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AfricInteract

Enabling research-to-policy dialogue for adaptation to climate change in Africa

## Research and Policies for Climate Change Adaptation in the West Africa Urban Sector SUMMARY



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## Acronyms and Abbreviations

AAS	African Academy of Sciences
ACMAD	African Centre of Meteorological Applications for Development
ATPS	African Technology Policy Studies
CAPA	City Adaptation Programme of Action
CSAG	Climate System Analysis Group of the University of Cape Town
ECOWAS	Economic Community of West African States
GEF	Global Environment Facility
ICTP	International Centre for Theoretical Physics
IDRC	International Development Research Centre
IPCC	Intergovernmental Panel on Climate Change
NACETEM	National Centre for Technology Management
NAPA	National Adaptation Programme of Action

NGO	Non-governmental organisation
START	Global Change System for Analysis, Research and Training
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-HABITAT	United Nations Human Settlements Programme

## Table of Contents

Acronyms and Abbreviations .....	2
1. Introduction .....	3
2. Overview of the West Africa Urban Sector.....	4
3. Research Related to Climate Change in the West Africa Urban Sector.....	5
4. Policies related to Climate Change in the West Africa Urban Areas .....	7
4.1 Climate change adaptation policy initiatives in West African cities .....	7
4.2 Policy actors and networks involved in urban climate change adaptation in West Africa.....	7
5. Gaps in Climate Change Adaptation Research and Policy in the .....	8
West Africa Urban Sector.....	8
6. Stakeholders and Opportunities for Collaboration in Research.....	10
on Climate Change in the West Africa Urban Sector .....	10
7. Conclusion and Recommendations .....	11
7.1 Conclusions .....	11
7.2 Recommendations .....	12

## 1. Introduction

Over half of the world’s population now lives in urban areas (Buhaug and Urdal 2012) and this global trend is evident in many parts of West Africa. Scientific evidence suggests that global climate change will have considerable implications for urban areas in West Africa. Some of the key climate-related hazards and trends observed include heat waves, rising sea levels and increased incidence of extreme events (Feiden 2011). Analyses of rainstorms on Lagos Island between 1971 and 1995 show that in the recent years, 1996–2005, rainstorms were heavier, although the numbers of rain days per annum had decreased (Adelekan 2010).

Many of the impacts of climate change are projected to significantly affect cities such as Port Harcourt, Lagos, Cotonou, Lome, Accra, Abidjan, Monrovia, Freetown, Conakry and Dakar, located along the coasts of West Africa where populations, capita assets and economic

activities are already at risk (Jalloh et al. 2011; Dodman and Satterthwaite 2008; Nicholls 2004). The impact of climate change and its complexity and scope require city authorities, governments, and stakeholders to collaborate to find innovative ways to manage the challenge of climate change. With increasing scientific knowledge on global climate change, adaptation becomes a major instrument in reducing the socio-economic costs of climate change and poverty in Africa (GLCA 2009), particularly in cities where the success of social and economic policies is crucial (World Bank 2010).

With support from IDRC, this review was commissioned by AfricaInteract and CORAF/WECARD (the West and Central African Council for Agricultural Research and Development), to enhance the knowledge base of researchers and to support research-based policy formulation for climate change adaptation in urban areas in West Africa. The review identified gaps and research and policies in climate change adaptation and mapped out climate change adaptation policy process, as well as how research informed policy formulation for climate adaptation in the urban areas of West Africa.

In conducting this review, answers were sought to the following key questions.

1. What is the role of climate change in the context of the multiple challenges and opportunities facing urban areas in the sub-region?
2. What is the current state of knowledge on adaptation to climate change in urban areas in the region?
3. What is the current state of knowledge on whether and how research findings are integrated in urban area policies in the region?
4. What are the major gaps in research on adaptation to climate change in urban areas?
5. What is needed to ensure that research findings are better integrated into urban area policies?
6. What is the current state of knowledge on the stakeholders involved with research and policy on adaptation to climate change in urban areas in the region, and how can stakeholder involvement be improved?

This publication is a Summary of the main report published by CORAF/WECARD and Future Agricultures.

## **2. Overview of the West Africa Urban Sector**

With a population of over 250m people and an estimated land area of 5m km<sup>2</sup>, West Africa's population is growing at an average annual growth rate of 3 percent (OHCHR 2011). Projections

show that the population of the sub-region could reach 430m by 2020 (Cour 2001). Many West African countries have a very young population, with over 40 percent of inhabitants fewer than 15 years of age (Hiraldo 2011).

According to Africapolis (2009), urbanization rates in West Africa range from 16 percent in Niger to 46 percent in Senegal. The countries in the West African region vary widely in population size, from Cape Verde's 500,000 to Nigeria's over 170m people. Another characteristic of urbanization in this region is the difference between the coastal and landlocked countries. Seven coastal and four landlocked countries have urbanization rates close to or above 40 percent and below 25 percent, respectively. The dynamics of urbanization has changed dramatically since the 1950s. For example, in the 1950s Liberia and Guinea had low urbanization rates while Nigeria and Guinea-Bissau were the most urbanized (Hitimana et al. 2011). This trend has changed in recent times. With economic growth rates of 5 percent in several countries and less political volatility, the urbanization dynamic and its associated transformations are expected to continue into the future (Hitimana et al. 2011).

### **3. Research Related to Climate Change in the West Africa Urban Sector**

The West African climate has undergone marked variability of climatic events. For example, there was a wet period between 1930 and 1960, followed by the drought of 1970–1980 and the return of rainfall in the 1990s and 2000s (Perret 2008). These events increase the level of exposure of people in West Africa to climate change risks. According to IPCC, projected impacts of climate change in West Africa include rising temperatures, rising sea levels and changes in the variability of rainfall (Parry et al. 2007).

Climate change could impact on economic activities in the coastal cities of West Africa in various ways, for example, damage infrastructure and affect the provision of electricity, water and sewerage systems. Rise in sea level and associated erosion threaten coastal industrial and residential areas and raise salinity levels, thereby changing the volume, timing and quality of surface water available for industrial and domestic use (Gasper et al. 2011). These impacts are not limited to the urban poor, but rich city-dwellers are better able to cope by protecting themselves from adversity through insurance of valuable property as well as their lives. Cities in West Africa that are most exposed to climate risk in the coastal lowland areas are Lagos and Port Harcourt in Nigeria (Abam et al. 2000), Cotonou in Benin and Banjul in The Gambia.

According to Jallow et al. 1999, the city of Banjul could disappear in 50–60 years through coastal erosion and sea level rise, placing over 42,000 people at risk. Metropolitan Lagos is highly susceptible to flooding in the rainy season (Adelekan 2010). In Cotonou, Benin, the areas most vulnerable to climate hazards such as coastal erosion comprise the first and fourth districts of Tokplégbé, Finagnon, Donatin, Akpakpa-Dodomey and JAK. One-tenth of Cotonou's population, estimated at 94,425 from the 2002 census, is affected by coastal erosion (Dossou and Gléhouenou-Dossou 2007).

### **Gender, social differentiation and adaptation to climate change in the urban areas of West Africa**

Gender is an important aspect in all dimensions of urban climate changes, including agriculture, water, energy resources, and climate-related natural hazards. Studies have shown that culturally determined factors play major roles in households and society, women and girls have crucial roles to play in the development of sustainable cities under the advent of climate change in creating resilient urban livelihoods.

Women and men have expressed coping strategies by diversifying their crops, investing human capital in the form of time and labour. In Niger, men regularly sell their livestock to sustain the household, while women retain their own livestock, and use livestock during natural hazards as a safety net for the household during natural hazards (Kristjanson et al. 2010). This example demonstrates interconnectivity between resilience, climate change impacts and gender differentiated roles. Therefore, to effectively address gender issues, it is important that climate risk management techniques incorporate gender differentiated groups are brought into play for appropriate climate adaptation strategies.

### **Rural-urban dynamics and climate change adaptation in West Africa**

Studies have shown that climate change impacts affect rural-urban interaction in a way that contributes to the vulnerability of populations (Okali et al. 2001). For example, in Aba, Nigeria, rural communities surrounding the town have contributed to the increasing number of migrants within the city as a result of declining agricultural yields which could be attributed to climate change. Aba is located the south-eastern part of Nigeria which is susceptible to soil erosion, and this affects arable lands, contributing to the movement of young men and women to the city.

The effect of this migration has been loss of capable men and women in the rural areas who could engage in agriculture and other crafts in response to climate change (Okali et al. 2012;

Okali et al. 2001). This study confirms that as climate change impacts intensify the rate of environmentally-induced migration increases (Tacoli 2011). Developments in the urban centres also attract immigrants, for example in Accra (Rain et al. 2011), the majority of migrants settle in the peri-urban fringes where house rents are less expensive and construction of housing uncontrolled. The dynamics of interaction between the rural and urban populations has significant effects on the over-stressed physical infrastructure, unplanned human settlements and waste management facilities in the urban areas. The experience of the study carried out in Aba shows how that city is ill-prepared to receive the migrating populations, and this often elevates the climate-related risks in the city (Okali et al. 2012).

## **4. Policies related to Climate Change in the West Africa Urban Areas**

### **4.1 Climate change adaptation policy initiatives in West African cities**

Currently, no country in West Africa has a specific Urban Climate Change Adaptation Policy. Rather, most countries have is a National Climate Change Policy, National Climate Change Framework, National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) and a National Adaptation Programme of Action (NAPA).

Urban climate change adaption policies are climate change or environmental plans of action at the level of provinces or states, for example in Lagos, Bayelsa and Ondo States in Nigeria.

Ghana, Nigeria and Senegal have dedicated National Climate Change Adaptation Strategies, Plans or Frameworks. On 12 September 2012, the Federal Executive Council of Nigeria officially approved a National Climate Change Policy and Response Strategy document (Okali et al. 2012). A Department of Climate Change has been established in the Federal Ministry of Environment to coordinate activities on climate change in the country (NEST 2011; Stern 2007). Ghana has also developed a National Climate Change Adaptation Strategy and National Climate Change Policy as well as established a National Climate Change Committee (GMEST 2012). Niger has established a National Strategy and Action Plan for Climate Change and Variability.

### **4.2 Policy actors and networks involved in urban climate change adaptation in West Africa**

Adapting to climate change impacts is challenging and actions that are required are often multi-national and from local to international, within public and private sectors. These stakeholders have been referred to as '*communities of practice*' (De Vit and Parry 2011; Wenger 2006).

Some of the stakeholders that are actively engaged in climate change adaptation in West Africa include the International Development Research Centre (IDRC), World Bank, Global Environment Facility (GEF), United Nations Human Settlements Programme (UN-HABITAT), Global Change System for Analysis, Research and Training (START), Heinrich Böll Foundation, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), World Food Programme (WFP) and International Fund for Agricultural Development (IFAD). Some of their networks include the AfricaAdapt Network, the Africa Partnership on Climate Change Coalition (APCCC) and the Climate Action Network – West Africa (CAN-WA). Government officials, research organizations, development specialists, sectoral experts and the business sector also participate in climate change adaptation programmes in the sub-region. West Africa does not have any organizations or networks specifically dedicated to urban climate change adaptation.

## 5. Gaps in Climate Change Adaptation Research and Policy in the West Africa Urban Sector

**Narrow scope of urban climate change adaptation research :** Very few research activities have been carried out specifically on climate change adaptation in the urban areas of West Africa. Evidence-based research activities were carried out on particular themes, including flooding, sea level rise and storm surge in coastal cities, droughts, food security, infrastructure damage from extreme events, sanitation, water demand and availability, urban biodiversity and air pollution. Research findings were reported on coastal cities, but there is little information on inland cities, except studies conducted on Aba, Nigeria and Ouagadougou, Burkina Faso.

There is also a major evidence gap on the quantification of climate change impacts on urban energy usage, rural-urban migration, infrastructure (sea ports, roads, water utilities, energy utilities, and waste management systems.) and water resources. Furthermore, very few research activities were carried out on cost-benefit analysis of climate change impact studies on West African cities.

**Advocacy on communicating and building awareness about climate risks:** Only a few research activities include mainstreaming adaptation measures into development plans and strategies (Osman-Elasha and Downing 2007). There is no synergy among the key stakeholders on implementation of adaptation programmes. Many agencies duplicate research programmes thus wasting resources. Most of the plans of action are also implemented without consideration for the development programmes

**Interconnectedness among different types of infrastructure:** Another research gap identified is the low level of research on the intricate interconnectedness among different types of infrastructure in the West Africa cities which are usually under conditions of stress and/or threat of climate change impacts. Urban centres provide excellent opportunities within which the interdependence of infrastructure systems and the services they provide could be studied in relation to climate change adaptation. Since a larger concentration of the infrastructure system is found in the urban centres, they are usually vulnerable to the same climate stressor and damage.

**Gender and climate change adaptation research :** Research on gender varies and is highly contextual, based on the social and cultural norms within the country of interest in West Africa. Some research activities have been carried out on the impacts of climate change on vulnerable urban groups such as women and girls. Although the the results suggest that women seem to have suffered more negative impacts of climate change in terms of their assets and well-being, there are exceptions where men seem to have suffered more impacts than women. Consequently, more research is needed in this area before strong conclusions can be drawn.

**Green Cities:** Many industries in the urban areas of West Africa are engaged in the production of products with large carbon footprints. However, many of these are in the process of developing sustainability standards for their products in order to reduce levels of carbon emissions. Companies committed to this kind of change are very interested in tools that will help them measure the environmental benefits (reduction in footprints) of the changes they are making to their products as a result of environmental policies on climate change. Research is needed to develop tools which will help industrialists to measure their footprints in the cities and other areas surrounding them where their customers are concentrated.

Other research priorities that should be carried out at the city level, include the following:

(i) studies on energy efficiency and climate change, (ii) municipal solid and liquid waste assessment, (iii) urban agriculture and climate change, (iv) early warning systems, climate change impact risk assessment and mapping, (v) adaptation technology needs assessment and the need for strengthening institutions to effectively organise and manage city-scale adaptation strategies.

**Urban climate change adaptation policy gap: the context:** Very few policy documents such as NAPAs, national communications, Climate Change Policies, National Climate Change Adaptation Plans and Frameworks address city-scale adaptation initiatives. Exceptions are Ghana's National Climate Change Policy (GMEST 2012) and Niger's NAPA documents. These countries have National Climate Change Adaptation Plans of Action that are mainstreamed around building resilience to climate change impacts in the cities. For example, Nigeria's National Plan (NASPA-

CCN) laid out strategies to discourage building and urban encroachment into vulnerable areas, high risk zones and low lying areas. In the same light, Ghana's Climate Change Policy articulated issues of increased rural-urban migration that could add to the pressure on cities and urban services in a bid to find lasting solutions to these challenges (GMEST 2012).

## **6. Stakeholders and Opportunities for Collaboration in Research on Climate Change in the West Africa Urban Sector**

The variety of climate change adaptation stakeholders in West Africa include research institutes, training and education institutions (knowledge institutions), credit institutions, policy and regulatory bodies, private consultants, NGOs, insurance firms, private sector and public services delivery organizations (Agwu et al. 2011). This framework captures the complex relationships between diverse actors, processes of institutional learning and change, market and non-market institutions, public policy, poverty reduction and socioeconomic development in an urban setting. Four key elements which are central to the functioning of the system are (i) knowledge institutions, (ii) finance element, (iii) business sector and (iv) national governments.

*Knowledge Institutions:* The role of knowledge institution in the proposed framework is to produce policy-relevant urban climate change adaptation research outputs as well as create awareness about opportunities for adaptation. They should also train students and support states or local governments on the issues of urban climate change adaptation. An example is the African Centre of Meteorological Applications for Development (ACMAD). Other key institutions dealing with climate data information include the Permanent Interstate Committee for Drought Control in the Sahel (Comité Inter-Etate pour la Lutte contre la Sécheresse au Sahel or CILSS), Institut de Recherche pour le Développement (IRD), French national meteorological service (Météo France), the Agro-Hydro-Meteorology (AGRHYMET) Regional Centre and the Climate System Analysis Group (CSAG) of the University of Cape Town. These organizations, as well as local universities, could collaborate on working with urban farmers to develop synergies in building resilient urban agriculture.

Countries seeking to build resilient cities collaborate with international agricultural research institutions such as the International Institute of Tropical Agriculture (IITA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and AfricaRice; with UN bodies such as the Food and Agriculture Organization (FAO), World Health Organization (WHO), UNEP and UNDP; and finally with international NGOs such as the World Wildlife Fund (WWF),

International Union for the Conservation of Nature (IUCN), Wetlands International and Environnement et Développement pour le Tiers Monde (ENDA-TM).

*Financing institutions:* These stakeholders provide funds for project execution as well as implementation of urban climate change adaptation projects. The main stakeholders in this category are GEF, UN-HABITAT, UNDP, START, the World Bank, Commercial Banks and the African Development Bank (AfDB). The challenge with this category is the accessibility of funds. Only Senegal has successfully accessed the Adaptation Fund while Ghana has just submitted a project for funding.

*Business Sector:* This sector includes all firms developing, producing and providing goods and services to build urban resilience. This stakeholder should relate with the knowledge institutions and invest in knowledge input from universities, research institutes and patent documents in order to create green goods and services in the cities. The private business sector should be interested in the development of university research and development agendas, especially that relating to climate change adaptation in the urban areas.

*National Governments:* National governments should provide enabling policy environments for efficient functioning of the business sector. Governments should also encourage the private sector to provide resilient urban infrastructure while providing critical infrastructure such as roads, water and low cost housing for the poor. This could be achieved through public-private partnerships. Furthermore, Governments should formulate pro-poor policies which allow the urban poor to afford climate change adaptation goods and services.

## **7. Conclusion and Recommendations**

### **7.1 Conclusions**

This study has explored urban climate change adaptation research activities and identified gaps in research and needs in the sub-region. It discussed the way urban climate change adaptation research has informed policy in the sub-region and outlined the link between countries and the regional economic bodies in West Africa. The review has thus provided a critical knowledge base for researchers to support research-based policy formulation for climate change adaptation in urban areas of West Africa.

*The state of knowledge of urban climate change adaptation*

Urban areas harbor over 40 percent of West Africans and are already stressed due to unfavorable socio-economic conditions. High population density, large sections of the urban population living in slums, and urban expansion on particularly risky sites such as low-lying coastal areas and steep slopes which are susceptible to mudslides or landslides, aggravate climate change impacts on cities in the sub-region. Significant impacts of climate change in West Africa include (i) flooding of cities due to rise in sea level along the coastlines and (ii) damage to the infrastructure such as seaports, telecommunication and transportation systems.(iii) rise in rural-urban migration which adds pressure to the already-over-utilised facilities in the urban areas;(iv) increased burdens on poor and vulnerable urban residents; and (v) stress on the capacity of governments to mainstream climate change strategies into development plans.

#### ***Urban climate change adaptation research and policy gaps***

Very few research activities have been carried out specifically on climate change adaptation in the urban areas of West Africa. Most of the research activities were based on particular sectors or themes such as flooding, sea level rise (and storm surge) on coastal cities, droughts, food security, infrastructure damage from extreme events, sanitation, water demand and availability, urban biodiversity and air pollution. Research findings were on coastal cities and there is little information on inland cities. There is also a major evidence gap on the quantification of climate change impacts on urban energy usage, rural-urban migration, infrastructure (seaports, roads, water utilities, energy utilities, waste management systems, etc.) and water resources.

#### ***Opportunities in urban climate change adaptation***

There are many opportunities that urbanization could bring to the region within the context of climate change adaptation. Several national adaptation plans and policies could be used by the cities as background information for their adaptation plans.

Urbanized coastal areas in the sub-region also have very rich biodiversity and this has attracted international donors whose mandate is to reduce vulnerability of such ecosystems to climate change impacts. Other opportunities include green building, green landscaping and increased uptake of research for adaptation policy.

## **7.2 Recommendations**

Policy options which are relevant to climate change adaptation cities in West Africa should respond to the issues that concern the state of knowledge, research and policy gaps as well as

barriers and opportunities in urban climate change adaptation strategies in the sub-region. Policy options for consideration in West Africa Urban sector include the following:

***Improvement in the state of knowledge on urban climate change adaptation strategies***

- Urban climate change adaptation research activities in West Africa are very few. The knowledge institutions and other stakeholders should identify and conduct relevant urban climate change research in regional priority areas using the same protocol and indicators. These activities should be conducted so that research outputs are translated to appropriate adaptation technologies and innovations that would make impacts on the most vulnerable groups in the urban areas.
- To minimize duplication and optimize expenditures, generating data about urban climate change action should be an integral part of the existing climate change units/departments. Departments should interact with and engage key stakeholders such as policymakers, knowledge institutions, the business sector, civil society and key players at the national and state levels.

***Improvement in linkages among the key stakeholders***

- Governments should harness the potentials of West Africans in the diaspora to increase the pool of experts in urban climate change adaptation. This initiative will be of immense assistance, especially in the area of knowledge and technology dissemination.

***Closing research and policy gaps***

- Few studies have been carried out on the impacts of climate change on urban agriculture despite the fact that it is key to sustainability of city-dwellers' livelihoods. More research should be carried out in urban agriculture as well as integrating it into urban development policies. As an adaptation measure, the economies in the West Africa region should diversify from climate-sensitive sectors to increase urban resilience.
- Governments should liaise with the capacity building centres with mandates to carry out climate change adaptation research at national and international levels on urban issues. This will provide opportunities to build climate change adaptation competence among categories of researchers at the local level. Institutions to participate in climate adaptation research should include the following: ATPS, IDRC, AAS, NACETEM, CSAG, UNFCCC, START, ACMAD, the Inter-Governmental Authority on Development (IGAD) Climate Prediction and Application Centre (ICPAC), United Nations Institute for Training and Research (UNITAR), One UN Training Service Platform on Climate Change (UN CC:LEARN) and International Centre for Theoretical Physics (ICTP).

- Improve model disaggregation to allow climate analysis at the city level. Governments should buy into initiatives at ACMAD, CSAG and ICTP, and more young climatologists, social scientists and other researchers from relevant disciplines with focus on urban climate change impacts in West Africa should be sponsored in PhD programmes.
- Governments should also develop capacity on how to make policy decisions on climate change adaptation.
- Governments should mainstream gender issues into development plans of the adaptation programme. Climate change adaptation projects should integrate gender disaggregated data at various stages of the project in order to understand the effect of climate change impacts on gender.
- Practical ways of communicating climate change adaptation research outputs to policymakers should be institutionalized in each West African country. Policymakers and communication experts should be incorporated in climate change projects to ensure effective and wide scale dissemination of research results for the transformation of climate change adaptation knowledge to actual products or service.
- Climate change adaptation plans and policies in the region should evolve into national plans of action where all countries with shared vulnerabilities are classified and grouped together for funding and execution of projects to build urban resilience throughout West Africa.
- In response to the vulnerability of the urban poor, climate change adaptation programmes should be mainstreamed into urban land use policies. In order to make this effective, land use regulations should be enforced and appropriate penalties administered.

#### ***Overcoming the barriers and exploiting the opportunities***

- Governments should explore opportunities for climate change adaptation in urban areas. Initiatives should include micro-insurance, low cost housing, sanitation, affordable healthcare and microfinance to help vulnerable urban communities build resilience against the effects of climate change.
- Areas of high population concentration with commercial activities in cities should be decentralized to reduce the pressure on infrastructure and critical utilities such as water and energy supplies.
- Municipal authorities should incorporate the costs of urban climate change adaptation projects into annual budgets.
- Countries should adopt a common protocol and indicators for methodologies to create a West Africa Urban Sustainability Index which can be used in the development of City Adaptation Plans of Action and other policy documents.

## 8. References

- Abam, T., Ofoegbu, C., Osadebe, C. and Gobo, A. (2000) 'Impact of hydrology on the Port Harcourt–Patani–Warri road', *Environmental Geology*, 40:153-162
- Adelekan, I.O. (2010) 'Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria', *Environment and Urbanization* Vol. 22 (2), pages 433-450.
- Adger, W.N., Agrawala, S., Mirza, M.M.Q., Conde, C., O'Brien, K., Pulhin, J., ... Takahashi, K. (2007) 'Assessment of adaptation practices, options, constraints and capacity', 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, UK: Cambridge University Press, 717-743
- Africapolis (2009) *Urbanisation Trends 1950–2020: A Geo-statistical Approach – West Africa*, Paris, France: Africapolis
- Bull-Kamanga, L., Diagne, K., Lavell, A., Lerise, F., MacGregor, H., Maskrey, A., ... Yitambe, A. (2003) 'Urban development and the accumulation of disaster risk and other life-threatening risks in Africa', *Environment and Urbanization*, 15(1):193-204
- Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, (2007) 'Africa', 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, UK: Cambridge University Press, 433-467
- Bryceson, D. and Potts, D. (2006) *African Urban Economies: Viability, Vitality or Vitiation?* Houndmills, Basingstoke: Palgrave Macmillan
- Buhaug, H. and Urdal, H. (2012) 'An urbanization bomb? Population growth and social disorder in cities', *Global Environmental Change*, 23(1):1-10
- Burton, I., Diringer, E. and Smith, J. (2006) *Adaptation to climate change: International policy options*, Arlington, VA: Pew Center on Global Climate Change
- Conway, G. (2009) *The science of climate change in Africa: impacts and adaptation*. Discussion Paper No. 1, London, UK: Grantham Institute for Climate Change
- Cour, J.M. (2001) 'The Sahel in West Africa: Countries in transition to a full market economy', *Global Environmental Change*, 11:31-47
- De Vit, C. and Parry, J.-E. (2011) *Review of Current and Planned Adaptation Action: West Africa*, Winnipeg, Canada: International Institute for Sustainable Development

- deWit, M. and Stankiewicz, J. (2006) 'Changes in water supply across Africa with predicted climate change', *Science*, 311:1917-1921
- Deressa, T.D., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. (2009) 'Analyzing the determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia', *Global Environmental Change*, 19(2):248-255
- Dessai, S. (2005) 'Robust adaptation decisions amid climate change uncertainties', PhD thesis, Norwich, UK: University of East Anglia
- Dodman, D. and Satterthwaite, D. (2008) 'Institutional capacity, climate change adaptation and the urban poor', *IDS Bulletin*, 39(4):67-74
- DOE (2012) *Climate Change and Infrastructure, Urban Systems, and Vulnerabilities*. Technical Report for the U.S. Department of Energy in Support of the National Climate Assessment, Oak Ridge, CA: U.S. Department of Energy
- Dossou, K.M.R. and Gléhouenou-Dossou, B. (2007) 'The vulnerability to climate change of Cotonou (Benin): the rise in sea level', *Environment and Urbanization*, 19:65-79
- Douglas, I., Kurshid Alam, K., Maghenda, M., McDonnel, Y., McLean, L. and Jack, M. (2008) 'Unjust waters: climate change, flooding and the urban poor in Africa', *Environment and Urbanization*, 20:187-205
- EEA (2012) *Urban adaptation to climate change in Europe: Challenges and opportunities for cities together with supportive national and European policies*. Report No. 2/2012, Copenhagen, Denmark: European Environment Agency
- Feiden, P. (2011) *Adapting to Climate Change: Cities and the Urban Poor*, Washington DC: International Housing Coalition
- Gasper, R., Blohm, A. and Ruth, M. (2011) *Social and Economic Impacts of Climate Change on the Urban Environment*, Elsevier Science Direct
- GMEST (2000) *Ghana's Initial National Communication*, Accra, Ghana: Ghana Ministry of Environment, Science and Technology
- GMEST (2012) *Ghana National Climate Change Policy*, Accra, Ghana: Ghana Ministry of Environment, Science and Technology
- Hewawasam, I. (2002) *Managing the marine and coastal environment of sub-Saharan Africa: strategic directions for sustainable development*, Washington DC: The World Bank

Hiraldo, R. (2011) 'Climate Change in West Africa: Key Issues', ENDA Energy, Environment and Development, Dakar, Senegal. September 2011

Hitimana, L., Heinrigs, P. and Tremolieres, M. (2011) 'West African urbanization trends', *West African Futures*, June 2011, Sahel and West Africa Club

Jalloh, A., Roy-Macauley, H. and Kuisseu, J. (2011) *Climate change research and development orientation framework: A CORAF/WECARD strategy for guiding climate change research and development in West and Central Africa*, Dakar, Senegal: Conseil Ouestet Centre Africain pour la Recherche et le Development Agricoles/West and Central African Council for Agricultural Research and Development

Jallow, B., Toure, S., Barrow, M. and Mathieu, A. (1999) 'Coastal zone of the Gambia and the Abidjan region in Cote d'Ivoire: sea-level rise vulnerability, response strategies and adaptation options', *Climate Research*, 6(Special Issue):137-143

Kristjanson, P., Waters-Bayer, A., Johnson, N., Tipilda, A., Njuki, J., Baltenweck, I., Grace, D., and MacMillan, S. (2010) *Livestock and women's livelihoods: A review of the recent evidence*, Nairobi, Kenya: International Livestock Research Institute / [http://mahider.ilri.org/bitstream/handle/10568/3017/Discussion\\_Paper20.pdf](http://mahider.ilri.org/bitstream/handle/10568/3017/Discussion_Paper20.pdf) [accessed 2 March 2011]

Lavell, A. (2003) *Local level risk management: Concept and practices*, Quito, Ecuador: Centro de Coordinación para la Prevención de los Desastres Naturales en América Central and United Nations Development Programme

Leary, N., Conde, C., Kulkarni J., Nyong, A. and Pulhin, J. (2008), *Climate Change Variability*, London, UK: Earthscan

Lundvall, B. (1985) *Product Innovation and User-Producer Interaction*, Aalborg, Denmark: Aalborg University Press

Mabogunje, A.L. (2001) *Nigeria and the good urban governance campaign*, presented at the First Plenary Session of the Launching of the Global Campaign in Nigeria for Good Urban Governance (GUG), Federal Ministry of Works and Housing, 10-12 April, Abuja, Nigeria

Mabogunje, A.L. (2004) *Framing the Fundamental Issues of Sustainable Development in Sub-Saharan Africa*. CID Working Paper No. 104. Cambridge, MA: Sustainable Development Program, Center for International Development, Harvard University / also published as TWAS Working Paper No. 1, Trieste, Italy: Third World Academy of Sciences

McGranahan, G., Mitlin, D., Satterthwaite, D., Tacoli, C. and Turok, I. (2009) *Africa's Urban Transition and the Role of Regional Collaboration, Human Settlements*. Urban Change Working Paper No. 5, London, UK: International Institute for Environment and Development

Metcalfe, S. (1995), "The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives", in P. Stoneman (ed.), *Handbook of the Economics of Innovation and Technological Change*, Blackwell Publishers, Oxford (UK)/Cambridge (US).

Moser, S.C. and Ekstrom, J. (2010) 'A framework to diagnose barriers to climate change adaptation', *PNAS*, 107(51):22026-22031

National Population Commission (2005) *Training Reference Manual for Census*, Abuja, Nigeria: National Population Commission, Government of Nigeria

Ndiaye, M.L. (2012) 'Urban agriculture in Dakar, Senegal: Health aspects related to polluted irrigation water', in Robertson, M. (ed), *Sustainable Cities: Local solutions in the Global South*, Ottawa, Canada: International Development Research Centre

Nelson, R.R. (1993) *National Systems of Innovation: A Comparative Study*, New York, NY: Oxford University Press

NEST (2011) *Reports of Research Projects on Impacts and Adaptation: Building Nigeria's Response to Climate Change (BNRCC)*, Ibadan, Nigeria: Nigerian Environmental Study

Ngigi, S.N. (2009) *Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa*, New York, NY: The MDG Centre for East and Southern Africa, The Earth Institute at Columbia University

Niang, I. (2007) *Climate Change Adaptation in Africa Programme: Institutional framework in relation to climate change in west and central Africa. Report on the existing institutional framework in relation to climate change in west and central Africa*. Université Cheikh Anta Diop, Dakar, Senegal.

Niang-Diop, I. (2005) 'Impacts of climate change on the coastal zones of Africa', in 'Coastal zones in sub-Saharan Africa: A scientific review of the priority issues influencing sustainability and vulnerability of coastal communities, London, 27-28 May 2003, Workshop Report 186', *ICAM Dossier*, 4:27-33

Nicholls, R.J. (2004) 'Coastal flooding and wetland loss in the 21st century: changes under the SRES climate and socioeconomic scenarios', *Global Environmental Change*, 14(1):69-86

Nicholls, R.J., Wong, P.P., Burkett, V.R., Codignotto, J.O., Hay, J.E., Ragoonaden, S. and Woodroffe, C.D. (2007) 'Coastal systems and low-lying areas', in *Climate Change 2007: Impacts*,

*Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC*, Cambridge, UK: Cambridge University Press, 315-356

Nkuba, M. (2011) *Small holder farmers' knowledge and adaptation to climate change in the Rwenzori region*, Research Report No. 001, March 2011 Kabarole Research and Resource Centre, Fort Portal, Uganda.

NMEFRN (2003) *First National Communication on Climate Change*, Abuja, Nigeria: Nigeria Ministry of Environment of the Federal Republic of Nigeria

NNECSD (2006) *National Adaptation Program of Action (NAPA)*, Niamey, Niger: Niger National Environmental Council for Sustainable Development

Nyong, A.O., Adesina, F.A. and Osman-Elasha, B. (2007) 'The value of indigenous knowledge system in integrating mitigation and adaptation to climate change', *Mitigation and Adaptation Strategies for Global Change*, 12:787-789

Nyong, A.O., Dabi, D., Adepetu, A., Berthe, A. and Ihemegbulem, V. (2008) 'Vulnerability in the Sahelina zone of northern Nigeria', in Leary, N. et al. (eds), *Climate Change and Vulnerability*, London, UK: Earthscan

Odum, E.P. (1971) *Fundamentals of Ecology*, 3rd edition, Philadelphia, PA: W.B. Saunders

OECD (2009) *Integrating Climate Change Adaptation into Development Co-operation: Policy Guidance*, Paris, France: Organisation for Economic Co-operation and Development

OHCHR (2011) *OHCHR West Africa Regional Office (2010-2011)*, Geneva, Switzerland: Office of the United Nations High Commissioner for Human Rights / <http://www.ohchr.org/EN/Countries/AfricaRegion/Pages/WestAfricaSummary1011.aspx> [accessed 19 February 2013]

Okali, D., Okpara, E., Madu, T., Nwosu, A. and Nzegbule, E. (2012) *Triggering rural-urban interactions to cope with climate change: an adaptation experiment in Aba and its region, southeastern Nigeria*. Final technical report on IDRC climate change adaptation in Africa project Nigerian Environmental Study Action Team (NEST), Ibadan, Nigeria.

Okali, D., Okpara, E. and Olawoye, J. (2001) "Rural-Urban Interactions and Livelihood Strategies: The Case of Aba and its Region, South-Eastern Nigeria". Human Settlements Programme, International Institute for Environment and Development. Available On-line at <http://www.iied.org/>

Osman-Elasha, B. and Downing, T. (2007) *Lessons Learned in Preparing National Adaptation Programmes of Action in Eastern and Southern Africa*, unpublished paper, Stockholm, Sweden: Stockholm Environment Institute

Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. (eds) (2007) 'Summary for Policymakers', 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, UK: Cambridge University Press, 7-22

Parnell, S. and Walawege, R. (2011) 'Sub-Saharan African Urbanisation and Global Environmental Changes', *Global Environmental Change*, 21:S12-S20

Perret, C. (2008) 'Climate and Climate Change', in *Atlas on Regional Integration in West Africa*. Environment series, Abuja, Nigeria and Paris, France: Economic Community of West African States and Sahel and West Africa Club

Population Reference Bureau (2012) *2012 World Population Data Sheet*, Washington DC: Population Reference Bureau

Potts, D. (2009) 'The slowing of sub-Saharan Africa's urbanization: evidence and implications for urban livelihoods', *Environment and Urbanization*, 21:253-259

Rain, D., Engstrom, R., Ludlow, C. and Antos, S. (2011) 'Accra Ghana: A City Vulnerable to Flooding and Drought-Induced Migration', in *Cities and Climate Change: Global Report on Human Settlements 2011*, Nairobi, Kenya: United Nations Human Settlements Programme / <http://www.unhabitat.org/grhs/2011>

Rayner, S. and Malone, E.L. (eds) (1998) *Human Choice and Climate Change Volume 3: The Tools for Policy Analysis*, Columbus, OH: Battelle Press

Roncoli, C., Crane, T. and Orlove, B. (2009) 'Fielding climate change in cultural anthropology', in Crate, S.A. and Nuttall, M. (eds), *Anthropology and climate change: From encounters to actions*, Walnut Creek, CA: Left Coast Press

Rosenberg, N.J. (1996) *A primer of climatic change: Mechanism, trends, and projections*. RFF Paper RR86-04, Washington DC: Resources for the Future

Ruth, M. and Coelho, D. (2007) 'Understanding and managing the complexity of urban systems under climate change', *Climate Policy*, 7: 317-336

SWAC/OECD (2007) *Livestock in the Sahel and West Africa*. Policy Note No. 3, Paris, France: Sahel and West Africa Club of the Organisation for Economic Co-operation and Development

Satterthwaite, D., Huq, S., Pelling, M., Reid, H. and Lankao, P.R. (2007) *Adapting to Climate Change in Urban Areas: The possibilities and constraints in low- and middle-income nations*. Human Settlements Discussion Paper Series: Climate Change and Cities – 1. International Institute for Environment and Development, London, UK.

Schneider, S.H., Semenov, S., Patwardhan, A., Burton, I., Magadza, C.H.D., Oppenheimer, M., ... Yamin, F. (2007) 'Assessing key vulnerabilities and the risk from climate change', 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, UK: Cambridge University Press, 779-810

Smith, B., Burton, I., Klein, R.J.T. and Street, R. (1999) 'The science of adaptation: a framework for assessment', *Mitigation and Adaptation Strategies for Global Change*, 4:199-213

Soyombo, O. (2006) *Main Report of the Lagos State Urban Upgrading Project Confirmation Survey*, Lagos, Nigeria: Lagos Metropolitan Development and Governance Project

Speilman, D.J. (2005) *Innovation Systems Perspectives on Developing Country Agriculture: A Critical Review*. ISNAR Discussion Paper 2, Washington DC: International Food Policy Research Institute

Stern, N. (2007) *The Economics of Climate Change: The Stern Review*, Cambridge, UK: Cambridge University Press

Tacoli, C. (2011) *Rural-Urban Interactions and Livelihood Strategies: Not only climate change – mobility, vulnerability and socio-economic transformations in environmentally fragile areas of Bolivia, Senegal and Tanzania*. Human Settlements Working Paper No. 28, London, UK: International Institute for Environment and Development

UNDP (2010) *Final project report: Integrating climate change in the development of Cabo Verde*. Project: Integrating Climate Change Risks and Opportunities into National Development Processes and UN Country Programming, New York, NY: United Nations Development Programme

UNDP (2012) *Sustainable Wetland Management in the Face of Climate Risks in Niger: The Case of La Mare de Tabalak*, New York, NY: United Nations Development Programme, Bureau for Crisis Prevention and Recovery

UNEP (2009) *A Preliminary Stocktaking: Organisations and Projects focused on Climate Change Adaptation in Africa*, Nairobi, Kenya: United Nations Environment Programme, Climate Change Adaptation Unit

UNFCCC (2012) *National adaptation programmes of action*, Bonn, Germany: United Nations Framework Convention on Climate Change

Wenger, E. (2006) *Communities of practice: A brief introduction*, Wenger-Trayern website / <http://www.ewenger.com/theory> [accessed 30 January 2013]

Wilbanks, T.J., Lankao, P.R., Bao, M., Berkhout, F., Cairncross, S., Ceron, J.-P., ... 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, UK: Cambridge University Press, 357-390

World Bank (2010) *Cities and Climate Change: An Urgent Agenda*. Urban Development Series Knowledge Papers Vol. 10, Washington DC: The World Bank

World Urban Campaign (2012) *Manifesto for cities: The urban future we want*. World Urban Campaign. Nairobi: Kenya.