and 2010, the price of goods consumed by the poor rose by 78% in urban areas and 85% in rural areas, while government efforts, such as a 20% devaluation of the currency in 2010, only temporarily lowered inflation levels (Evans, 2012).

Of the potential vulnerabilities addressed in this study, all respondents cited a stable and affordable food supply as their most serious concern; it also poses a challenge



that many people have been unable to overcome. Some are resorting to reducing food intake or securing leftover or waste food. Those who are making such changes are not only the extremely poor and already vulnerable, but also the working class, including teachers and government employees. They describe the situation as follows:

“We minimize the amount we buy because it is better to live than die.” (3)

“They are not overcoming it. They minimize the amount of their consumption. Teachers have their own system for diet. They call it five-eleven. They don’t eat breakfast, lunch and dinner. They eat brunch and take another meal around 5:00 P.M. Others take very small and food lacking nutrition. If you take youths around Markato, they buy the leftover food from restaurants. They call it ‘euffa.’ This is how they survive.” (4)

“You have to minimize the amount of your consumption too. Presently, our monthly household consumption is only 25% of our consumption in the past. The value of the money is decreased. We also try to replace *teff* [grain] with maize and barley. If you have good income, it is okay. For the poor and those who do not have permanent income, the situation is difficult.” (5)

A significant reduction of food intake or a switch to less nutritious foods is maladaptive due to its negative impacts on health (Barnett and O’Neill 2010). In this case, people are adapting to changes according to their capacity, but those adaptations may end up further increasing rather than decreasing vulnerability.

The emergence of food as a major issue was explained variously, for example by reference to population growth, food exports and manipulation by food traders. All of these causes indicate increased market stress and intensifying challenges:

“It has never been like this in my life. I don’t mean to exaggerate things. I was born and grew up here. It is strange. It is a big problem now (...) The population is increasing. People are flowing from the countryside to the city because the size of farmlands is shrinking. The demand for food is high as all these people need to eat (...) All these things are contributing to the rise in food prices. In addition, in the past, only a few food products like sesame, linseed, niger seed and green beans were exported. Now, all farm products are exported. That results in a high cost of living.” (2)

Almost all participants expressed concern and frustration with the trend of exporting agricultural produce:

“It is good to export, but first the internal need should be satisfied. After that you can send and get money. It is not wise to export food while people are starving.” (2)

“The government exports barley, chick peas, etc. and

imports wheat. It is no use. It would be much better if we keep our own production. Actually, the government is in big problem because it needs foreign currency for the construction of the dams and other things. We need to export more to get foreign currency and thereby reach to where the other world is now. Our money value is not good enough to afford the foreign currency.” (12)

The role of traders within the Ethiopian food market produced an interesting discussion, with some respondents asserting that traders ought to be able to buy and sell as they wish in a free market, while others felt that the price of foodstuffs ought to be regulated by the government and the hoarding of certain crops prohibited. Most of the study participants believe that the market needs to be regulated, particularly with respect to basic necessities:

“The traders. They send most food overseas and stockpile the remaining stock until they make sure that they can sell it at maximum profit. There is no one to control them (...) There was community dialogue on the issue, but it didn’t improve the situation. Price rating was also tried, but traders said it is a free market economy and they hide the food (...) We have no choice. I am very unhappy to be Ethiopian. This is very difficult. There is a big difference in price between last year and this year. What is new? A few years ago, we were complaining about the price of *shiro* [roasted beans], which was 9 birr for 1 kilo. But now it is 27 birr. Some even say 30 birr. Mind you, *shiro* is food for the poor. So how can we stand it?” (2)

“There is a big struggle so you have to struggle for survival. I don’t know what to do. The traders say that the government sets high tax rates, and consumers say that the traders have set a high price. In the middle of all this, the poor can’t afford to live. It is not life.” (2)

“All these problems result from cruelty, the free market; merchants call one another to increase the cost of basic food items.” (10)

Several participants mentioned the impact that ongoing environmental changes such as rising temperatures are believed to have on agricultural production, including changes in rainfall and ground water for irrigation.

“There are farmers who depend on the rain to grow crops because there is no water nearby for irrigation. In that case, it will affect their harvest.” (3)

“People are saying that it is because of the shift in the rainy season, which made the farmers to hold their crops.” (5)

However, contrary to these statements, some indicate that between 1999 and 2009 more land was being cultivated and yields were higher (Evans, 2012). The

exact level of increase has been called into question on a number of occasions; nonetheless, it seems that shifting rainfall patterns are not significantly reducing overall agricultural output at this time, particularly as the government is investing heavily in agricultural development, from fertilizer and new seed varieties to irrigation and rural infrastructure. The government has also created one of Africa's most effective social protection systems, the Productive Safety Net Program (Evans, 2012). Yet hunger remains widespread.

One of the responses that has recently emerged in attempting to deal with rising food costs is the creation of Consumers' Associations (CAs), cooperatives through which members attain goods at lower prices by collective purchasing through direct farmer-to-consumer sales channels. CAs are growing in number throughout Addis Ababa, and many respondents who mentioned, or are members of, CAs were appreciative of their services yet also frustrated with their inability to secure food at consistently lower prices and to provide goods that people need.

"I am also a member of the Association. The Association provides very small things. We Ethiopians mostly consume teff, wheat, barley and the like, but the Association can't provide these things. They offer soap and detergents. Sometimes they bring food oil and sell to traders. So it is not helping." (2)

"There is a Consumer Association, but the association brings some items from wholesalers and sells to retailers, who are still traders. So it is not helping. The traders are selfish and always try to withhold the product in anticipation of an increased price in the future (...) The issue of food items is still serious." (11)

The ways in which people are adjusting to the changes in food prices (eating less nutritious food, reducing caloric intake, and eating waste food) are largely maladaptive and have resulted in increasing vulnerabilities. Food insecurity in Addis Ababa is not limited to the urban poor, but includes the working class, pensioners, and young families. The United Nations Secretary-General's High-level Panel on Global Sustainability (2012) suggests that individuals and governments alike can support positive changes regarding the consumption of foods towards a more sustainable diet. Strategies include improving agricultural practices; reducing waste and inefficiencies in the preparation, delivery and provision systems; adding micronutrients to staple foods; controlling unhealthy foods; and reducing the production of animal-based foods in favor of plant-based foods.

## Water

The provision of safe drinking water in Addis Ababa has

become increasingly difficult as the supply is subject to competing demands from a growing residential population, expanding industry located in and near the city and municipal uses such as sanitation. In the past, most residents sourced their water from rivers and streams that traversed the city, but many of those waterways have become polluted, have seen their course altered due to construction or have run dry, either due to decreased rainfall or upstream diversion. The recent introduction of piped water raised water quality and accessibility, but demand has outpaced infrastructure expansion, and long-term supply is uncertain as temperatures increase and rainfall patterns vary. Furthermore, contamination remains a serious concern, and many residents boil the government-provided water before drinking it. Future prospects for water availability, quality and delivery are grim, as an unsustainable reliance upon groundwater resources will stress already strained systems (McDonald et al., 2011).

Water shortages and outages are thus common throughout the city. However, not all districts experience the same challenges in ensuring a stable water supply: some areas rarely experience outages while others go weeks without water. Wherever one lives, the problem of contamination remains. Interviewees described the challenges they face:

"People suffer a lot. You can stand an electricity shortage, but water, you can't stand it more than two or three days. If you go to Feresay Legassion, you hear people complaining about water cuts that last for 15 or 20 days. They are suffering. Those who are able may find some, but the weak remain without water." (8)

"You can't live without water." (3)

The majority of the interviewees cited increased population as the main cause of shortages. Some also commented on the link between irregular rainfall and municipal water shortages or highlighted the effect that overconsumption and misuse of water can have on supply.

"The increase in population, houses and water consumption. We wash cars and utensils. People take showers, and the roads themselves are washed these days. So demand and supply do not match." (6)

"It is because there are many people in the city that the water usage and sewage increase. And if enough rain does not fall, we are likely to have a water shortage. It is a must. So a water shortage goes with the increase in the population." (7)

Everyone has been forced to adapt to the inconsistent water supply. Some strategies include filling up large containers and tanks while water is available, adjusting consumption levels or storing rainwater. Interviewees

explained:

“When the water comes once a week, people collect it and use it throughout the week. We have learned about saving. In the past we were wasteful, but now we save. We use jerry cans and other things to gather the water.” (2)

“Those who used to wash their face twice a day come to wash once. One who used to shower once a week starts to wash once a month. This is how we are withstanding the situation. Otherwise what can be done?” (4)

Apart from boiling, no participants mentioned any filtration or purification options. This may be an area for potential intervention: in Addis Ababa, *Giardia* (an intestinal parasite) is present in contaminated water, and rain-harvested water contains much particulate matter. Both of these forms of contamination call for public or private solutions.

Despite these water shortages, most participants do not cite water as one of the greatest challenges they are facing. They have been able to adapt, whether by adjusting consumption, saving water or purchasing it. However, this remains a significant vulnerability: population is growing, future supplies are uncertain, rising temperatures will likely increase consumption, rainfall patterns may shift and extreme weather events may create sudden crisis. The measure most commonly proposed by interviewees was the drilling of wells by municipal authorities to increase supply:

“If capacity permits, it is better to dig and use wells. We are using it (water from polluted rivers) because we have no choice. Otherwise using polluted water is not good for us.” (2)

One local government has already connected newly dug wells to the local water lines. This has not solved the problem, but it has alleviated it:

“Because of large number of construction and limited water sources, water scarcity is getting severe and severe. Underground water sources must be established, as there is plenty of underground water in Addis Ababa. For example, in our *Kebele* two borehole wells were constructed and connected to the water line and we are using from such source. But still there is a water shortage, and people move from one area to another carrying jerry cans in search of water.” (11)

Digging water wells, however, may not be as simple a solution as many participants believe, due to unsustainable usage and water contamination. Thus one participant believes that water will need to be sourced from outside the city:

“I know there are some attempts to dig water wells. But

that is also difficult because there are so many wells for toilets. So where can one dig a well? Even if you dig, it will be easily polluted. Hence, the water we use should come from outside the city.” (12)

Contamination of water occurs at the source, while being collected, during transportation and also at the site of use. Overlapping duties at the ministerial level complicate the situation, as the Ministry of Water and Energy is in charge of the provision of safe and clean water while the Ministry of Health monitors water quality. The exact responsibilities of each ministry remains unclear; as a result, water testing is not done regularly, and most of the data measure consumption *quantity* rather than water *quality*. Furthermore, limited funding is set aside to address issues of water quality throughout the country. As of 2012 there was neither an updated national database on water quality nor an established system in place to monitor water quality.

The specific question of water shortages and the broader issue of responsibility for social issues highlighted differences in attitude among interviewees. Some felt that such issues should be addressed by governmental bodies while others said they actively address these problems in their communities and advocate for governmental solutions:

“The government is supposed to solve the problem, not me.” (3)

“Government by itself means nothing. It works in collaboration with the people. Even in our surrounding now, a water well has been dug so water can be filtered and distributed to the people. This is one solution. As I said [before], the problem is high population size.” (7)

“Now, it is getting better after we started to raise the issue in our meetings with the government sector offices. Now, water cuts last no longer than two days.” (3)

The greatest stresses with respect to water stem from provision and contamination. Systems must be created to ensure the reliable provision of safe water to all. To achieve this, a number of measures are available. Water storage capacity, at the household and national levels, needs to be increased dramatically. Education on wiser use of water, water recycling and water collection should lead to greater conservation. On the community level, bore wells and decentralized treatment plans can also alleviate some stress on the water supply. Finally, the national government can implement efficiency standards, pollution regulations and integrate sustainable drainage systems (Shaw et al., 2007).

### Sanitation

In Addis Ababa, a combination of rapid population growth, inadequate sanitation infrastructure and competing demands for increasingly scarce water have

placed the existing sanitation and sewage provision under great pressure. The system is currently unable to meet residents' demands, which increases individual and community exposure to disease spread by open sewers, polluted waterways and uncollected trash:

"People dump their garbage on your doorway and throw waste everywhere. The city is unclean. Household waste is not being collected regularly. Especially during holidays, you can't go outside your house because the innards of animals are thrown away everywhere. It is very difficult." (5)

"The problem is the factories. They dump their waste in the rivers, and we use those rivers to grow vegetables. Sometimes toilets may also be connected to rivers and pollute the surroundings. This affects our health." (2)

The government has taken measures to improve the situation, such as establishing a household waste collection industry, whereas in the past people disposed of their waste independently. In addition, new housing developments with improved drainage and waste disposal systems are replacing older homes. On the municipal level, the government is also constructing improved sewer systems and has enacted legislation on waste disposal.

Public toilet facilities are an affordable option for the government as a means to control waste in areas where open defecation is common. There are a number of options in addition to fixed toilets, such as portable toilets and 'flying' toilets; in some cases these are set up as micro-businesses to address the sanitation challenge and create jobs. These initiatives are laudable, yet much remains to be done to safeguard public health.

## Conclusion

This study presents macro- and micro-level data to identify the climate-related challenges and adaptations that exist in Addis Ababa, the largest urban center in Ethiopia, and facilitates the prioritization of vulnerabilities to inform and support programming and policies. As the effects of climate change are already being felt and are expected to increase in intensity over time, effective governmental action will be critical in making the city a livable place. As identified in this study by interviewees, hazards abound, from poor sanitation to unreliable supplies of drinking water and electricity. Most importantly, food security and supply were noted as posing the greatest vulnerability, yet its causes are complex and suggested remedies would rely upon the regulation of markets to determine prices and restrict exports and hoarding.

Vulnerabilities within the urban environment currently have the greatest impact upon the poor, a problem that experts and city residents anticipate will increase.

Participants in this study believed that economic progress in Ethiopia "will benefit some and ignore some" (10) and that the "poor remain poor" (5). The adaptations made by the poor and other populations within the city will enhance or reduce overall vulnerability.

There must be intersectoral action by international and local stakeholders in order to address these challenges, from foreign investment to sanitary provisions in urban slums. The recommendations made by departments of environment must be reflected in all other governmental sectors: development, investment, trade, education, health care and beyond. Otherwise, if action is piecemeal and uncoordinated, the hardships faced by city residents are sure to increase. Tanner et al. (2009) found five characteristics that form the basis of climate resilient urban governance systems: (1) decentralization and autonomy, (2) accountability and transparency, (3) responsiveness and flexibility, (4) participation and inclusion and (5) experience and support. The local governance system in Addis Ababa satisfies the first point; however, the remaining four will require significant effort from government and civil society. Neither individuals nor governmental authorities will be able to address these challenges alone: all must cooperate. In particular, residents must be included and seek a role in relevant decision-making processes in order to develop climate-resilient communities, and communities must be empowered to make development choices within the wider framework objectives.

The study also highlights the need for additional research. The factors involved in food pricing, as well as the roles played by hoarding and exporting, need further investigation. More analysis also needs to be done on current government measures, such as currency devaluation, to understand their effectiveness. As agricultural production levels have risen in recent years, a trend that will not be sustained over the long term, more research needs to look at how access to food will change as population grows and yield increases level off. This paper highlights many options for potential improvement, and each one needs to be looked at specifically to understand how market dynamics and incentives can be used on the individual, corporate and governmental levels to enable much-needed enhancements to municipal systems and greater urban sustainability.

## REFERENCES

- ACCRA (2011). Preparing for the future? Understanding the influence of development interventions on adaptive capacity at the local level in Ethiopia.  
<http://oxfamilibrary.openrepository.com/oxfam/bitstream/10546/188290/3/rr-accra-ethiopia-development-adaptive-capacity-report-271011-en.pdf>.
- Adger WN, Agrawala S, Mirza MMQ, Conde C, O'Brien K, Pulhin J, Pulwarty R, Smit B, Takahashi K (2007). Assessment of adaptation practices, options, constraints and capacity. pp.717-743 in *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Cambridge:

- Cambridge University Press.
- Adger WN, Huq S, Brown K, Conway D and Hulme M (2003). *Adaptation to climate change in the developing world*. *Progress Dev. Stud.* 3(3):179-195.
- Asian Cities Climate Change Resilience Network (2009). *Responding to the urban climate challenge*. Boulder: Eds. ISET.
- Barnett J, O'Neill S (2010). *Maladaptation*. *Global Environ. Change* 20:211-213.
- Bartlett S (2008). *Climate change and urban children*. London: IIED.
- BBC (2012). Addis Ababa. Retrieved 23 June 2012 from [www.bbc.co.uk/weather/344979/](http://www.bbc.co.uk/weather/344979/).
- Bennett F, Roberts M (2004). *From input to influence: Participatory approaches to research and inquiry into poverty*. London: Joseph Rowntree Foundation.
- Brock K (1999). *It's not only wealth that matters – it's peace of mind too: A review of participatory work on poverty and illbeing*. Washington, DC: World Bank.
- Brooks N, Adger WN, Kelly PM (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Climate Change* 15:151-163.
- Bryman A (2008). *Social research methods*. Oxford: Oxford University Press.
- CGD (2012). *Mapping the impacts of climate change vulnerability*. Retrieved 10 February 2012 from [http://www.cgdev.org/section/topics/climate\\_change/mapping\\_the\\_impacts\\_of\\_climate\\_change](http://www.cgdev.org/section/topics/climate_change/mapping_the_impacts_of_climate_change)
- CIA (2012). Ethiopia. Retrieved 23 June 2012 from <https://www.cia.gov/library/publications/the-world-factbook/geos/et.html>.
- Cochrane L (2011). *Food security or food sovereignty: The case of land grabs*. *Journal of Humanitarian Assistance*. Retrieved from <http://sites.tufts.edu/jha/archives/1241>.
- Conway D, Mould C, Bewket W (2004). Over one century of rainfall and temperature observations in Addis Ababa, Ethiopia. *Int. J. Climatol.* 24(1):77-91.
- CSA (2012). *Welfare monitoring survey 2011*. CSA Statistical Bulletin 545. Addis Ababa: CSA.
- CSA (2009). *Large and medium scale commercial farms sample survey 2008/09 (2001 E.C.)*. CSA Statistical Bulletin 446. Addis Ababa: CSA.
- Dinku T, Asefa K, Hilemariam K, Grimes D, Connor S (2011). *Improving availability, access and use of climate information*. WMO 60(2).
- Evans A (2012). *Resources, risk and resilience: Scarcity and climate change in Ethiopia*. Center on International Cooperation, New York: New York University.
- Federal Democratic Republic of Ethiopia (2007). *Climate change national adaptation programme of action of Ethiopia*. Addis Ababa: National Meteorological Agency.
- Ferris E (2012). *Protection and planned relocations in the context of climate change*. Legal and Protection Policy Research Series, PPLA/2012/04. Geneva: UNHCR.
- Herman K (2010). *Hearing their voices and meeting their needs: Victims of violence against women in Afghanistan*. *Journal of Humanitarian Assistance*. Retrieved from <https://sites.tufts.edu/jha/archives/694>.
- IIED (2007). *Adapting to climate change in urban areas (discussion paper)*. IIED. Retrieved from <http://pubs.iied.org/pdfs/10549IIED.pdf>
- IIED (2009). *Participatory learning and action: Community-based adaptation to climate change*. London: IIED.
- IPCC (2007). *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the 4<sup>th</sup> Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- Kelly PM, Adger WN (2000). *Theory and practice in assessing vulnerability to climate change and facilitating adaptation*. *Climate Change*, 47: 325-352.
- Khattri A, Parameshwar D, Pellech S (2010). *Opportunities for private sector engagement in urban climate change resilience building*. Hyderabad: Intellectap.
- Kifle B (2003). *Urban heat island and its feature in Addis Ababa*. Retrieved from [http://nargo.geo.uni.lodz.pl/~icuc5/text/P\\_6\\_11.pdf](http://nargo.geo.uni.lodz.pl/~icuc5/text/P_6_11.pdf)
- Krishna A (2009). *One illness away*. Oxford: Oxford University Press.
- McDonald R, Douglas I, Revenga C, Hale R, Grimm N, Gronwall J, Fekete B (2011). *Global urban growth and the geography of water availability, quality, and delivery*. *AMBIO* 40:437-446.
- McSweeney C, New M, Lizcano G (2007). *Ethiopia: UNDP climate change country profiles*. Retrieved 12 February 2012 from <http://ncsp.undp.org/sites/default/files/Ethiopia.oxford.report.pdf>.
- Menter J (2012). *U.S. farmers increase production and protect the land*. *Yale Environment* 360. Retrieved from <http://e360.yale.edu/>.
- Moser C, Satterthwaite D (2008). *Towards pro-poor adaptation to climate change in the urban centres of low- and middle-income countries (Discussion Paper)*. IIED. Retrieved from <http://www.iied.org/>
- Naess L, Sullivan M, Khinmaung J, Crahay P, Iberger A (2010). *Changing climates, changing lives: Adaptation strategies of pastoral and agro-pastoral communities in Ethiopia and Mali*. A joint ACF International, IDS and Tear Fund Report.
- Olhoff A, Schaer C (2010). *Screening tools and guidelines to support the mainstreaming of climate change adaptation into development assistance: A stocktaking report*. New York: United Nations Development Programme.
- Pradhan NS, Khadgi VR, Schipper L, Kaur N, Geoghegan T (2012). *Role of policy and institutions in local adaptation to climate change: Case studies on responses to too much and too little water in the Hindu Kush Himalayas*. Kathmandu: ICIMOD.
- Satterthwaite D, Huq S, Pelling M, Reid H, Lankao P (2007). *Adapting to climate change in urban areas: The possibilities and constraints in low- and middle-income nations*. Human Settlement Discussion Paper Series. London: IIED.
- Shaw R, Colley M, Connell R (2007). *Climate change adaptation by design: A guide for sustainable communities*. London: TCPA.
- Skinner E (2011). *Gender and climate change: Overview report*. Sussex: Institute of Development Studies.
- Tanner T, Mitchell T, Polack E, Guenther B (2009). *Urban governance for adaptation: Assessing climate change resilience in ten Asian cities*. Institute of Development Studies Working Paper 2009: 315.
- UNDESA (2009a). *World population prospects: The 2009 revision*. POP/DB/WUP/Rev.2009/1/F2.
- UNDESA (2009b). *World population prospects: The 2009 revision*. POP/DB/WUP/Rev.2009/1/F3.
- UNDESA (2009c). *World population prospects: The 2009 revision*. POP/DB/WUP/Rev.2009/2/F11a.
- UNEP (2009). *Tree Planting Campaign Hits Four Billion Mark*. Retrieved from [www.unep.org/Documents.Multilingual/Default.asp?DocumentID=589&ArticleID=6200&l=en](http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=589&ArticleID=6200&l=en).
- UNFPA (2008). *Summary and statistical report of the 2007 population and housing census*. Addis Ababa: UNFPA.
- UNHABITAT (2011). *Cities and climate change: Policy directions*. London: Earthscan.
- United Nations Secretary-General's High-level Panel on Global Sustainability (2012). *Resilient people, resilient planet: A future worth choosing*. New York: United Nations.
- USAID (2010). *Feed the future: Ethiopia FY2010 implementation plan*. Retrieved from <http://feedthefuture.gov/resource/ethiopia-feed-future-fy2010-implementation-plan>
- Westley F, Olsson P, Folke C, Homer-Dixon T, Vredenburg H, Looibach D, Thompson J, Nilsson M, Lambin E, Sendzimir J, Banerjee B, Galaz V and Leeuw S (2011). *Tipping toward sustainability: Emerging pathways of transformation*. *AMBIO*, 40: 762-780.
- Wilbanks T J, Lankao PR, Bao M, Berkhout F, Cairncross S, Ceron J-P, Kapshe M, Muir-Wood R, Zapata-Marti R (2007). *Industry, settlement and society*. In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- World Bank (2008). *Climate resilient cities: A primer on reducing vulnerabilities to climate change impacts and strengthening disaster risk management in east Asian cities*. Washington: World Bank.
- World Bank (2010). *The economics of adaptation to climate change*. Washington: World Bank.
- World Bank (2012). *Climate Change Knowledge Portal*. Retrieved 12 February 2012 from <http://sdwebx.worldbank.org/climateportal>.