Acknowledgement
This review was undertaken under the auspices of the AfricaInteract project funded by the International Development Research Centre (IDRC).

About AfricaInteract: AfricaInteract is a platform enabling research-to-policy dialogue for adaptation to climate change among a broad range of African stakeholders in sub-Saharan Africa. These include civil society, researchers, policy-makers, donors, and the private sector working on adaptation to climate change in the agriculture and health sectors as well as urban areas with water and gender as cross cutting issues. The overall objective of AfricaInteract is to develop a platform for the effective and efficient transfer of information to policy makers, with the ultimate aim of enhancing the resilience of vulnerable populations. AfricaInteract is funded by the International Development Research Centre (IDRC) and coordinated by the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) under the auspices of the Forum for Agricultural Research in Africa (FARA). The regional focus of AfricaInteract is based on the Regional Economic Communities in the four sub regions of sub-Saharan Africa. Focal organizations coordinating regional activities are as follows: The Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) – East Africa; Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) – Southern Africa; Commission des Forets d'Afrique Centrale (COMIFAC) – Central Africa; and Energie-Environnement et Developpment (Enda) – West Africa.

About CORAF/WECARD: The West and Central African Council for Agricultural Research and Development (CORAF/WECARD) is a constituent of the Forum for Agricultural Research in Africa, and comprising 22 National Agricultural Research Systems in West and Central Africa. CORAF/WECARD's mission is "Sustainable improvements to the competitiveness, productivity and markets of the agricultural system in West and Central Africa by meeting the key demands of the sub-regional research system as expressed by target groups" with strong alignment and commitment to the overall goal of the Comprehensive Africa Agriculture Development Programme of the New Partnership for Africa's Development. www.coraf.org

AfricaInteract

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

Research and Policies for Climate Change Adaptation in the East Africa Health Sector SUMMARY

Andrew K. Githeko,
Abdulai Jalloh,
Hezron Mogaka

Andrew K. Githeko[1], Abdulai Jalloh[2], Hezron Mogaka[3]

[1] Chief Research Officer, Head: Climate and Human Health Research Unit,Centre for Global Health Research, Kenya Medical Research Institute,Busia Road, P.O. Box 1578-40100, Kisumu, Kenya

[2] Programme Manager**,** Natural Resources Management Programme, Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles/West and Central African Council for Agricultural Research and Development (CORAF/WECARD), 7 Avenue Bourguiba, BP 48, cp 18523 Dakar, Sénégal

[3]Programme Manager, Natural Resource Management & Biodiversity, Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) P. O Box 765, Entebbe, Uganda

Acronyms and Abbreviations

ACT	Artemisinin-based combination therapy
ACPC	African Climate Policy Centre
CDC	Centers for Disease Control and Prevention
DFID	Department for International Development
EAC	East African Community
HPP	Health Policy Project
icipe	International Centre of Insect Physiology and Ecology
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
KEMRI	Kenya Medical Research Institute
NAPA	National Adaptation Plan of Action
NGO	Non-governmental organisation
UNDP	United Nations Development Programme
UNFCCC	United Nation Framework Convention on Climate Change
USAID	United States Agency for International Development
WHO	World Health Organization

Table of Contents

1. Introduction

The health profile of human populations in the East African region includes infectious and non-infectious diseases. Most of these health conditions are rooted in the environment and poverty, with climate variability and change playing a major role in the increased risk of exposure and transmission of diseases (Yanda et al. 2005; Morse 1995).Climate change may modify many health parameters while ongoing health interventions may modify current disease trends. As countries strive to meet the Millennium Development Goals, health statistics in the region will change. There is an urgent need to formulate national policies to address adaptation to climate change and variability through evidence based research. An important issue is whether such research informs the formulation of climate change adaptation policies in the health sector in the East African region.

With funding from the International Development Research Centre (IDRC), CORAF/WECARD under the auspices of the AfricaInteract project, commissioned a desk review of research and

policies related to climate change adaptation in the health sector in Africa. The goal of the review is to enhance the knowledge base and to support research-based policy formulation for climate change adaptation in the sub-Saharan Africa health sector. The review sought answers to the following questions:

- What is the role of climate change challenges in the context of the multiple challenges and opportunities facing the health sector in the region?
- What is the current state of knowledge on adaptation to climate change in the health sector in the region?
- What is the current state of knowledge on whether and how research findings are integrated in health sector policies in the region?
- What are the major gaps in research on adaptation to climate change in the health sector?
- What is needed to ensure that research findings are better integrated into health sector policies?
- What is the current state of knowledge about the stakeholders involved with research and policy on adaptation to climate change in the health sector in the region, and how can stakeholder involvement be improved?

The main thrust of this review of the East Africa heath sector is synthesising research-generated knowledge related to climate change adaptation. In particular, the review focussed attention on:

- Climate change adaptation research and policy pertaining to the health sector, including the relationship with water resources and gender
- Gaps in climate change adaptation research and policy in the health sector, and the way research informs policymaking
- Key stakeholders and opportunities for improving the climate change adaptation research-policy nexus in the health sector

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

2. Overview of the East Africa Health Sector

The Governments of Kenya, Tanzania and Uganda carry out demographic health surveys every 5 years to assess the health of their populations and collect data for planning in the health

sector. All three countries have similar health indicators, but the national statistics are different. In general, infant mortality rates have significantly declined since 1999 while life expectancy at birth has increased. In the three countries, these indicators reveal a general improvement in health. Table 1 shows variations in the basic health indicators for the three East African countries in the last demographic and health survey. Compared to the survey carried out 10 years earlier, there has been an overall improvement in health in the region. There is a difference in the indicators among the countries, with Kenya having the slightly better population health and Uganda having lower levels of indicators. Tanzania has values close to those of Kenya.

Table 1 Variations in key indicators within the region

	2009	2010	2010
Indicator	**Kenya**	**Tanzania**	**Uganda**
Crude birth rate	**34.8**	**38.1**	**45.2**
Crude death rate	**Unknown**	**10.5**	**12.3**
Inter-censal growth rate	**2.8**		
Total fertility rate	**4.6**	**5.4**	**6.2**
Infant mortality rate (per 1000 births)	**52.0**	**51**	**61.2**
Life expectancy at birth	**58.9**	**57**	**50.4**

2.1 Climate change projections for different parts of the region

The Ministries of Health in the region are yet to formally use climate information to prevent well known climate sensitive diseases. Nevertheless, ad hoc climate and health committees have been set up by the Intergovernmental Authority on Development's Climate Prediction and Applications Centre (ICPAC). These committees are issued with rainfall forecasts during the seasonal climate outlook forum and the health sector determines the impacts of the forecast on health. Ministries of Health have not used meteorological data for disease epidemic control. Instead they have used epidemiological data to detect outbreaks and epidemics: an example of a disaster management strategy.

Results from the North Carolina State University enhanced version of the RegCM3 regional model (NCSU ReGCM3) (Anyah et al. 2006) which were run for control and a climate change (A2 scenario) simulation, have been analysed for Kenya (WeADAPT 2011). Climate analysis using the Regional GCM model indicates that Kenya is likely to experience the following climate changes between the late 2020s and 2100:

a. Average annual temperature will rise by between 1°C and 5C, typically 1°C by 2020s and 4°C by 2100.

b. Climate is likely to become wetter in both rainy seasons, but particularly in the Short Rain (October to December). Global Climate Models predict increases in northern Kenya (rainfall increases by 40% by the end of the century), whilst a regional model suggests that there may be greater rainfall in the West.

c. The rainfall seasonality i.e. Short and Long Rains are likely to remain the same.

d. Rainfall events during the wet seasons will become more extreme by 2100. Consequently flood events are likely to increase in frequency and severity.

e. Droughts are likely to occur with similar frequency as at present, but to increase in severity. This is linked to the increase in temperature.

f. The Intergovernmental Panel on Climate Change (IPCC) predict an 18 to 59 cm rise in sea- level globally by 2100. One study suggests that 17% of Mombasa's area could be submerged by a sea-level rise of 30 cm (Orindi and Adwera, 2008). (WeADAPT 2011)

In Tanzania by the end of the century, average temperatures are projected to increase between 1.9°C and 3.6°C, while sea level is projected to rise between 65cm and 1m. Rainfall is expected to decrease in the dry season and to increase during the rainy season, leading to a growing risk of floods, water shortage and related conflicts. Climate change is also expected to increase the severity, duration and frequency of weather related extreme events such as drought and floods, threatening water availability and food security for millions of poor people. Climate change is considered one of the greatest threats to the survival of present and future of humanity in Tanzania.

In Uganda, there is evidence that average temperatures have increased by as much as 1.4°C since the 1960s. Looking further ahead, up to 4.3°C change in average temperatures is possible by the 2080s. The rainfall projections are the same as for the rest of East Africa.

2.2 Possible impacts of climate change in the health sector in East Africa.

Increasing temperatures are associated with increased altitudinal range of malaria and schistosomiasis, particularly in the highlands of East Africa. Malaria epidemics have occurred in the highlands of Kenya, Tanzania, Uganda, Rwanda, Burundi and Ethiopia. During one epidemic in Rwanda the disease prevalence increased by more than 500 percent (Loevinsohn 1994). A wetter short rainy season (during September, October, November and December) will increase

the risk of malaria transmission because these months are a warm period and increased wetness will increase malaria transmission. Flooding will increase the risk of Rift Valley fever epidemics in all flood prone areas. Endemic and epidemic cholera are likely to increase in the region as the transmission thresholds are exceeded due to climate change. Diarrhoeal diseases increase due to contamination of public water supplies due to flooding. The meningitis belt may expand eastwards into Uganda and Kenya as the region becomes dry. Drought driven famine is likely to increase in north-eastern Kenya and parts of Tanzania.

Extreme events such as severe droughts and flooding increase and will be associated with landslides and drowning. Floods and drought may damage food cops resulting in food shortages and famine. Increased humidity will increase the risk of mycotoxins such as aflatoxins which will reduce stored food safety. Higher temperatures affect food and livestock production as well as fish production from lakes in the region.

3. Research related to climate change in the East Africa health Sector

Climate change may be responsible for new maize diseases such as the Maize Lethal Necrosis which spread from Kenya to Tanzania and Uganda in 2011. This disease destroyed 30-100 percent of the crop in Kenya. Excessive rainfall has been associated with poor drying of the harvested maize crop and its contamination with aflatoxins. According to the UN Food and Agriculture Organization (FAO), mycotoxins contaminate up to 25 percent of agricultural crops, and aflatoxicosis can be a lethal disease. (Lewis et al. 2005). Scientists in the region are developing new maize strains that are disease resistant and that can adapt to climate change.

3.1 Status of scientific evidence associating climate change with food and water borne diseases

Cholera: The major food and water borne disease is cholera. This disease occurs in endemic and epidemic forms. Cholera is caused by *Vibrio cholerae,* bacteria that normally lives in water. The pathogen can be found in seas, lakes and rivers as a free living organism. Transmission of the pathogen occurs through drinking contaminated water or eating food that is contaminated by human faeces. The disease causes diarrhoea, severe dehydration, and death, if not treated.

In the East African region public health sanitation is poor, particularly in rural areas and in poorly developed urban areas. Drinking water is usually obtained from rivers, lakes, ponds and shallow wells. Drought can also reduce the availability of safe drinking water, particularly in the arid and semi-arid areas. Shrinking water bodies can also increase the pathogen dose making water more infectious. In northern Kenya during a flood event, for example, over 6,000 shallow

wells were contaminated. These had previously served 350,000 people in Wajir Central. Two major cholera epidemics have occurred in East Africa, the 1983 and the 1997 events that were associated with El Niño events (Nkoko et al. 2011; Emch et al. 2008; Yanda et al. 2006). In Zambia a 1°C rise in temperature six weeks before the onset of the outbreak explained 5.2 percent of the increase in the number of cholera cases from 2003 to 2006. In addition, a 50mm increase in rainfall three weeks before explained an increase of 2.5 percent (Luque Fernández et al. 2009).

Cryptosporidiosis: Cryptosporidiosis is an infection caused by protozoa of the genus *Cryptosporidium* that infect humans through the faecal-oral route. In East Africa, the infection is commonly found in people who are HIV positive. In Tanzania the prevalence of *Cryptosporidium* in cattle was 54.5 percent, indicating a large reservoir of the parasite in livestock (Swai and Schoonman 2010). *Cryptosporidium* species were found in 8.9 percent of chimpanzees in Tanzania. It was found that the prevalence of the parasites was three times greater during the rainy season compared to in the dry season. Furthermore, the prevalence of the parasites declined at temperatures above 28°C (Gonzalez-Moreno et al. 2013). In Kenya it was confirmed that the peak of the *Cryptosporidium* species in surface water occurred at the end of the rainy season coinciding with infections in human populations (Muchiri et al. 2009).

3.2 Status of scientific evidence associating climate change with vector borne diseases

The major vector borne diseases in the East African region include: Malaria, Schistosomiasis, Filariasis, Leishmaniasis, Rift Valley fever, Dengue, Chikungunya, Trypanosomiasis, Plague, West Nile fever, O'nyong'nyong

Malaria **:** Malaria occurs from the coastal lowlands to the highlands at about 2,200m above sea level. The disease is caused by four *Plasmodium* parasites, namely *P. falciparum, P. ovale, P. malarie* and *P. vivax*. Over 90 percent of the malaria infections in East Africa are caused by *P. falciparum* and this causes a potentially fatal disease. Malaria epidemics in the western Kenya highlands have been associated with El Niño events that are characterised by anomalous warming and heavy rainfall (Githeko et al. 2012; Githeko and Ndegwa 2001). Similar observations have been reported in the south-western highlands of Uganda (Lindblade et al. 1999). In other sites in the East African highlands climate variability has played an important role in initiating malaria epidemics (Zhou et al. 2004; Githeko et al. 2000).

Schistosomiasis: There is little evidence that the epidemiology of schistosomiasis has changed as a result of climate change. The disease only exists in endemic forms and not in epidemic forms. It has been reported that schistosomiasis may have shifted to higher altitudes in the western Uganda highlands but more research is required to confirm this observations (John et al. 2008).

***Rift Valley fever*:** Rift Valley fever is mainly a zoonotic disease affecting livestock but it is also infectious to humans. The disease causes hemorrhagic fevers in humans and can cause fatalities. The major routes of infections are through bites by infected mosquitoes and by direct contact with fluids from infected animals (Hoch et al. 1985). Warming of the western Indian Ocean, a phenomenon known as the Indian Ocean Dipole Oscillation, during El Niño events can enhance rainfall and lead to extensive flooding (Anyamba et al. 2002). According to IPCC assessment (Christensen et al. 2007) rainfall is likely to increase in the Horn of Africa and this will increase the frequency and intensity of Rift Valley fever epidemics (Martin et al. 2008). There is evidence that the geographic range of Rift Valley fever has increased recently in Kenya, moving from the former North Eastern Province to Central Province (Linthicum et al. 2008). In Tanzania the disease has spread away from the Kenyan border toward Dodoma and Arusha (IRIN 2007).

Dengue: Dengue, like malaria, is a climate sensitive disease caused by a group of four viruses, in this case transmitted by *Aedes aegypti* and *Ae. albopictus* mosquitoes. Dengue epidemics have been caused by heavy rainfall and droughts. *Aedes* vectors breed in containers around human settlements and this includes outdoor and indoor containers. The development of the aquatic stages of the dengue vector is temperature sensitive and so is the dengue virus. Humidity increases the longevity of the adult mosquito and the temperature increases its feeding frequency.

During droughts *A. aegypti* commonly breeds in water containers in or around houses and this increases human-vector contact and dengue transmission. There have been few dengue epidemics in the East African region. Epidemic dengue fever was reported in Kenya as early as 1982 (Choudhuri et al. 2011). Very low dengue transmission was reported in 1997 on the Kenyan coast (Turell et al. 2002). Infections remain largely underestimated in the region but it appears to be on the increase (Sang 2007). Recently, evidence of infections has been found inland in western Kenya (Blaylock et al. 2011). In 2011 an outbreak affecting 5,000 people occurred in Mandera, an area in then North Eastern Province next to the Somalian and Ethiopian borders. A similar outbreak was reported in the same area in 2013 (Blaylock et al. 2011). The first report of dengue fever in Tanzania was in 2010 (TEPHINET undated). Dengue has been reported in coastal Tanzania including Dar es Salaam and Zanzibar (Crisis Consulting 2010).

***Chikungunya*:** Chikungunya is another viral disease transmitted by *Ae. aegypti* and *Ae. albopictus* (Lahariya and Pradhan 2006). The disease has been largely absent in East Africa since its discovery in Tanzania in 1952 (Pialoux et al. 2007). However, there have been large chikungunya epidemics in the Indian Ocean Islands of the East African coast (Murithi et al. 2011) and coastal Kenya. Investigations in coastal Kenya indicated that the outbreak was associated with drought (Chretien et al. 2007). It is still not clear what role *Ae. albopictus* plays

in the transmission of chikungunya in East Africa. This vector was brought from Asia on ships and its presence may have increased the transmission of the disease particularly in rural areas. *Ae. aegypti* is an urban vector. While climate change may increase the risk of chikungunya transmission, other environmental changes may also play significant roles.

Trypanosomiasis: Trypanosomiasis is a disease that affects both humans and livestock. Human trypanosomiasis or sleeping sleekness is caused by the protozoan parasites *Trypanosoma brucei* subspecies *gambiense* and *rhodesiense,* and affects about 0.5 million people in sub-Saharan Africa. *T. b. rhodesiense* causes acute disease in Eastern and Southern Africa. The disease is transmitted by tsetse flies of the *Glossina* genus. These flies occupy different habitats in forest, savannah and riverine ecosystems. Climate change and land-use changes are likely to alter these tsetse ecosystems and impact the disease transmission. Historically, trypanosomiasis epidemics have occurred in Africa. For example, a large epidemic occurred in Uganda from 1976-1992 transmitted by *Glossina fuscipes fuscipes* (Gibson and Gashumba 1983. The epidemic in south-eastern Uganda was also attributed to a breakdown in public health and disease control (Smith et al. 1998). In the endemic Lambwe Valley in Kenya an epidemic was attributed to an increase in the vector population (Gibson and Wellde 1985).

4. Health Policies related to climate change in the East Africa Health Sector

Currently climate change adaptation in East Africa has been driven by the National Adaptation Programmes of Action (NAPA) and the disaster preparedness and management framework. The NAPAs are a requirement of the United Nations Framework Convention on Climate Change (UNFCCC) for the Least Developed Countries (LDCs) that could benefit from adaptation funds.

4.1 Climate change considerations in national government health sector policies and strategies

The Kenyan government developed a National Climate Change Response Strategy (NCCRS) which was published in 2010 to guide formulation of the national climate change policy. Uganda had not developed a national climate change policy by November 2012 (Musoke 2012). However, a Climate Change Unit has been approved by the Cabinet and it is expected to start work on the national climate change policy. Tanzania has focused on developing its NAPA. It has been recommended that Tanzania should be supported to develop a new National Climate Change Policy and Strategy or 'new' NAPA which includes the screening of current and future sector initiatives.

While these three East African countries in collaboration with WHO have developed guidelines and policies for disease prevention and control, there is a need to address the new risks posed by climate change. These risks include: epidemics and outbreaks; changes in disease seasonality and intensity of transmission; changes in geographic rage of disease epidemiology; and emerging and re-emerging infections.

4.2 Climate change considerations in regional health sector policies and strategies

On 20 November 2009 the Heads of State directed the East African Community (EAC) to develop a regional climate change policy and strategy. The policy is consistent with the fundamental principles of the Treaty establishing the EAC and principles of international environmental law according to the EAC Protocol on Environment and Natural Resources, the Protocol on Sustainable Development of Lake Victoria Basin and the UNFCCC. The policy aims to implement priorities identified in the National Adaptation Plans of Action. In order to implement the regional policy, each state is required to develop national policies and strategies.

4.3 Policy statements and actions for the health sector in the East African Community

In 2009, Kenya published a national disaster preparedness policy (Government of Kenya 2009) which outlined the actors to respond to disasters, caused by climate change. Health disasters such as epidemics are covered in this draft policy. The draft policy could be a precursor to a national climate change adaptation policy that emphasizes early warning and disaster prevention. The document also identifies the major stakeholders involved in the national disaster preparedness; these include all government ministries, development partners and UN and other international agencies.

In Tanzania the National Disaster Management Policy was published in 2004. The policy aims to mainstream disaster management activities as an integral part of development programmes in all sectors. Thus all sectors in Tanzania are stakeholders in disaster preparedness and response.

Uganda also has an outline of a disaster management and preparedness plan which was mainly developed to address climate related disasters. The policy includes all sectors in the government and international agencies such as the Red Cross.

Key policy statements in the region include:

- Develop effective early warning systems and emergency health measures for climate change related diseases;
- Facilitate availability of health facilities, equipment and medicine to assist in early diagnosis and treatment in climate change related diseases;
- Enhance capacity of medical personnel on climate change, including traditional/indigenous knowledge;

- Promote awareness among populations on climate change related diseases and their prevention;
- Provide access to healthcare services to vulnerable groups such as pregnant women, children, older persons and others; and
- Promote measures for preventing the spread and mitigating impacts of HIV/AIDS on the climate vulnerable populations; i.e. those living in co-infection hotspots such as highlands and flood prone areas.

5. Gaps in climate change adaptation research and policy in the health sector

Climate change is a dynamic process that needs continuous monitoring and response. National health policies should therefore be designed to address the challenges of climate change adaptation. The adaptation policies must also include support for research and capacity building and the ability to anticipate health outcomes and to undertake preventative measures. Such an approach will be much more cost effective than attempts to control disease epidemics.

Major gaps in research on adaptation to climate change in the health sector

The following major gaps in research on adaptation are identified in the East African region:

a. Detecting changes in disease geographic distribution
b. Detecting changes in disease seasonality
c. Attributing these changes to climate change and variability
d. Developing locally applicable, affordable and sustainable disease prevention and control strategies
e. Developing early warning systems for detection of disease outbreaks and geographic spread
f. Developing rapid response systems for disease prevention and control
g. Identifying epidemic and disease hot-spots
h. Tracking emerging and re-emerging infections

Missing elements in national policy frameworks

Many of the health policies in the region are in line with those of WHO. For example, the strategy for managing malaria epidemics is spelt out in the Abuja Declaration and was guided by the Roll Back Malaria programme of WHO (Eldis 2014). For new strategies to be accepted by the Ministries of Health in the regions they also need the approval of WHO. Extensive testing

and validation of the new research findings and products is required and this calls for multiple stakeholder involvement. It is not sufficient to develop new products and stop at publication. If research findings have direct application there is need to share the knowledge with major stakeholders such as technocrats and policymakers as well as WHO and funding and development agencies. In addition, mass media can help in the mobilisation of public opinion and gather support for the product.

There was perception that climate change adaptation is a separate programme from the normal government development programmes. In this regard, it was felt that extra financing is required to fund adaptation programmes. However, it has become clear that adaptation will be embedded in the normal development budgets, perhaps with some external support. The concept of disaster management previously dominated the adaptation debate. However, disaster prevention has become a priority. The development of early warning systems facilitates launching interventions before the impacts of an impending disaster can occur.

6. Stakeholders and Opportunities for Collaboration in Research on Climate Change in the East Africa Health Sector

6.1 Major research institutions

Kenya and Tanzania each have fairly well developed national medical research institutes. Uganda has not developed such an institute. There are also many foreign universities collaborating with local universities and research institutions to carry out research in health in the region. The US-based CDC carries out extensive research on major disease in East Africa, mainly in Kenya and Uganda. It addresses diseases such as malaria, HIV/AIDS, tuberculosis and diarrhoea. It also has a programme on emerging and re-emerging infections.

In East Africa, only the Kenya Medical Research Institute (KEMRI) has a climate and human health research programme addressing epidemic malaria in Kenya. The KEMRI's climate and human health research unit undertakes collaborative research with institutions in Tanzania and Uganda.

In Kenya, two large international research institutions, the International Centre of Insect Physiology and Ecology (*icipe*) and the International Livestock Research Institute (ILRI) collaborate with KEMRI on research in human and livestock diseases. The UK-based Wellcome Trust also collaborates with KEMRI and has carried out extensive research on malaria in Kenya. KEMRI and the Tanzanian National Institute for Medical Research (NIMR) are the major health research institutions in the region, collaborating extensively in medical research.

6.2 Major policy Stakeholders

The policy stakeholders in East Africa that play a role in formulating policies that affect human health and adaptation to climate change include the following: Ministries of Health, Departments of Meteorology, Ministries of Finance, Development partners, UNFCCC, WHO, NGOs, Research institutions, Research funding institutions, Regional economic communities, Regional climate policy bodies – EAC and the African Climate Policy Centre (ACPC)

7. Conclusion and Recommendations

7.1 Conclusions

The role of climate change challenges in the context of the multiple challenges and opportunities facing the health sector in the region

The health sector in West Africa faces challenges, including (i) shortage in the provision of health services, (ii) re-emerging diseases such as HIV/AIDS, avian flu and tuberculosis.(iii) pathogens develop resistance to drugs and vectors to insecticides and (iv) climate change.

Climate change has significantly increased the populations at risk of malaria in the East African highlands. Cholera outbreaks and epidemics are becoming more frequent in the region, and the geographic range of Rift Valley fever is growing. Droughts have intensified and these have short-term and long term impacts on human health.

The current state of knowledge on adaptation to climate change in the health sector in the region

No guidelines exist to inform health related decisions under climate change conditions. For example, no mapping has been carried out to indicate the extent of changes in geographic range of climate sensitive diseases and climate change has not been featured as a health risk in the sector. Besides malaria and Rift Valley fever epidemics, no other disease outbreaks have been attributed to climate change.

The current state of knowledge on whether and how research findings are integrated in health sector policies in the region

East African countries have initiated regional guidelines for national policies to deal with the impacts of climate change in the health sector. While local research may have identified potential impacts of climate change in the health sector, much remains to be done in practicing active climate change adaptation.

Ensuring that research findings are better integrated into health sector policies

Local capacity should be strengthened in all the relevant fields in the health sector to handle issues of climate change and human health. Skills should be acquired in health sciences,

statistics and meteorology to enhance understanding of the relationship between diseases, climate change and variability. In addition, technical groups should be formed that assimilate research findings to inform policy formulation in climate change adaptation.

7.2 Recommendations

Recommendations for research and policy

- Integration of the biology of transmission and mathematical models should be developed to accumulate a reliable corpus of information and knowledge to describe the relationship between disease epidemiology, climate change and variability. Such relationships will be used in determining future trends in the risk of disease transmission and thus the actions that need to be taken to prevent the potential impacts of diseases.
- Mathematical models should be developed to illustrate the potential geographic spread of climate sensitive diseases.
- Biologists and meteorologists should collaborate closely, data and knowledge sharing in developing predictive tools.
- The policy space should be expanded by including major stakeholders and increasing capacities in evaluating the risks posed by climate change, proposing interventions and allocating resources for implementation.

8. References

Adam Corner, Panos Eastern Africa Communicating climate change in Uganda: Challenges and Opportunities 2011 http://psych.cf.ac.uk/understandingrisk/docs/hidden_heat.pdf

Anyah, Richard O. Fredrick HM Semazzi, and Lian Xie. "Simulated physical mechanisms associated with climate variability over Lake Victoria Basin in East Africa." Monthly weather review 134.12 (2006): 3588-3609.

CHEN, H., GITHEKO, A. K., ZHOU, G., GITHURE, J. I. & YAN, G. (2006) New records of Anopheles arabiensis breeding on the Mount Kenya highlands indicate indigenous malaria transmission. Malaria Journal, 5, 17.

GONZALEZ-MORENO, O., HERNANDEZ-AGUILAR, R. A., PIEL, A. K., STEWART, F. A., GRACENEA, M. & MOORE, J. (2013) Prevalence and climatic associated factors of Cryptosporidium sp. infections in savanna chimpanzees from Ugalla, Western Tanzania. Parasitology research, 1-7.

LOEVINSOHN, M. E. (1994) Climatic warming and increased malaria incidence in Rwanda. The Lancet, 343, 714-718.

MORSE, S. S. (1995) Factors in the emergence of infectious diseases. Emerging infectious diseases, 1, 7.

MUCHIRI, J. M., ASCOLILLO, L., MUGAMBI, M., MUTWIRI, T., WARD, H. D., NAUMOVA, E. N., EGOROV, A. I., COHEN, S., ELSE, J. G. & GRIFFITHS, J. K. (2009) Seasonality of Cryptosporidium oocyst detection in surface waters of Meru, Kenya as determined by two isolation methods followed by PCR. Journal of water and health, 7, 67.

Ronald Musoke Uganda to get Climate Change Policy 09 November 2012 http://www.independent.co.ug/news/news/6780-uganda-to-get-climate-change-policy?format=pdf.

OGALLO, P. M., KIRUMIRA, E., NANYUNJA, R., BAGUMA, T., SIGALLA, R., ACHOLA, P. & YANDA, P. (2006) Adaptation to Climate Change/Variability-Induced Highland Malaria and Cholera in the Lake Victoria Region.

OLAGO, D., MARSHALL, M., WANDIGA, S. O., OPONDO, M., YANDA, P. Z., KANGALAWE, R., GITHEKO, A., DOWNS, T., OPERE, A. & KABUMBULI, R. (2007) Climatic, socio-economic, and health factors affecting human vulnerability to cholera in the Lake Victoria basin, East Africa. AMBIO: A Journal of the Human Environment, 36, 350-358.

PAAIJMANS, K. P., READ, A. F. & THOMAS, M. B. (2009) Understanding the link between malaria risk and climate. Proceedings of the National Academy of Sciences, 106, 13844-13849.

PASCUAL, M., AHUMADA, J. A., CHAVES, L. F., RODO, X. & BOUMA, M. (2006) Malaria resurgence in the East African highlands: temperature trends revisited. Proceedings of the National Academy of Sciences, 103, 5829-5834.

RANSON, H., NÂ€™GUESSAN, R., LINES, J., MOIROUX, N., NKUNI, Z. & CORBEL, V. (2011) Pyrethroid resistance in African anopheline mosquitoes: what are the implications for malaria control? Trends in parasitology, 27, 91-98.

SWAI, E. S. & SCHOONMAN, L. Investigation into the Prevalence of Cryptosporidium Infection in Calves among Small-Holder Dairy and Traditional Herds in Tanzania. Veterinary medicine international, 2010.

SWAI, E. S. & SCHOONMAN, L. (2010) Investigation into the Prevalence of Cryptosporidium Infection in Calves among Small-Holder Dairy and Traditional Herds in Tanzania. Veterinary medicine international, 2010.

WORT, U. U., HASTINGS, I. M., CARLSTEDT, A., MUTABINGWA, T. K. & BRABIN, B. J. (2004) Impact of El Nino and malaria on birthweight in two areas of Tanzania with different malaria transmission patterns. International journal of epidemiology, 33, 1311-1319.

YANDA, P. Z., KANGALAWE, R. Y. M. & SIGALLA, R. J. (2005) Climatic and socio-economic influences on malaria and cholera risks in the Lake Victoria region of Tanzania. AIACC Working Paper.

WeADAPT Climate changes in East Africa 30th March 2011 http://weadapt.org/knowledge-base/national-adaptation-planning/climate-changes-in-east-africa
http://www.sei-international.org/weadapt