22 Climate Change and Health in Africa

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The continent is too large to describe. It is a veritable ocean, a separate planet, a varied, immensely rich cosmos. Only with the greatest simplification, for the sake of convenience, can we say 'Africa'. In reality, except as a geographical appellation, Africa does not exist.

(Kapuściński, 1998)

poverty and other forms of entrapment (King, 1990; Butler, 2004). Africa is home to almost 60 separate states, most of them independent, yet still cartographically captured by lines (44% of them straight) drawn by Europeans, with scant regard for local cultures, languages or rivalries.

22.1 The African Continent

Africa, the 'cradle of humanity', is the home of numerous languages, peoples, customs and cultures. Its size is enormous – almost ten times that of India. Like India, it has a deep history of imperialism and colonialism, still visible today (Rodney, 1972). At a time when the people of the continent had already been raided for centuries, by both Europeans and Arabs, often in collusion with and assistance from people born in Africa, the Berlin conference in the mid-1880s formally 'divided' most of the continent among just a few European powers; principally, the UK, France, Germany, Italy and the King of Belgium.

Today, it has a population exceeding 1 billion, in many parts still growing rapidly, with consequences feared by some as of Malthusian,

22.2 Climate Change in Africa

The fraction of the world's total emissions of greenhouse gases (GHGs) that originate from African nations, mainly from power generation and transport, is minor, whether in the past, present or projected into the future (Collier *et al.*, 2008). Deforestation, a major source of GHGs from some developing countries such as Indonesia, is also occurring in Africa, both in the Congo, for valuable timber, and the Sahel, for energy. Its tropical belt harbours one of the largest and most biodiverse rainforests in the world: it is vulnerable to clearing at an increasing rate (Nogherotto *et al.*, 2013).

The methane emissions of Africa's large and expanding herd of cattle (like in the Sudan) probably constitute a significant proportion of the continent's total climate footprint (Thorpe, 2009).

All regions and populations of the world are vulnerable to climate change, but numerous authors, including some based in Africa, agree that many African developing countries are particularly vulnerable. This is due principally to the continent's widespread poverty (Collier *et al.*, 2008; Hope, Sr, 2009; Kula *et al.*, 2013). But this is added to, and in some parts worsened by, its high birth rate and its history of conflict and poor governance.

Some analysts believe that the impacts of climate change on Africa are already apparent, and also that the physical changes due to climate change in Africa will be unusually severe (Collier *et al.*, 2008). Climate change affects different regions in different ways: East Africa may become wetter and South Africa drier. The Intergovernmental Panel on Climate Change (IPCC) reports with 'medium' confidence that, since the 1950s, West Africa has experienced a trend towards more intense and longer droughts. Sea level rise will be problematic in some regions, especially the Nile delta (Bohannon, 2010), Lagos and Banjul, the capital of The Gambia (Douglas *et al.*, 2008). Africa is considered, with small island states, as the region least likely to be able to afford to protect its coasts (Nicholls *et al.*, 2011).

Development in many sectors (particularly agriculture, water and health) will be an important counterweight to climate change. Before describing the various likely health effects, we outline climate change and agriculture in Africa, as the capacity to grow and protect more food is crucial to positive African development scenarios. Without enough food for all, many other problems will be more difficult to solve. If hunger and undernutrition worsen, then it is likely that many other problems will be aggravated, including those that are health related.

22.3 Climate Change and Agriculture in Africa

Home to 15% of the world's population, Africa, especially its sub-Saharan region, houses (with India) one of the largest and greatest concentrations of undernourished children and adults in the world. Few African nations are net food exporters. In fact, Africa is a major grain importer,

responsible for importing about one-third of the world's internationally traded rice and one-quarter of the wheat (Seck *et al.*, 2013). Its main staple is maize, a grain native to Central America. Comparatively little maize is imported, but in much of southern Africa the rain-fed maize crop already experiences frequent drought stress (Collier *et al.*, 2008). This is thought likely to worsen, particularly in parts of Zimbabwe and South Africa. Wheat yields in North Africa are also likely to be threatened, including because of salinity and sea level incursion to the Nile delta, not only from sea level rise but also from subsidization due to loss of silt trapped by the Aswan High Dam (Bohannon, 2010).

A substantial part of Africa's agricultural potential is considered highly vulnerable to climate change (Collier *et al.*, 2008), from East Africa (Grace *et al.*, 2012) to West Africa (Jalloh *et al.*, 2013) and the conflict-prone Horn of Africa (Funk, 2011). Fisheries are also vulnerable, impacted by overfishing (including predation of resources by wealthier nations) and by climate change, as reported of Lake Tanganyika (Verschuren, 2003). In the scenario of an average increase of 4°C of warming globally, then agricultural prospects in Africa may, without exaggeration, be dire (New *et al.*, 2011).

Patterns of livestock use are already changing, partly driven by climate change. Increasingly, the Maasai, traditionally cattle herders, in Kenya and Tanzania are raising chickens. These changes in the patterns of people, animals and land use can, in turn, lead to novel encounters between hosts and pathogens and the creation of new and re-emerging illnesses.

However, it remains to be seen how effective these strategies will be for reducing poverty, especially in drought areas, where water is precious and the effort to acquire it is becoming more and more risky and extremely time-consuming under climate change (Ndenyele and Badurdeen, 2012).

'Land and water grabs'

Adding to these problems is the issue of the acquisition and control of land and its associated water (Rulli *et al.*, 2013), whether by purchase or lease, in developing countries by nations in East Asia, the Persian Gulf and elsewhere.

Often pejoratively called 'land grabs', these leaseholds are claimed to be of mutual benefit. Poor nations gain financial capital and the promise of the transfer of technology and expertise. Leaseholders gain the potential for additional food supplies, which could be very useful if climate or other forms of adverse global environmental change cause agricultural deterioration in their own nations. But, poor nations lose, at least temporarily, use of the natural capital, that is, of the land and its water. It is unknown whether food and fuel produced by such areas will be exported in future, even if there is a major domestic shortage of such commodities.

However, in the 19th century, British India exported food to Europe, even during severe famine. Already, in Sudan, land acquired by foreign interests along the Blue Nile (the best source of water in an otherwise dry region) is used increasingly for the large-scale export of food commodities. Yet Sudanese smallholder access to water and land is diminishing, and an increasing number of Sudanese are becoming dependent on food aid and subsidies (Rulli *et al.*, 2013). Further illustrating such concerns, the author, Robin Palmer, reports how African leaders from Mozambique, Ethiopia or Zambia have claimed that many millions of hectares can be used to grow biofuels 'without threatening food production'. The Ethiopian Minister for Agriculture suggested that pastoralists displaced by land grabbing 'can just go somewhere else' (Palmer, 2011).

Another form of land grab also occurred in Zimbabwe, particularly in the 1990s under President Mugabe, as the 6000 white commercial farmers gradually lost control of their land, culminating in 2000 with the introduction of the 'fast-track' programme, resulting in the coercive acquisition of about 90% of commercial farms still owned by white farmers. Exacerbated by drought, HIV/AIDS and hyperinflation, Zimbabwe agriculture regressed from southern Africa's breadbasket to an impoverished land of hunger and undernutrition (Gwatirisa and Manderson, 2012).

Mycotoxins and pests

Both drought stress and floods increase the risk of mould and fungi in staple crops, including stored grain. Such food can be contaminated by

mycotoxins. People ingesting such contaminated food will usually not see or taste anything abnormal, and can develop liver failure and hepatocellular carcinoma. Though a simple fluorescence test can usually determine aflatoxin contamination, it is rarely used in developing countries. Climate change may increase the burden of disease from mycotoxins, including through increased rainfall events during or immediately after harvest (Tefera, 2012).

Many insect pests may be worsened by climate change, including maize, an important African staple (Diffenbaugh *et al.*, 2008). On the positive side, some analysts think that conditions for growing the root crop, cassava, will be improved by climate change (Jarvis *et al.*, 2012).

Possible improvements to African agriculture

Though progress is being made, the Green Revolution has not yet fully reached the continent, due mainly to a lack of human expertise and institutional capacity (Ejeta, 2010). Only 4% of Africa is irrigated, compared to 40% in South Asia (Costello *et al.*, 2011). This at least suggests a possibility of great improvement; irrigation is also thought to be a good buffer for climate change, at least for crops (Hassan, 2010). Another possible improvement is to use more fertilizer (Editorial, 2012), including with phosphorus. African soils are deficient in this vital element, and yet Morocco, including occupied Western Sahara, is the world's major phosphate exporter, hardly any of which is used in sub-Saharan Africa (Cordell *et al.*, 2009).

More optimistically, 'evergreen agriculture', which integrates fertilizer (nitrogen fixing), fruit and fodder tree species with food cropping, is being promoted as a fresh way to improve rain-fed agricultural productivity for smallholders, in regions as diverse as Malawi, Niger and Burkina Faso (Garrity *et al.*, 2010). Advocates of these methods hope that these techniques can be scaled up across the entire continent. Advocates of an African Green Revolution, African aquaculture and genetically modified organisms targeted for the African environment also remain hopeful. For example, Monsanto is trying to develop maize with increased drought tolerance, and has made

its work available to WEMA – the Water-Efficient Maize for Africa consortium (Jones, 2011).

22.4 Climate Change and Health in Africa

Consistent with the general framework of this book, this chapter will discuss three main categories of health effect: *primary* (e.g. heatwaves and perhaps reduced coldwaves in highland areas, flooding and disasters); *secondary*, especially vector-borne diseases and changes to other infectious diseases; and *tertiary*, including famine, conflict and large-scale migration. While the latter two phenomena are not often considered *health* problems, they each clearly have important health manifestations and consequences.

22.5 Primary Health Effects of Climate Change

Heatwaves

In June 2010, Climate Signals reported that Chad and Niger set new maximum temperature records (www.climatesignals.org). In Sudan, the mercury peaked at 49.6°C (121.3°F) at Dongola. Heatwaves cause acute and chronic stress, not only for humans but also for animals, including cattle, birds and bats. Impacts on these may have many indirect effects to human well-being. Extreme high air temperatures contribute directly to deaths from cardiovascular and respiratory disease, particularly among elderly people (see Chapter 3, this volume).

The number of African megacities is growing (e.g. Cairo, Lagos, Nairobi and Johannesburg), and these are likely to be vulnerable to heatwaves, including their interaction with air pollution. However, there is as yet little literature on heatwaves and health in Africa (Capuano *et al.*, 2012).

Flooding and disasters

Climate change may be altering the frequency of intense precipitation in Africa (Douglas *et al.*,

2008), as in most of the world. The vulnerability of the poor to flooding is enhanced by urbanization and inadequate regulation. The poor are frequently forced to build low-quality shelters on river flood plains, steep hillsides (at the risk of erosion and landslides) and other locations considered undesirable by people with more means. Both circumstances are compounded by a lack of insurance and limited or no chance of compensation. Due to flooding, the poor experience higher rates of trauma and property loss and some infectious diseases, such as gastroenteritis and leptospirosis. The poor are also likely to experience increased rates of mental stress from their experience of such events in comparison to those who are better off.

In recent years, extremely heavy rainfall events have occurred in several parts of Africa, particularly in East and West Africa (Cissé *et al.*, 2011). In 2000, floods in Mozambique affected up to 1 million people (Douglas *et al.*, 2008). In 2002, floods in East Africa displaced thousands of people from their homes in Kenya, Rwanda and other regions. Due to insufficient data, the IPCC recently concluded with only low confidence that heavy precipitation had increased in this region, though they found, with medium confidence, that it would increase in future, due to climate change (Field *et al.*, 2012, p. 18). If so, this will contribute to many disasters, particularly in lesser cities and areas with limited infrastructure and reduced adaptive capacities for disaster risk reduction (Cissé, 2013).

22.6 Secondary Health Effects of Climate Change

Secondary effects are less direct than primary ones, but more causally obvious than tertiary health effects. An important mechanism for this group is an altered distribution of arthropod vectors, intermediate hosts and pathogens, due to a shift in environmental parameters that make areas more or less welcoming to hosts and pathogens. This in turn will produce changes in the epidemiology of many infectious diseases. Some diseases may expand their range, but others are predicted to decrease.

Irrigation, if used more widely in Africa, is likely to contribute to local environmental change, including the temperature and humidity,

This could favour vector-borne diseases; however, the wealth from irrigation, combined with public health measures, could reduce such diseases. This has been called the 'paddies paradox' (Ijumba and Lindsay, 2001). However, recent studies in India show that the wealth-related reduction of malaria may need decades to take hold (Baeza *et al.*, 2013).

Malaria and other febrile arthropod-transmitted illnesses

Many parts of Africa, especially away from the highlands, have very high rates of infectious diseases. West Africa was long called the 'fever coast' by European invaders, and mysterious febrile illnesses delayed European incursions and conquest. While most of these fevers were caused by malaria, many illnesses mimic malaria. According to the historians, McNeill and Crosby, both malaria and yellow fever were introduced to the New World due to the slave trade. Malaria has shaped the genome of many Africans, with red cell variants including sickle cell disease, thalassaemia and G6PD deficiency (Eridani, 2011).

In general, the incidence of malaria is declining in Africa, due to public health measures, especially the prompt treatment of malarial fevers with the artemisinin combination therapies (ACTs) (that also inhibit transmission) and the use of insecticides (particularly pyrethroids in relation to treated bed nets) (Feachem *et al.*, 2010). Numerous non-climatic factors influence the epidemiology of malaria, though it is implausible that changes in temperature, rainfall and humidity will not also play a role (see Chapter 7, this volume). These factors not only influence the distribution, longevity and activity of arthropod vectors, but in some cases accelerate the life cycle of the parasite within the vector. There is good evidence that climate change is already contributing to the increased survival of *Anopheles* vectors at higher altitudes (Chen *et al.*, 2009) and of malaria transmission (Alonso *et al.*, 2011). In some cases, the changes wrought to malaria by climate change may be beneficial (Meyrowitsch *et al.*, 2011), but on the whole, they are likely to be harmful. It is also plausible that already existing resistance to ACTs and pyrethroids (Trape *et al.*, 2011) will spread

in Africa, again expanding the malarial disease burden (Gosling and Chandramohan, 2008).

Other fevers, such as dengue and chikungunya,¹ may be on the increase in Africa (Simon *et al.*, 2008), especially as pools and containers of water in urban settlements allow greater breeding opportunities for vectors, and as population density increases.

Meningococcal meningitis

Epidemics of this vaccine-preventable infection occur worldwide, but the highest incidence is observed in the 'meningitis belt' of sub-Saharan Africa, from Senegal on the Atlantic to Ethiopia on the Red Sea (Greenwood, 2006). Populations in northern Nigeria are particularly vulnerable. Other areas in the Rift Valley, the Great Lakes and southern Africa are also affected.

Seasonal, climate-related epidemics occur during the dry season, associated with the dusty Harmattan, which is postulated to impair nasopharyngeal defences (Greenwood, 2006). Changes in the Harmattan have been linked to land-use change and alterations in regional climate (Molesworth *et al.*, 2003).

Other infectious diseases in Africa

HIV/AIDS could worsen in future, in Africa, as a consequence of falling morale and failing public health, for example in a 'four-degree world' with large-scale undernutrition, conflict and declining governance (McMichael *et al.*, 2008). In turn, poorly controlled HIV/AIDs would increase the risk of deepening systemic failure, due to high mortality and consequent lack of cultural transmission and diminished expertise.

The pattern of numerous other infectious diseases is potentially altered in Africa by climate change. These include geohelminths and schistosomiasis (see Chapter 10). African trypanosomiasis, Rift Valley fever virus, cholera and diseases borne by ticks and rodents. Stress from deforestation could weaken immunity in bats, potentially enhancing bat-borne diseases such as Henipavirus and even Ebola. No doubt there are others (we cannot be exhaustive).

Several studies have confirmed and quantified the effects of high temperatures on common forms of food poisoning, such as salmonellosis (Fleury *et al.*, 2006). Contact between food and pest species, especially flies, rodents and cockroaches, is also temperature sensitive. Fly activity is driven largely by temperature rather than by biotic factors (Goulson *et al.*, 2005).

Climate change-related alterations in rainfall, surface water availability and water quality could affect the burden of water-related diseases, including cholera. At least 50 people were killed in a cholera outbreak in Nigeria's northern state of Jigawa bordering Niger and over 100 in Ibadan following different flood episodes in 2011.

22.7 Tertiary Health Effects

The easiest way to think of the tertiary health effects of climate change may be as a 'threat multiplier'. Famine, large-scale migration and conflict can all occur without climate change, but climate change increases the risk of all of these phenomena. While climate change is neither necessary nor sufficient for these effects, it is increasingly likely to be a factor, and in some cases already is. In the long run, the health effects of these tertiary conditions are likely to exceed those of the others, perhaps by two or more orders of magnitude. For this reason, all possible steps to minimize their risk should be taken. A 'four-degree world' should remain theoretical, not something which the next generation has to endure.

Climate change, food security, Africa and the Food and Agricultural Organization (FAO)

Climate change and agriculture in Africa has been discussed above, but food security also depends critically on governance (local, regional and global) and purchasing power (see Chapter 13). Numerous high-level food agencies, especially the FAO, have been slow to comprehend the risk to food security represented by climate change. For example, while the first models which expressed concern about global food insecurity

induced by climate change were published in leading journals in the early 1990s, it took more than a decade for a high-level response from the FAO, when it belatedly highlighted climate change at the 29th session of the FAO Committee (Butler, 2009). Some of this lag seems likely to reflect sources of funding and thinking which are biased toward people and institutions with pre-existing power, few of whom have been based in Africa and few of which lobby on behalf of her people. However, this situation has changed markedly (Jalloh *et al.*, 2013); recognition is 'better late than never'.

Climate change, food security and famine

Africa has experienced several severe famines in recent decades, particularly in the Sahel, including Ethiopia, Somalia and Niger. These have arisen through drought, poor governance and conflict. In the recent Somali famine, Islamist militants called Al Shabaab attacked famine relief workers (Moszynski, 2011). On the positive side, global governance measures, especially famine relief, have been able to reduce the most severe effects partially. But, chronic undernutrition is widespread in many parts of Africa, even without overt famine. This reflects and creates vulnerabilities, including the risk of being exploited by those who are better fed and stronger.

Climate change was not a factor in the Rwandan genocides of the early 1960s and again in 1994, but food insecurity and the anticipation that this would worsen due to land scarcity, in the absence of sufficient other sources of income, was (André and Platteau, 1998). Today, the population in Rwanda is higher than in 1994. The birth rate of this substantially Catholic country is declining, but political tensions are returning. However, its human carrying capacity today is also higher, due in part to extensive foreign aid (25% of its GNP in 2006) (Beswick, 2010). But this has been complemented by a large increase in income from ecotourism, particularly associated with the observing of habituated gorillas in the Virunga National Park, a legacy of the fierce and controversial conservationist Dian Fossey.

Climate change and migration

The refugee camp of Dadaab, with almost half a million people, is the world's largest (Polonsky *et al.*, 2013). In large part, the outflow of migrants from Somalia and regional countries that generated this settlement (founded in 1991) has been caused by a combination of ecological and social factors, most recently the interaction of drought and the lack of a functional government in part of Somalia, creating a vacuum which has been filled in part by the militant Islamist group, Al Shabaab.

Already, poverty and insecurity at home and the hope for a better life has motivated hundreds of thousands of Africans to migrate, including to Europe. Climate change is likely to increase the number of attempted migrants and refugees, perhaps by a large factor. In 2012, the African Union Convention on the Protection of and Assistance to Internally Displaced Persons in Africa (the Kampala Convention) came into force. For the first time, this treaty recognizes that displacement can occur because of climate change, as well as several other factors (UNHCR, 2013). However, as with all tertiary manifestations (and primary and secondary ones, too), the scale of this can be modified by other forms of development and by mitigation. Climate change adaptation, including through migration (Black *et al.*, 2011) is also vital, but should not be used as a substitute for mitigation. Adapting to a four-degree world may be impossible.

Climate change, resource scarcity and conflict in Africa

Climate change is also likely to multiply the risk of conflict, especially by diminishing resource availability. This effect could be substantial in Africa over coming decades, as resources such as water, food, productive cropland and animal pasture are already scarce.

Two socio-political characteristics make conflict a particularly likely consequence of resource scarcity in many African countries. One of these is low levels of institutional inclusivity, which impede other routes to redress grievances (Kahl, 2006). The degree to which a

society is divided, whether along religious, ethnic, cultural or class lines, also influences the risk that scarcity will lead to violence. In societies with high levels of such cross- and sub-national 'groupness', identity and security is associated strongly with membership to a single group. At times of stress, people turn to these groups alone for support, rather than the collective state or a network of groups, in so doing often excluding other groups, who become competitors. Such fault lines are also prone to manipulation by leaders to increase support and distract from more fundamental grievances (Kahl, 2006).

Weak states, of which Africa has a disproportionate number, heighten the potential for violent spillover, including cross-border diffusion of military skills and grievances. War in Darfur (Sudan) spread into Chad and the Central African Republic. Inconsistency between international and cultural borders and the presence of failing states can both create safe havens for insurgents and internationalize civil conflicts.

22.8 Conclusion

Perhaps more than anywhere except small island states, African health is hostage to the increasingly accepted myth that adaptation can be a sufficient solution to climate change. Africa is responsible for only a small part of the annual global emission of heat-trapping gases. Climate change mitigation in Africa may therefore seem of little importance. However, some forms of 'technological leapfrogging' offer hope, both locally and globally. One is the rapid spread of mobile telephony and the Internet, which is particularly strong in Kenya (Aker and Mbiti, 2010). Another may be the widespread replacement of polluting and increasingly expensive kerosene lamps by highly efficient light-emitting diodes.²

Photovoltaic technology, the cost of which is declining rapidly, offers hope to provide electricity in remote locations, where it is currently lacking. Allied with access to the Internet, this could accelerate literacy, human development and reduce market asymmetries, in ways which reduce poverty and vulnerability. Infrastructure such as railways and roads, designed and built by Chinese, principally to allow the export of raw materials, may also be used by Africans for

trade and travel, further reducing isolation. However, improved governance and slower population growth in many parts of Africa are also essential if the numerous challenges of climate change are to be met. Recently, Goodluck Jonathan, the president of Nigeria, has hinted at an understanding that slowed population growth will lessen poverty (Rosenthal, 2012). To date, his calls have met resistance (Population Media Center, 2012). On the other side of the continent, President Museveni of Uganda continues to be pro-natalist, despite the existence, within his nation, of the Lords Resistance Army, a group whose barbaric practices suggest a continent where a heart of darkness still beats.

Somehow, the population of more than 1 billion people on this enormous continent need to find ways to reduce their poverty and to improve their food security and nutrition, and also to find ways to collaborate effectively with people of goodwill everywhere, whether from China, Europe or the Middle East. Religious and ethnic differences must become subsidiary to the recognition that we are all human. But rich populations, represented by almost all who read this chapter, must reduce their own dependency on coal and other forms of 'Earth poison', to give not only Africans a chance to flourish but also the whole world.

Notes

¹ First isolated in the early 1950s after an epidemic of polyarthritis in Tanganyika (now Tanzania). In Kimakonde, a language spoken in Tanzania and Mozambique, it means 'that which contorts or bends up'. In the Congo, people call it 'buka-buka' or 'broken-broken' (Simon *et al.*, 2008).

² The World Bank is financing a project called 'Lighting Africa'.

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