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Original Contribution

Climate Change and Health in Sub-Saharan Africa: A Case-Based Perspective

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Abstract: Over the coming decades, sub-Saharan Africa will face profound stresses and challenges from global climate change. Many of these will manifest as adverse health outcomes. This article uses a series of five hypothetical cases to review the climate impacts on the health and well-being of individuals and populations in sub-Saharan Africa. This approach fosters insights into the human dimensions of the risks to health, their interaction with local human ecology, and awareness of the diverse health ramifications of external environmental changes. Each case illustrates the health impact resulting from a specific environmental or social consequence of climate change, including impacts on agriculture and food security, droughts, floods, malaria, and population displacement. Whereas the article focuses on discrete manifestations of climate change, individuals will, in practice, face multiple stresses from climate change (i.e., floods and malaria) concomitant with other non-climate stressors (i.e., HIV/AIDS, globalization, etc.). These multiple sources of vulnerability must be considered when designing climate change and socioeconomic development interventions.

Keywords: climate change, Africa, health and development, climate change and health

INTRODUCTION

Over the coming decades, sub-Saharan Africa and its growing population will face profound stresses and challenges from global climate change (Sokona and Denton, 2001; Davidson et al., 2003). Many of these will manifest as adverse health outcomes (IPCC, 2007a). The negative impacts of climate change will, in general, be greater in sub-Saharan Africa than in other regions, despite the small carbon footprints of most African citizens. Furthermore, many African societies, already straining under the combined pressures of poverty, HIV/AIDS, and weak public health and physical infrastructure, have very limited capacity to adapt to the coming shifts in climate (Reid and Cogel, 2006; UNDP, 2007).

Although reviews of climate change and health abound, few articles consider the specific health and development impacts of climate change in sub-Saharan Africa. This article uses a case-based approach to review how climate change will affect the health and well-being of individuals, households, and populations in sub-Saharan Africa (referred to as "Africa" for simplicity). Each of the five cases illustrates, at the micro-scale and within the frame of human ecology, the health impacts resulting from a specific environmental or social consequence of climate change, including impacts on

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agriculture and food security, droughts, floods, malaria, and population displacement.

Case Reports

Case 1: Ms. Kappa

Ms. Kappa is a 28-year-old farmer who presents to a UNICEF re-feeding center in northern Kenya. She is extremely emaciated and has minimal muscle mass. She explains that she contracted HIV from her husband, whom she must now care for along with her five children. Ms. Kappa states that, in the past, she was able to feed herself and her family with only minimal difficulties. Recently, however, her small farm has become less and less productive as the rains have become less frequent. Ms. Kappa has thus watched her income fall as she was able to sell less surplus at the local market, while at the same time prices for imported food items at the market have increased sharply.

Discussion

Undernutrition currently causes 1.7 million deaths in Africa annually, and Ms. Kappa's experience with decreased agricultural productivity may become more common with climate change. Climate change will impose further stress on local food yields, on livelihoods and family income, and, along with other local factors, will put at least some communities and individual families at much greater risk of serious undernutrition. Between 2000 and 2020, yield from rain-fed agriculture in Southern Africa could be reduced by up to 50% (IPCC, 2007a). In particular, mid-latitude (subtropical) regions in Africa—as in all continents, north and south—are anticipated to undergo long-term drying as rainfall systems are displaced polewards by the warming process (IPCC, 2007c). Crop net revenues could fall by as much as 90% by 2100, with small-scale farmers being the most affected (Boko et al., 2007). These changes will occur, particularly along the margins of semi-arid and arid areas, alongside declines in the area suitable for agriculture, the length of the growing seasons, and yield potential (IPCC, 2007a).

Although some farmers will be able to adapt to the changing climate, the poor are the least able to afford to change their techniques or invest in new infrastructure. Overall adaptive capacity is low in Africa due to poverty, manifesting through constraints such as low GDP per capita, low education levels, high rates of disease and absent social safety nets, including after harvest failures and severe illness (African Development Bank et al., 2003; Speranza et al., 2008). Decreased agricultural productivity will contribute to decreased food security and subsequent increases in undernutrition, which is currently estimated to be the largest contributor to climate change mortality (Patz et al., 2005). Climate change has been implicated as one of several conjoint contributory factors to the dramatic recent upswing in world food prices, reflecting declines in yields in various regions including parts of sub-Saharan Africa (Lovell, 2008). Many of those regions are already food-insecure (FAO, 2007; Sheeran, 2008).

Climate change will interact with other threats to food security, including poverty, social and political unrest, and HIV/AIDS (Misselhorn, 2005). As the case of Ms. Kappa demonstrates, agriculture is a key sector where climate change and HIV/AIDS will interact to synergistically impact on the nutritional status of the population. AIDS-affected households have an impaired ability to undertake farm work and, as a consequence, have reduced agricultural output. Some 20% of the rural families in Burkina Faso were estimated to have reduced their agricultural work or even abandoned their farms because of AIDS (UNAIDS, 2002). The future of the AIDS epidemic may interact with climate change and other social stressors to push agricultural productivity to even more depressed levels.

Case 2: Beniam

Beniam is 7-year-old boy accompanied by his mother who presents to a pediatric clinic in rural Ethiopia. His mother wants to have him weighed and have his height checked because she has noticed that he is much smaller than his two older brothers were at the same age. She states that she has had trouble feeding him and caring for him in recent years, as food has become more expensive and as she has had to travel greater distances each day to collect water for the family. On examination, Beniam looks small for his age and has a bad cough.

Discussion

Currently one-third of Africa's population lives in drought-prone areas and is vulnerable to the impacts of drought (World Water Forum, 2000). Furthermore, it has been estimated that, even in the absence of climate change, African countries will exceed the limits of the "economi-

cally usable, land-based water resources before 2025'' (Ashton, 2002). Even without climate change, the proportion of the global population living in water-stressed regions is projected to double by 2025 (Arnell, 1999). Based on a wide range of climate models, the population at risk of increased water stress in Africa is projected to be between 75–250 million by the 2020s and 350–600 million by the 2050s (Boko et al., 2007). Across the planet, climate change is projected to cause droughts to become slightly more frequent and of much longer duration by the second half of the 21st century (IPCC, 2007c).

In 2005, droughts in the Horn of Africa and Southern Africa threatened the lives of over 14 million people across a swathe of countries from Ethiopia and Kenya to Malawi and Zimbabwe (UNDP, 2007). Droughts have numerous implications for the health and well-being of vulnerable populations. As is the case with Beniam's mother, women often have to travel greater distances to collect water. Women in Northern Kenya may already be walking greater distances to collect water, ranging from 10 to 15 km a day (Practical Action, 2006). In extreme cases, drought and the consequent loss of livelihoods trigger population movements, particularly rural to urban migration (Barios et al., 2006).

Droughts also have a direct impact on health, particularly for children. In Ethiopia, children aged 5 or less are 36% more likely to be undernourished and 41% more likely to be stunted, if they were born during a drought year and affected by it. A study in Kenya found a strong link between droughts and subsequent food insecurity, including famines (Speranza et al., 2008). Being born in a drought year in Kenya increases the likelihood of a child being undernourished by 50% (UNDP, 2007). A study in Zimbabwe found that a series of droughts from 1982 to 1984 reduced the average stature of a cohort of children by 2.3 cm, delayed the start of school, and resulted in a 14% loss of lifetime earnings (Hoddinott and Kinsley, 2001). These effects were particularly strong among children residing in poorer households.

Case 3: Mr. Joma

Mr. Joma is a 25-year-old male trader in rural Nigeria, who presents in a state of severe dehydration to a government-run hospital a week after a major flooding event in the region, complaining of diarrhea for 3 days. He lives with his family in a nearby village where he was born. He reports that the area has been prone to more and more floods over the past few years, as the rains seem to explode out of the sky and the river swells its banks. His grandparents tell him that, compared to when they were children, this is very strange weather. A diagnosis of cholera is made.

Discussion

Paradoxically, while much of the continent will experience an increase in periods of drought, flooding will also become a more widespread problem. Increased flooding results from both rising sea levels and the increased incidence of heavy precipitation events associated with warming oceans and rising air temperature (IPCC, 2007c). Forty percent of the population of West Africa live in coastal cities, and many of Africa's large cities are coastal (Boko et al., 2007). Heavy rainfall events have already become more common in Angola, Namibia, Mozambique, Malawi, and Zambia (Usman and Reason, 2004). In September 2007, some of the worst flooding in decades struck across East Africa. Hundreds of thousands of people were affected by the damage wrought by the floods, as well as the subsequent outbreaks of diseases such as malaria and diarrheal illnesses (BBC News, 2007).

The health impacts of floods range from deaths, injuries, infectious diseases and toxic contamination, to mental health problems (Ahern et al., 2005). Outbreaks of diseases such as cholera and malaria are common sequelae of floods. Flooding in Mozambique in 2000 appeared to increase the number of malaria cases by a factor of 1.5–2, compared with 1999 and 2001 levels (Ahern et al., 2005). Immunocompromised patients, infants, the elderly, and pregnant women are particularly susceptible to the waterborne diseases which spread rapidly in the wake of floods (Epstein and Mills, 2005).

The sequelae of natural disasters such as floods last far after the event itself, especially for the poor, who in periods of stress may be forced to sell off their physical assets such as land, livestock, and farming implements (Misselhorn, 2005; African Development Bank et al., 2003). This loss of physical capital undermines the sustainability of their livelihoods over the longer term (African Development Bank et al., 2003). Floods can also destroy food supplies, as occurred in Malawi in 2001/2002 when the country suffered one of the worst famines in recent history after localized floods cut maize output by one-third. Up to 20,000 are estimated to have died as an indirect result of associated undernutrition and disease (UNDP, 2007). Similarly, floods in Mozambique in the year 2000 damaged

about 10% of farmland and 90% of irrigation, displaced two million people, and affected up to 1.5 million livelihoods mostly in poor rural areas (McMichael et al., 2008). It can take years for patients such as Mr. Joma to return to their pre-flood level of health and economic well-being.

Case 4: Bibi

Bibi is a 64-year-old married woman who lives in the highlands of Rwanda and is brought by her children to a local clinic because of a 1-week history of fever, chills, and night sweats. Bibi's children were told by a neighbor that it looked like malaria, but they didn't know anyone else who had ever contracted malaria while living in their village, and Bibi has not traveled outside of the village for 10 years. They have noticed mosquitoes around the village recently. A blood smear at the clinic finds malaria parasites.

Discussion

An estimated 700,000 to 2.7 million people die of malaria each year, and 75% of those are African children (Patz and Olson, 2006). In Africa, Tanser and colleagues estimated that the risk of exposure to malaria, measured in person months, will be 16%–28% higher in 2100 than at present (Tanser et al., 2003). While there is ongoing debate over the precise boundaries of the future map of malaria transmission in Africa, it is clear that populations which are currently not exposed will become exposed over the coming decades (Pascual et al., 2006). For example, the previously malaria-free highland areas in Ethiopia, Kenya, Zimbabwe, Rwanda, and Burundi could experience malaria by the 2050s, with conditions for transmission becoming highly suitable by the 2080s (Boko et al., 2007). Furthermore, the cases of malaria in regions to which it spreads are likely to cause higher rates of morbidity and mortality, as severe malaria is more common in areas of low-to-moderate transmission and in populations with lower levels of acquired immunity such as the highlands of East Africa (Boko et al., 2007).

Case 5: The Kano Family

The Kano family present to a UNHCR camp in inland Nigeria requesting food and shelter. They tell the intake staff that their home was washed away in a recent storm on the southeastern Nigerian coast. Mr. Kano had been working on a fishing boat for the past 10 years, but the boat and harbor had also been destroyed in the storm. The family decided to move inland as they no longer felt safe living on the coast, since over the past two decades they had seen the sea level rise and storms become more intense. The four Kano children all appear undernourished, and Mrs. Kano is pregnant with a fifth child. Both parents appear to be depressed and anxious, and Mrs. Kano is later diagnosed with post-traumatic stress disorder (PTSD).

Discussion

The coasts of Africa are vulnerable to the combination of rising sea levels and extreme weather events, as the case of the Kano family illustrates. More than one quarter of Africa's population lives within 100 km of the coast, and most of Africa's largest cities are along coasts vulnerable to sea level rise, coastal erosion, and extreme weather (African Development Bank et al., 2003). Again, poorer populations living in more vulnerable coastal areas will bear the brunt of the impacts of rising sea levels (Confalonieri et al., 2007). Aside from the immediate morbidity, mortality, and property damage caused by rising sea levels, the encroachment of the ocean may also cause a large group of migrants to move inland (Boko et al., 2007). This group of migrants could move into new settlements, seek new livelihoods, and place additional demands on existing infrastructure. Such mass migration could result in conflict over scarce resources, such as water, as well as over land and employment opportunities (Ashton, 2002; Boko et al., 2007). The mental health impacts of such climate shocks may encompass depression and anxiety disorders such as PTSD, conditions which are already common in Africa (WHO, 2001).

Discussion

While this article has focused on discrete environmental and biotic manifestations of climate change, the reality is that individuals will face multiple stresses from climate change (e.g., both floods and malaria) along with other non-climate stressors such as HIV/AIDS, the depletion of natural resources for agriculture, and the impacts of globalization. Vulnerability to climate change is shaped by such non-climatic factors as conflict, poor governance, high debt burdens, economic globalization, unequal terms of trade, disrupted ecosystems, and changing disease patterns, including rising levels of both chronic diseases as well as the

ongoing HIV/AIDS epidemic (Thomas and Twyman, 2005; Tschakert, 2007). This notion of multiple exposures is explored by Leichenko and O'Brien (2002) in the form of climate change and economic globalization. These authors argue that African farmers are struggling to adapt to both climate stress as well as trade liberalization, removal of subsidies, and altered marketing norms (Leichenko and O'Brien, 2002).

The complex interplay between physical, ecological, and social stressors suggests that any analysis of climate change in Africa, as well as any solutions, must be multi-sectoral and encompass broad-based socioeconomic development. Adaptation strategies in Africa must address both short-term disaster prevention and long-term investment in infrastructure. Promoting equitable and sustainable economic growth through decreased population growth, international trade, bilateral aid, and technical support are key components of long-term adaptation plans for African countries. Outside of Africa, true primary prevention requires that climate change itself be slowed or prevented by mitigation of emissions. Long-term mitigation solutions span shifts in energy sources and transportation policy, curtailment of deforestation, and achieving sustainable agricultural practices, in Africa as elsewhere. These policies are discussed extensively elsewhere (IPCC, 2007b).

Conclusion

This article has used a case-based perspective to illustrate the health impacts of climate change on agriculture and food security, droughts, floods, malaria, and population displacement. There is a further cautionary conclusion to be drawn from this article. While the mainstream analysis of measurable health impacts (specific disease events) due to climate change, and the model-based projection of health risks due to future scenarios of climate change, remain very important—both as part of the research task and as input to policies—there is an even wider penumbra of effects of well-being and health, including those that cascade across families, communities, and generations.

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References

African Development Bank, Asian Development Bank, UK DFID, Netherlands DGIS, European Commission DG for Development, German BMZ, et al. (2003) Poverty and climate change: Reducing the vulnerability of the poor through adaptation. Available: http://www.undp.org/energy/povcc.htm [accessed May 16, 2008]

Ahern MJ, Kovats RS, Wilkinson P, Few R, Matthies S (2005) Global health impacts of floods: Epidemiological evidence. *Epidemiology Review* 27:36–45

Arnell NW (1999) Climate change and global water resources. *Global Environmental Change* 14:S31–S49

Ashton PJ (2002) Avoiding conflicts over Africa's water resources. *Ambio* 31:236–242

Barios S, Bertinelli L, Strobl E (2006) Climactic change and rural-urban migration: The case of sub-Saharan Africa. *Journal of Urban Economics* 60:357–371

BBC News (2007) Million hit by floods in Africa. Available: http://news.bbc.co.uk/2/hi/africa/6998651.stm [accessed April 15, 2008]

Boko M, Niang I, Nyong A, Vogel C, Githeko A, Medany M (2007) Africa. In: *Climate Change 2007: Impacts, Adaptation, Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Parry ML, Canziani OF, Palutikof JP, Linden PJvan der, Hanson CE (editors), Cambridge, UK: Cambridge University Press, pp 433–467

Confalonieri U, Menne B, Akhtar R, Ebi KL, Hauengue M, Kovats RS (2007) Human health. In: *Climate Change 2007: Impacts, Adaptation, Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Parry ML, Canziani OF, Palutikof JP, Linden PJvan der, Hanson CE (editors), Cambridge, UK: Cambridge University Press, pp 391–431

Davidson O, Halsnaes K, Huq S, Kok M, Metz B, Sokona Y, et al. (2003) The development and climate nexus: The case of sub-Saharan Africa. *Climate Policy* 3S(1):S97–S113

Epstein PR, Mills E (2005) *Climate Change Futures: Health, Ecological and Economic Dimensions*, Boston: The Center for Health and the Global Environment, Harvard Medical School

Food and Agricultural Organization (FAO) (2007) *The State of Food Insecurity in the World, 2006*, Rome: FAO

Hoddinott J, Kinsley B (2001) Child growth in the times of drought. *Oxford Bulletin of Economics and Statistics* 63:409–436

IPCC (2007a) *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

IPCC (2007b) *Climate Change 2007: Mitigation of Climate Change Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge, UK: Cambridge University Press

IPCC (2007c) *Climate Change 2007: The Physical Science Basis Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge, UK: Cambridge University Press

Leichenko RM, O'Brien KL (2002) The dynamics of rural vulnerability to global change: the case of southern Africa. *Mitigation and Adaptation Strategies for Global Change* 7:1–18

Lovell J (2008) Dearer food unleashes silent tsunami, U.N. says. Reuters News. Available: http://www.reuters.com/article/topNews/idUSL2283160720080422?sp=true [accessed May 16, 2008]

McMichael AJ, Friel S, Nyong A, Corvalan C (2008) Global environmental change and health: Impacts, inequalities, and the health sector. *British Medical Journal* 336:191–194

Misselhorn AA (2005) What drives food insecurity in southern Africa? A meta-analysis of household economy studies *Global Environmental Change* 15:33–43

Pascual M, Ahumada JA, Chaves LF, Rodo X, Bouma M (2006) Malaria resurgence in the East African highlands: Temperature trends revisited. *Proceedings of the National Academy of Sciences of the United States of America* 103:5829–5834

Patz JA, Campbell-Lendrum D, Holloway T, Foley JA (2005) Impact of regional climate change on human health. *Nature* 438:310–317

Patz JA, Olson SH (2006) Climate change and health: Global to local influences on disease risk. *Annals of Tropical Medicine and Parasitology* 100:535–549

Practical Action (2006) Shouldering the burden. Adapting to climate change in Kenya. Available: http://practicalaction.org/?id=climatechange_panniers [accessed July 25, 2008]

Reid P, Cogel C (2006) Living and responding to multiple stressors in South Africa—glimpses from KwaZulu-Natal. *Global Environmental Change* 16:195–206

Sheeran J (2008) The challenge of hunger. *The Lancet* 371:180–181

Sokona Y, Denton F (2001) Climate change impacts: Can Africa cope with the challenges. *Climate Policy* 1:117–123

Speranza CI, Kiteme B, Wiesmann U (2008) Droughts and famines: The underlying factors and the causal links among agro-pastoral households in semi-arid Makueni district, Kenya. *Global Environmental Change* 18:220–233

Tanser FC, Sharp B, le Sueur D (2003) Potential effect of climate change on malaria transmission in Africa. *The Lancet* 362:1792–1798

Thomas SG, Twyman C (2005) Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environmental Change* 15:115–124

Tschakert P (2007) Views from the vulnerable: Understanding climactic and other stressors in the Sahel. *Global Environmental Change* 17:381–396

UNAIDS (2002) *Report on the Global HIV/AIDS Epidemic 2002*, Geneva: UNAIDS

UNDP (2007) *Human Development Report 2007/2008 Fighting Climate Change: Human Solidarity in a Divided World*, New York: UNDP

Usman MT, Reason CJC (2004) Dry spell frequencies and their variability over southern Africa. *Climate Research* 26:199–211

World Health Organization (WHO) (2001) *World Health Report 2001. Mental Health: New Understanding*, New Hope, Geneva: WHO

World Water Forum (2000) *The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socioeconomic Development,* UNWater/Africa