Vulnerabilities of Key Agriculture Sectors to Climate Change

Economic development, in particular poverty alleviation, is a major issue for many African countries, which may consider climate change as a negligible problem compared with the huge challenge of hunger and poverty. But, in recent years, it has become evident that climate change impacts might hinder the achievement of development goals in developing countries.

Several arguments for integrating climate change issues into development policies and thus reducing vulnerabilities have been framed by Davidson *et al.* (2003):

- Food production needs to double to meet the needs of an additional 3 billion people in the next 30 years. Climate change is projected to decrease agricultural productivity in the tropics and subtropics for almost any amount of warming.
- One-third of the world's population is now susceptible to water scarcity. Populations facing water scarcity will more than double over the next 30 years. Climate change is projected to decrease water availability in many (semi)arid regions.

- Wood fuel is the main source of fuel for one-third of the world's population. Wood demand is expected to double in the next 50 years. Climate change will make forest management more difficult due to increases in pests and fires.
- Today, 1,6 billion people are without electricity. Electricity demand in developing countries will increase three to five times over the next 30 years. Fuel-based electricity production will exacerbate climate change.

The following sections try to give an overview of possible vulnerabilities of economic sectors in East Africa to climate change.

Primary production

Agriculture, crop production, and food security

Various assessments of climate change impacts on agriculture in Africa state that certain agricultural areas might undergo negative changes (Mendelsohn *et al.*, 2000b).

The UNFCCC states with respect to food security in Africa that, due to climate change, yields from rainfed crops could be halved by 2020 in some countries. Net revenues from crops could fall by 90% by 2100 (UNFCCC, 2007).

Detailed scientific research on potential crop losses due to climate change in East Africa is still lacking. However, East Africa's strong dependence on rainfed agriculture and the resulting vulnerability to climate change makes crop impact assessment a top priority.

In East Africa, the link between climate and livelihood is very strong. As East Africa depends heavily on rainfed agriculture, rural livelihoods are highly vulnerable to climate variability such as shifts in growing season conditions (WWF, 2006; IPCC, 2001). Furthermore, agriculture contributes 40% of the region's GDP and provides a living for 80% of East Africans (IFPRI, 2004). Due to temperature increase in the region and precipitation decrease in some areas, impacts can already be observed. For instance, from 1996 to 2003, a decline in rainfall of 50-150 mm per season (March to May) led to a corresponding decline in long–cycle crops (e.g., slowly maturing varieties of sorghum and maize) across most of eastern Africa (Funk *et al.*, 2005). Long-cycle crops depend upon rain during this typically wet season and progressive moisture deficit results in low crop yields in the fall, thereby impacting the available food supply (WWF, 2006).

According to the FAO State of Food Insecurity Report (2004), all East African countries suffered from weather-related food emergencies in 2003-2004, and can therefore be considered as vulnerable to the impact of climate change on their agriculture. Uganda also had to face the same challenge, but the food insecurity in Uganda was caused more by conflicts than by weather events (FAO, 2004; Funk *et al.*, 2005).

Some specific studies and analysis on potential impacts of climate change on crops in East Africa are available.

It is reported for Tanzania that, in the same farming system, positive and negative impacts may occur on different crops. It is suggested that impacts on maize, the main food crop, will be strongly negative for the Tanzanian smallholder, while impacts on coffee and cotton, significant cash crops, may be positive (Agrawala *et al.*, 2003).

In Kenya, a 1-m sea-level rise would cause losses of almost US$500 million for three crops (mangoes, cashew nuts, and coconuts) (Republic of Kenya, 2002). In the tea-producing regions of Kenya, a small temperature increase of 1.2 °C and the resulting changes in precipitation, soil moisture, and water irrigation could cause large areas of land that now support tea cultivation to be largely unusable. As Kenya is the world's second largest exporter of tea, accounting for roughly 25% of export earnings and employing about 3 million people (10% of the population), the economic impact could be tremendous (Simms, 2005; WWF, 2006).

The Ugandan National Adaptation Program for Action demonstrates the dramatic impact that a 2 °C temperature rise might have on coffee-growing areas in Uganda. The analysis indicates that most areas could become unsuitable for coffee growing.

Livestock production

Research on the impact of climate change on livestock farming in Africa has recently been conducted by Seo and Mendelsohn (2006a,b as cited in IPCC, 2007).

These are their results:

- In case of a 2.5 C° temperature rise, the income of small livestock farms could increase by 26% (+US$1.4 billion), in particular due to stock expansion.
- Further increases in temperature, however, would then lead to a gradual fall in net revenue per animal.
- A warming of 5°C would probably increase the income of small livestock farms by about 58% (+US$3.2 billion), largely as a result of stock increases.
- However, a warming of 2.5°C would be likely to decrease the income of large livestock farms by 22%(–US$13 billion).
- A warming of 5°C would probably reduce income by as much as 35% (–US$20 billion), resulting both from a decline in the number of stock and a reduction in the net revenue per animal.
- Increased precipitation of 14% would likely reduce the income of small livestock farms by 10%(–US$ 0.6 billion), mostly due to a reduction in the number of animals kept.
- The same reduction in precipitation would be likely to reduce the income of large livestock farms by about 9% (–US$5 billion) due to a reduction both in stock numbers and in net revenue per animal.

The study by Seo and Mendelsohn (2006a) also indicates that higher temperatures are beneficial to small farms that keep goats and sheep because it is easy to substitute animals that are heat-tolerant. Large farms, however, are more dependent on species such as cattle, which are not heat-tolerant. Increased precipitation is likely to be harmful to grazing animals because it implies a shift from grassland to forests, an increase in harmful disease vectors, and also a shift from livestock to crops (IPCC, 2007).

Detailed research on livestock vulnerability in East Africa is lacking and impact assessments should be carried out.

An example of impact of climate change on livestock in East Africa is given in the NAPA of Uganda. The subdivision of the Ugandan climate is reflected in the distribution of natural resources such as water, forest, and vegetation. The so-called cattle corridor lies in the semiarid climate zone and is predominantly a pastoral area, although rainfall is sufficient to support the growing of food for consumption in the area and neighboring regions.

The cattle corridor, stretching from the northeast to the southwest of Uganda, is a fragile ecosystem and depends on rainwater for human consumption and production. The prolonged and severe drought of 1999–2000 and the resulting water shortage led to loss of animals, low production of milk, food insecurity, increased food prices, and generally negative effects on the economy (NAPA Uganda, 2007).

Fisheries

Fisheries represent a significant source of revenue, employment, and proteins for all East African countries. Climate change may have an impact on fisheries as has been demonstrated for Lake Tanganyika by O'Reilly *et al.* (2003). They conclude that primary productivity in Lake Tanganyika may have decreased by as much as 20% over the past 200 years. Recent declines in fish abundance in East African Rift Valley lakes have also been linked to climatic impact on lake ecosystems (O'Reilly, 2007).

As many tropical fish have a critical thermal maxima beyond which they are unable to survive, climate change may also impact fisheries in East Africa (WWF, 2006). Many tropical fish can indeed endure temperatures that are close to their temperature threshold. A 1 to 2°C increase, however, may exceed these limits, in particular for populations that currently exist in thermally marginal habitats (Roessig *et al.*, 2004). However, because there are little data on the ability of these species to adjust their tolerance for water temperature, their response to climate change is largely unknown (WWF, 2006).

Although the impact of climate change on fisheries is likely to be significant, it clearly needs to be assessed together with other human activities, including impacts that may arise from governance of fresh and marine waters (AMCEN/UNEP, 2002). Furthermore, other factors depleting fish resources should be taken into account, such as pollution and overfishing.

Source

This article is drawn from a wider discussion in *Economic Impact of Climate Change in the East African Community (EAC)* by Josef Seitz, Global21 Consulting Toulouse/France and Dr. Wilfred Nyangena, School of Economics. Nairobi, Kenya. Final Report, 14 August 2009. Global 21 Consulting.

References

Agrawala, S., Moehner, A., Hemp, A., van Aalst, M., Hitz, S., Smith, J. , Meena, H., Mwakifwamba, S.M., Hyera T., Mwaipopo, O.U. 2003. Development and climate change in Tanzania: focus on Mount Kilimanjaro. Environment Directorate and Development Cooperation Directorate, Organisation for Economic Co-operation and Development, Paris. 72 p.

AMCEN/UNEP. 2002. Africa environment outlook: past, present and future perspectives. Earthprint, Stevenage. 410 p.

Davidson, O., Halsnaes, K., Huq, S., Kok, M., Metz, B., Sokona, Y., Verhagen, J. 2003. The development and climate nexus: the case of sub-Saharan Africa. Climate Policy 3S1: S97-S113.

Funk, C. *et al*. 2005. Recent drought tendencies in Ethiopia and equatorial-subtropical Eastern Africa. FEWS-NET.

IPCC (Intergovernmental Panel on Climate Change). 2001. Climate change 2001: impacts, adaptation, and vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken, and K.S. White (eds.). Cambridge University Press, Cambridge, UK. 1032 p.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hansen, (eds.). Cambridge University Press, Cambridge, UK. 976 p.

O'Reilly, C.M., Alin, S.R., Plisnier, P.D., Cohen A.S., McKee, B.A. 2003. Climate change decreases aquatic ecosystem productivity of Lake Tanganyika, Africa. Nature, 424: 766-768.

O'Reilly, C.M. 2007. The impact of recent global climate change on the East Africa Rift Valley lakes. Earth-Science Review

Republic of Kenya. 2002. First National Communication of Kenya to the Conference of Parties to the United Nations Framework Convention on Climate Change. Ministry of Environment and Natural Resources. Nairobi. 155 p.

Roessig, J. M., Woodley, C. M., Cech, Jr., J. J., Hansen, L. J. 2004. Effects of global climate change on marine and estuarine fishes and fisheries. Rev. Fish Biol. Fisheries 14: 251-275.

Seo, S.N., Mendelsohn, R. 2006a. Climate change impacts on animal husbandry in Africa: a Ricardian analysis. Centre for Environmental Economics and Policy in Africa. Discussion Paper No. 9. University of Pretoria, Pretoria.

Seo, S.N., Mendelsohn, R. 2006b. Climate change adaptation in Africa: a microeconomic analysis of livestock choice. Centre for Environmental Economics and Policy in Africa. Discussion Paper No. 19. University of Pretoria, Pretoria.

Simms, A. 2005. Africa: up in smoke? The second report from the Working Group on Climate Change and Development. New Economics Foundation, London.

UNFCCC. 2007. Climate change: impacts, vulnerabilities, and adaptation in developing countries. Bonn, Germany.

WWF (Worldwide Fund for Nature) (2006). Climate change impacts on East Africa. WWF Gland, Switzerland.