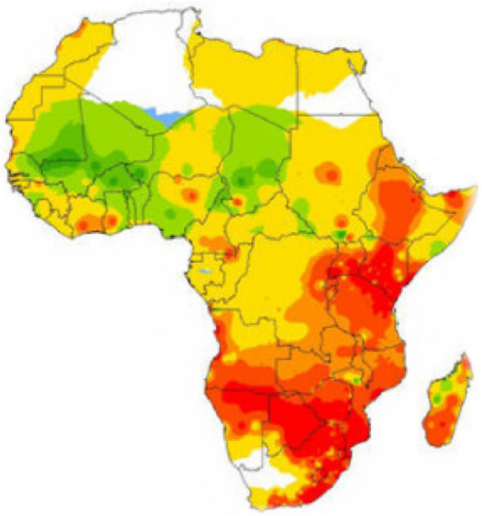
Climate Change and Disease-Induced Instability

Challenges and Opportunities

Robert | Marty



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Climate Change and Disease-Induced Instability
Emerging Hotspots and Harnessing Natural Resource Revenues

May 2013

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Global climate change will alter and amplify disease trends due to rising temperatures, new rainfall patterns, ecological disturbances, and increasingly severe weather events. This increased health burden threatens stability in developing states as worsening health conditions overwhelm existing health infrastructure, stunt economic growth, and cause greater sectarian conflict.

This report identifies emerging hotspots of disease-related instability in sub-Saharan Africa. Among the hotspots, East Africa is uniquely positioned to prepare for the looming health challenges. Recent natural gas and oil discoveries in the East Africa can provide the necessary funding to launch and build public health initiatives and infrastructure. The international community should partner with states benefiting from natural resource discoveries to ensure funds are effectively invested in public health sectors.

Introduction

Climate change is associated with rising temperatures, new patterns in precipitation, ecological disturbances, and more severe extreme weather events, all of which can affect the prevalence of disease.

Sub-Saharan Africa has been identified as the region likely to be most vulnerable to the health impacts of climate change.[1] For example, southern Africa and the east African highlands are predicted to face significantly higher incidents of malaria in the future.[2] A growing health burden due to disease is only part of the story, however.

The picture is more dire after considering that many African states also confront challenging economic, political, and demographic conditions, which will impede their ability to respond effectively to new or more prevalent diseases. A government's inability to manage an increased disease burden may stunt economic growth, amplify internal tensions, and potentially strengthen violent extremist groups of concern to the international community.

Although scholars have made the connection between climate change, disease, and political instability, thus far the literature has only focused on the broadest links between the three. Speaking before the U.S. House Science and Technology Committee, Andrew Price-Smith, a leading national health security expert and professor at Colorado College, warned that, "the [global climate change] induced proliferation of disease may facilitate socio-political destabilization, particularly in the weak states and impoverished populations of the developing world."[3] He broadly pointed to areas where disease-induced instability may occur, saying that "we should be concerned about nations in South Asia, Central and East Asia, Southern Africa, and South America."

The intention of this report is to dig deeper. Namely, to ask where hotspots of disease-induced instability may occur in sub-Saharan Africa, and how disease will interact with existing socio-political conditions.

Of the regions that are likely to be hotspots, this report asserts that East Africa is uniquely positioned to deal with a greater disease burden. Natural gas and oil deposits worth billions of dollars have been discovered throughout the region.[4] Thus, the international community must ensure that natural gas revenues are used to improve readiness for an increased disease burden. This can be accomplished by bolstering health infrastructure and ensuring climate and health stakeholders are involved in developing public health policy.

Climate Change and Disease

> *Climate change is the biggest global health threat of the 21st century.*
>
> —*Lancet*, 2009[5]

Many of today's most prevalent and lethal diseases are significantly influenced by environmental conditions. The global climate is changing at unprecedented levels, which will increase the frequency and spread of diseases.

Climate Change

Transformation of the global climate will likely accelerate in the future. The International Panel on Climate Change (IPCC), representing the scientific consensus on the global climate, estimates that mean temperatures will increase between 0.2°C and 0.5°C per decade in the next hundred years, culminating in a 2°C to 6°C increase by the end of the century.[6] This increase will be a "faster climb than the Earth had experienced in more than ten thousand years."[7]

Spread and Amplification of Disease

Increasing temperatures will have far ranging impacts on environmental and ecological processes, ultimately affecting a number of diseases.[8] Rising temperatures will change precipitation patterns and increase the number and spread of mosquitos that transmit diseases, as well as the proliferation of bacteria that cause diarrheal disease. Warming and rising seawater will increase the frequency and severity of extreme weather events, affecting the spread of a host of infectious diseases. Climate change will shift ecological patterns and heighten the risk of diseases being transmitted from animals. Finally, increasing drought conditions also will increase the prevalence of disease. While other indirect links between climate change and health exist, these represent the primary climate-sensitive disease trends in Africa.[9]

- *Vector-Borne Diseases.* Vector-borne diseases, such as malaria and dengue, are those transmitted by insects, most commonly the mosquito.[10] Vector-borne diseases exist only in certain temperature ranges, and prefer wet and humid environments. Furthermore, factors such as mosquito reproduction and biting rates are positively correlated with temperature and precipitation levels. A 1°C increase in temperature can increase the abundance of malaria by over ten-fold.[11]

  Due to rising temperatures and changing precipitation patterns, estimates suggest that malaria will affect 260-230 million more people in 2080, doubling the current amount of cases.[12] Furthermore, a 2.5°C increase, a moderate IPCC estimate, would put an additional 2.5 billion people at risk for dengue.[13]

- *Water-Borne Diseases.* Climate change will increase the risk of water-borne diseases, such as cholera and diarrhea, through: increasing the severity and frequency of extreme weather events, expanding drought areas, and warming seawaters. Floods, cyclones, and heavy precipitation will strain sewage systems and make populations more susceptible to diarrheal diseases. Water scarcity leads to poor hygiene, which increases the risk of water-borne diseases.[14] Approximately 200 million people currently experience water stress in Africa and, according to the International Panel on Climate Change, this number is expected to grow to 350-600 million people by 2050.[15] Lastly, rising sea temperatures facilitate the growth of disease organisms.[16] Researchers at the Basque Centre for Climate Change report that a 1°C increase would increase the risk for cholera in Tanzania by 23 percent.[17]

- *Drought Induced Diseases.* Drought conditions not only heighten the risk for water-borne diseases. The IPCC reports that while the causal mechanism is poorly understood, diseases such as meningitis thrive under dry and dusty conditions.[18]

- *Zoonotic Diseases.* Zoonotic diseases are those that crossover from animals to humans, often times becoming transmittable between humans.[19] They include many diseases that have become global pandemics, such as SARS, HIV/AIDS, and influenza, and those that have become regional epidemics, such as Ebola.[20] While the causes of zoonotic diseases less understood, researchers highlight the dangers of climate change for increasing the prevalence of zoonotic diseases. Researchers have found that environmental stress increases the risk of Ebola.[21] In addition, researchers at Columbia University have noted that the four most recent influenza pandemics (1918, 1957, 1968, and 2009) were preceded by La Niña events.[22] La Niña is a periodic cooling of the Pacific Ocean that causes a shift in migration patterns of birds, which are the primary reservoirs of influenza viruses.[23] Ultimately, the ecological impacts of climate change result in animals and humans coming into closer proximity, increasing the risk of new diseases.[24]

Emergence of Hotspots In Sub-Saharan Africa

> *It is well known that warming facilitates the propagation of certain harmful bacteria and the spread of disease. . . It is much less easy to predict how these changes affect different societies. . . Societies will cope more or less well depending on a lot of variables. How adaptable are they, how effective are their political organizations?*
>
> —Strategic Studies Institute, 2008[25]

Growing disease burdens pose a risk to political stability by undermining the human and economic capital of a state.[26] To understand where disease-induced cases of instability may appear, two factors must be considered: (1) underlying economic, political, and demographic pressures that enable an increase in disease, and (2) the magnitude of the social and economic impact of diseases on populations.

Socio-Political Conditions that Enable Disease Proliferation

A state's ability to cope with climate change induced disease hinges on its ability to: provide health services to an increasing number of people, and prevent an increased disease burden in the first place through infrastructure development. However, a state that is strong on both counts is not immune to increases in climate-driven disease. Extreme weather events can overwhelm the most developed states and areas. Virulent pandemics also can immobilize any health care system. Nonetheless, well-governed states with strong financial resources will be better able to cope than their less privileged neighbors.

Several underlying factors influence whether diseases spread uncontrolled. Poor health care, weak governance, and financial constraints are primary indicators of the ability of a state to handle an increased disease burden. Urbanization and limited research capacity further increase the likelihood that weak states will be unprepared.

- *Poor Healthcare Capacity.* The health infrastructure in many developing states will have difficulty coping with an increased disease burden. In an analysis of states' climate adaptation plans, the World Health Organization concluded that over 75 percent of states' plans were "unlikely to support the resilience process and protect public health from the negative effects of climate change."[27] In one telling example, Mozambique's National Disaster Management Institute concluded that, "unless immediate action is taken, the country will be overwhelmed by the impacts of cyclones, floods, droughts and disease outbreaks."[28]

- *Weak Governance.* Governance plays a key role in determining whether a state effectively invests resources to improve public health. For example, strong political leadership in Botswana improved the country's response to the HIV/AIDS pandemic. Under former President Festus Mogae, an Oxford-trained

economist, the country mobilized resources to ensure drugs were accessible to infected persons.[29] In contrast, the political administration of Zimbabwe was marred by widespread corruption. Consequently, the government did little to protect populations from the spread of HIV/AIDS.[30]

- *Poor Economic Conditions.* States with smaller economies have fewer resources to invest in health infrastructure. The WHO indicates that countries with higher Gross National Income (GNI) per capital invest more in malaria control efforts, and thereby have significantly lower rates of malaria than poorer countries.[31]

- *Urbanization.* The IPCC reports that "urbanization and climate change may work synergistically to increase disease burdens."[32] High population densities facilitate the spread and emergence of diseases, thus further straining health systems.[33] Africa's rate of urbanization is among the highest in the world.[34] Between 2010 and 2050, Africa's urban population will triple to 1.2 billion.[35] High rates of urbanization further stress limited state resources, as citizens move to places unequipped to support such a rapid growth in population. Ronak Patel and Thomas Burke of Harvard Medical School warn that mass migrations to cities could create a humanitarian disaster because the consequences of unplanned urbanization, such as increasingly large slum populations, facilitate the propagation of diseases.[36]

  Furthermore, urban centers facilitate the emergence of zoonotic outbreaks.[37] Cities strain both their immediate and distant ecological systems in their need for resources.[38] Paul Sharp of the University of Edinburg and Beatrice Hahn of the University of Pennsylvania notes that rapid urbanization coupled with destabilization of social structures facilitated the early dissemination and evolution of HIV/AIDS.[39]

- *Brain Drain and Scientific Institutions.* Much of Africa is experiencing an outflow of skilled professionals to more developed regions. According to the International Organization for Migration, 20,000 professionals emigrate from Africa annually.[40] The health sector is among the hardest hit. Africa has lost over $2 billion of investment due to health workers leaving the continent.[41] However, the impact of the brain drain to the health sector is compounded in light of emerging climate-sensitive diseases. To defend themselves against disease, states not only need medical professionals but also climate and health researchers to improve understanding of and predict emerging climate-driven disease threats. The WHO has emphasized the need to bolster technical capacities of countries to better address climate change.[42] The WHO criticized African climate adaptation plans for their weak epidemiological analysis, stating that programs did "not meet standard public health requirements."[43]

Threat of Climate-Sensitive Diseases

Disease threatens political instability only to the extent that they impose significant social and economic costs.[44] Climate-sensitive diseases meet both conditions because of their varied and wide-ranging impact on health. These diseases have some of the highest mortality rates. Moreover, their chronic impact on human health inhibits economic development.

- *Social Impact*

  Climate-sensitive diseases are among the most lethal illnesses and more drug resistant strains are emerging.

  Malaria is lethal primarily to children and pregnant woman and acute cases can cause severe death or illness within a day.[45] Populations in regions beyond the former transmission range of malaria lack protective immunities, leaving them especially susceptible to the disease. A lack of immunity can increase mortality by 20-30 percent.[46] Cholera is an extremely virulent disease.[47] Seventy-five percent of those infected do not display obvious symptoms, causing people unknowingly to spread the disease. More severe cases can kill within hours if left untreated. Meningitis kills half of its victims if left untreated and take the lives of five to ten percent of those infected even if treatment is started early.[48] Zoonotic diseases, such as Ebola, are unique due to their unpredictable emergence and lethality. In 2000, the Kenyan Minister for Public Health noted that, "Ebola haemorrhagic fever is one of the most virulent viral diseases known to humankind."[49] During an outbreak in the Democratic Republic of Congo, those infected were thought to be possessed due to the agonizing nature of their death, provoking fears that the outbreak was a form of divine punishment.[50]

  More lethal drug resistant strains of many climate-sensitive diseases also are emerging. Resistance develops as diseases mutate and gradually build protection against drug interventions. Researchers at the Kenya Medical Research Institute (KEMRI) have found evidence that malaria strains are developing a resistance to the latest antimalarial drug (artemisinin-based drugs), previously hailed as "one of the greatest advances in fighting malaria."[51] Furthermore, Edward Ryan of Harvard Medical School reports more virulent strains of cholera have been detected in Africa.[52]

- *Economic Impact*

  High disease burdens impose significant economic costs on states. Climate-sensitive diseases diminish workforce productivity, drain state financial resources, and stunt educational development. The economic cost imposed by these diseases may begin a vicious cycle of economic decline.

  Less Productive Workforce. Disease can reduce worker productivity and have direct consequences for business. Health burdens particularly affect labor-

intensive sectors such as agriculture that are especially dependent on good health. The African Development Bank reports that 60 percent of all Africans are employed in agricultural sectors.[53] The WHO found that public health efforts can increase incomes of farmers by up to 60 percent.[54] Furthermore, forty percent of companies in Africa report that malaria negatively impacts their business. Companies have reported a 28 percent return when investing in malaria prevention programs for their employees.[55]

Fewer State Resources. Disease outbreaks require states to increase funding for health initiatives, drawing resources away from other sectors.[56] In addition, disease can deprive states of tax revenue. Disease deteriorates individual economic circumstances, which erodes the tax base a state draws from to provide public goods.[57] Furthermore, disease outbreaks negatively impact trade and tourism. Researches from the University of Washington found that cholera outbreaks in the early 2000s caused as much as a ten percent decline in exports in Mozambique, Kenya, Tanzania, and Uganda, due to fears of cholera being spread via food.[58] Furthermore, a study sponsored by USAID found that tourism revenue declined by 72% during a cholera epidemic in Peru.[59] Underreporting of cholera often happens to avoid trade and travel sanctions.[60]

Lower School Achievement. Infectious disease can impair cognitive and physical development, and prevent children from attending school. A study on the impact of diarrheal disease on school performance found that the rate of diarrheal disease before age two was the most important predictor of later school achievement.[61] Furthermore, meningitis causes severe brain damage in ten to twenty percent of survivors.[62] Such an impact on cognitive functioning reduces intellectual capital and hinders the ability of developing countries to shift their economies towards more highly-skilled industries.[63]

Figure 1. Hotspots of Disease-Induced Instability

Location of Hotspots

Analysis of broad health and socio-political trends indicates that much of Africa will suffer from disease-related instability (see Figures 3 and 4 in appendix for socio-political and health trends respectively). The National Intelligence Council ranks twenty-four African countries as having 'unsuitable' health care and twenty countries as having 'poor' health care (unsuitable defined as where health care is not a national priority and where medical care is generally unavailable; poor defined as where health care is a low national priority and where medical care is unavailable to large sectors of the population).[64] Furthermore, according to the Corruption Perceptions Index (CPI), which gathers expert opinions to rank countries as very corrupt (ranking '0') to not corrupt (ranking '100'), only Botswana and Rwanda ranks above a 50.[65] This suggests that few countries will handle an increased health burden effectively.

In spite of Africa's overall vulnerability to disease-related instability, certain countries will be particularly susceptible to this instability. Poor health conditions, weak governance levels, existing unrest, and notable projected increase in diseases distinguish certain African states (see Figure 1).

- *West Africa: Ivory Coast and Nigeria.* Climate-induced emergence of water-borne diseases and meningitis threatens West Africa. Rapid urbanization is occurring along coastal waters that are rising and warming.[66] Thus, urbanization, climate changes, and poverty will heighten the risk of water-borne diseases.[67] Furthermore, the "meningitis belt," a region of the highest incidences of meningitis, runs through West Africa and is projected to expand southward.[68] In addition, while dryer conditions may reduce malaria in some parts of West Africa, countries such as Nigeria are projected to see increases.[69]

  While no country is immune to these risks, the Ivory Coast and Nigeria stand out as being particularly vulnerable. Both face unsuitable health systems and poor governance. Indicative of poor governance, both faced notable levels of violence in the past three years.[70] Nigeria especially stands out as nearly eight percent of all violent events in Africa occurred in the country and due to having the largest population throughout Africa.[71] In addition, poor health and governance levels have directly contributed to unrest, further suggesting these countries are ill prepared for emerging disease threats. The Ivory Coast has a history of medical providers going on strike, demanding better pay and working conditions.[72] The most recent strike occurred in February 2013.[73] In 2012 in Nigeria, the Lagos state government fired 788 doctors for not responding to questions about a previous strike.[74] This enraged fellow medical personnel, and instigated a nationwide strike that lasted for nearly a month.[75]

- *Eastern Africa: Burundi, Ethiopia, Kenya, Somalia, and Uganda.* For East Africa, the rising impact of climate-sensitive disease is not a future threat; it is an existing reality. Highland regions of East Africa, which were previously considered places to escape malaria, now experience 12.4 million cases of malaria per year, or about

2.5 percent of the world malaria burden.[76] Highland areas lie at critical temperature ranges, where small increases in temperature threaten to dramatically increase cases of malaria.[77] According to the Kenya Medical Research Institute (KEMRI), the malaria parasite can only mature in temperatures above 18 degrees Celsius.[78] KEMRI further notes that mean annual temperatures in the highland regions have risen from 17 degrees in 1989 to 19 degrees today.

This increased health burden will fall on countries with weak health systems and largely affect a region the Center for Strategic and International Studies calls, "one of the most conflicted and poorly-governed corners of the world."[79] Burundi, Ethiopia, Kenya, Somalia, and Uganda all have unsuitable or poor health infrastructure, high levels of violence, and must now contend with the spread of malaria into highland regions (see Figures 3 and 4).[80]

- *Southern Africa: Madagascar, Malawi, Mozambique, and Zimbabwe.* Dr. Zweli Mkhize, a South African doctor and legislator, reported that the geographic range of malaria could double in Southern Africa and put five million people formerly safe from the disease at risk.[81] Southern African countries such as South Africa, Botswana, and Angola have some of the best health infrastructure in Africa. However, Madagascar, Malawi, Mozambique, and Zimbabwe consistently have some of the worst health indicators in the world and low levels of development.[82]

  Malawi is one of the least developed countries in the world and is facing among the highest rates of urbanization in the world.[83] Like Malawi, Madagascar is also ranked as one of the poorest countries in the world. Madagascar is especially threatened by malaria climbing into previously safe highland regions.[84] Furthermore, researchers at Duke University warn that climate change could facilitate an increase in zoonotic diseases.[85] Zimbabwe stands out due to current high levels of corruption and unrest. Mozambique is notable because its population centers are clustered along the coast, making the country especially vulnerable to water-borne diseases. Currently, over 13 million people reside in coastal areas, and this number is increasing because there are more economic opportunities along the coast.[86] World Bank economist David Wheeler has listed Mozambique as the sixth most vulnerable country to extreme weather risk.[87]

- *Central Africa: Democratic Republic of Congo.* Malaria is prevalent across Central Africa.[88] While not as pronounced as Eastern and Southern Africa, rising temperatures are projected to amplify malaria burdens.[89] However, of particular concern in Central Africa is the increasing frequency of zoonotic diseases, such as Ebola.[90] Sally Lahm, the principle investigator of decade long study of Ebola in Central Africa, reports that environmental stress facilitates disease transmission, especially under drought conditions.[91] Models project prominent decreases in rainfall in Central Africa, indicating that incidences of Ebola may increase.[92] The Democratic Republic of Congo emerges as a hotspot due to unsuitable health conditions, poor economic conditions, existing high levels of violence, and projected increases in malaria and Ebola.

Ebola outbreaks are unique due to the fear they cause in nearby countries. For example, a 2007 Ebola outbreak originating in the Democratic Republic of Congo caused Tanzania to tighten its borders and raised concern in Kenya about their own ability to protect themselves from the disease.[93]

Disease-Induced Instability

> *The health and well-being of the population forms the very foundation of prosperity, of political stability, and indeed of the power of disparate societies relative to one another.*
>
> —Andrew Price-Smith, 2009[94]

Hotspots of disease-induced instability will not have uniform political consequences. The varying social and economic costs of disease, and their different biological characteristics, all contribute to unique political impacts. For example, infected people often spread of cholera through unintentionally contaminating food or water sources. Cholera outbreaks, as a result, have been associated with violence against groups that are blamed for spreading the disease.[95] In contrast, malaria cannot be directly attributed to groups of people because mosquitoes transmit the disease. Therefore, malaria only has an indirect political impact.

However, as a whole, increasing disease burdens will cause similar political consequences. Disease-related social and economic costs threaten to erode state capacity and can intensify perceived government illegitimacy. This, in turn, can produce violence against the state and may exacerbate tensions between economic classes and sectarian and ethnic groups.

Instigating Unrest

Deteriorating social and economic conditions resulting from disease threatens unrest. In addition, disease outbreaks themselves combined with poor governance or lack of health services can directly instigated unrest. For example, in 2008 in Zimbabwe, the Information Minister accused its former colonial power, Britain, of instigating a cholera outbreak.[96] More recently, in March 2013 a parliamentary deputy in Mozambique said efforts at stopping an epidemic, "were hindered by people of bad faith, by some opposition politicians who, unable to find any credible discourse to recover the grass roots they have lost promote shameless disinformation about cholera… [they had] promoted violence in the communities, and the destruction of health equipment. They attack health professionals, and most seriously they beat up and lynch community leaders."[97]

In addition, poor government responses to disease can fuel unrest. For example, in April 2011 hundreds of Burundians demonstrated in the capital city, protesting high rates of disease and lack of attention to health services.[98]

Exacerbating Social Tensions

An increase in disease can exacerbate social tensions to the extent that access to quality healthcare is unequal. Wealthier members of society may have better access to quality, private health care, while poorer citizens are often left with limited access to inadequate public health services. Similarly, tensions between ethnic groups can increase as diseases differently affect groups, either as a result of geography or differences in the way the government responds to disease.

However, the causal arrow between disease and ethnic or sectarian violence is not unidirectional. Researchers at the CDC have found that essential medicines become scarce during period of civil unrest, making it harder to control disease.[99] The spread of disease due to climate change, therefore, may start a vicious cycle in which disease weakens a government, increases social tension, and results in violence that in-turn further weakens the government's health care response, thereby promoting greater unrest.

Fueling Violent Extremism

A heightened disease burden can increase the risk of violent extremism through two mechanisms. First, the drain on state resources erodes a government's ability to deal with discontent that fuels violent extremist groups. Second, deteriorating social and economic conditions along with differential treatment of groups can erode popular support for the government. As a result, spread of disease due to climate change may empower several terror or insurgent groups:

- *Al Shabaab.* The risk of malaria and cholera in East Africa is increasing concurrently with the growing influence of the Somalia-based terrorist organization al Shabaab.[100] Deteriorating social and economic conditions ultimately threatens to facilitate al-Shabaab's growing influence. The international community has previously emphasized the role of health in fostering the discontent that enables the group. For example, after the 2010 World Cup Bombings in Uganda, both Uganda and the U.S. increased initiatives to diminish al Shabaab's influence. A key initiative of the United States was improving health conditions for marginalized Ugandan Muslims.[101]

  In addition, in some cases al Shabaab has caused health conditions to deteriorate. For example, in July 2012 the World Health Organization reported that there were a growing number of cholera cases in the al-Shabaab held town in of Kismayo, in southern Somalia.[102] Al Shabaab reportedly did not allow chlorination of water, which facilitated the spread of the disease.[103]

- *Boko Haram.* Worsening health conditions in Nigeria also may empower Boko Haram, a terrorist group with rising potential to attack Western targets in Africa and the U.S.[104] Boko Haram is based in the predominantly marginalized Muslim north, as opposed to the heavily Christian south.[105] Boko Haram uses this perception of government bias to justify its violent tactics.[106] Tim Cook, a Reuters news correspondent, quotes one Nigerian citizen saying in response to Boko Haram bombings, "The government is supposed to look after health, education, water, but we see them doing nothing except getting rich, so why are they surprised there is a rebellion?"[107]

  Malaria accounts for 60 percent of clinical visits in Nigeria, and according to Nigeria's National Malaria Control Program, Nigeria experiences a $906 million financial loss annually to malaria.[108] Warming temperatures will amplify malaria burdens throughout the country, in some regions by up to 60 percent.[109] The greatest increase, though, is expected in the south.[110] In addition, water-borne diseases already threaten coastal population centers in the South and warming and rising seawaters will heighten this threat.[111] 40,000 cases of cholera were reported in 2010 alone, many of which included more lethal multi-drug resistance strains.[112]

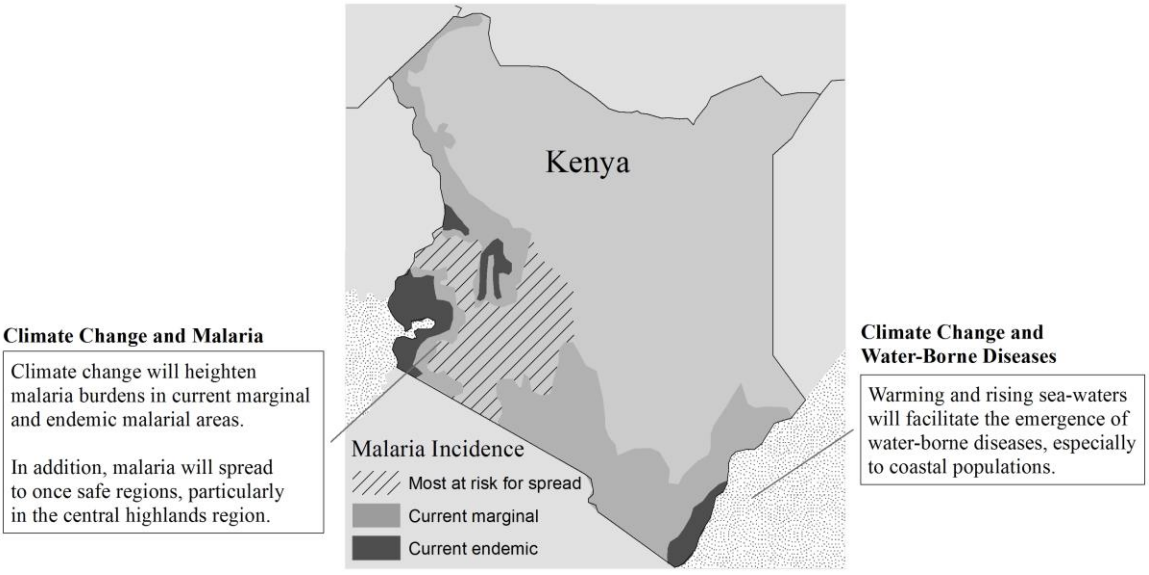
  The South comprises the economic and population center of Nigeria, with 20 million people (22 percent of the total population) living along the coast.[113] Thus, as disease burdens grow limited resources will likely be prioritized for the south while the north also faces deteriorating health conditions. This may worsen the Muslim North's perceived alienation from the wealthier, predominantly Christian South, thus fueling Boko Haram's violence.

Disease-Induced Instability in Kenya

> *Malaria is likely to become a major problem, with the change in climate, where temperatures are increasing. So, malaria is likely to become a major problem in Kenya and Africa as a whole. As a country and region, we need to focus on malaria, if we intend to address the issue of economic development.*
>
> —Kenyan Parliamentary Member, Dr. Otichilo[114]

The case study of Kenya is used to illustrate the causal chain from a changing climate, emerging diseases, to political instability. Kenya is already heavily burdened by disease, and its health care infrastructure is ultimately unprepared to deal with the any rise in infection rates. A heightened disease burden threatens to provoke unrest, exacerbate ethnic tensions, and fuel violent extremisms. Furthermore, Kenya is a regional source of stability, and thus increased political strife and economic contraction will have repercussions on neighboring countries.

Figure 2. Emerging Disease Threats to Kenya[115]



Emergence of Climate-Driven Diseases

A research team at the Kenya Medical Research Institute (KEMRI) warns that rising temperatures will put four million additional people at risk of malaria in Kenya.[116] Malaria is moving into the population dense central highland region, which includes the capital city, Nairobi.[117] People in this once-safe region lack protective immunities, which increases the lethality of the disease. Further research by KEMRI shows that people in highland regions tend to view malaria as a life-threatening illness, as opposed to a "mild everyday illness" in already endemic areas.[118] In addition, the WHO reports that climate change will amplify burdens in current endemic areas.[119]

Cholera is currently prevalent in the western region of Lake Victoria as well as the Coastal Province to the east. Researchers from the Kenya National Academy of Sciences report that warming and rising sea water puts communities along the coast at greater risk for cholera outbreaks.[120]

Risks of Disease to the State

The Kenyan health system fails to meet current health needs and will not easily absorb an increased in disease.[121] The current healthcare system faces a variety of challenges, including inadequate staffing, low drug availability, poor diagnostic capabilities in remote regions, and an informal market of drugs of questionable quality.[122]

Outbreaks of climate-sensitive diseases have already overwhelmed Kenya's health infrastructure. In 2011, a cholera outbreak infected over 5,000 people within weeks.[123] News sources attributed the fast spread to "limited health facilities, a shortage of medical

personnel and poor sanitation."[124] A nurse at one hospital in the region noted that hundreds of patients "were unable to access treatment as they could not pay the fees charged for diagnosis, treatment and admission."[125] Economic and education sectors were hit hard, as people became sick, were fearful of being infected, or needed to attend to ill relatives. A teacher at a primary school reported that, "only three out of 22 teachers had reported to work while more than half the school population of 1,900 pupils had not turned up."[126]

Malaria, too, has significant impacts on the Kenyan economy. Speaking to the Kenyan Parliament in July 2008, Secretary-general Dr. Eseli highlighted the costs:

> "[Malaria] has not been given the due attention that it requires. Just by anybody suffering from malaria, the man-hours lost, namely, people not going to work or maybe going to work, but not being productive effectively, are many. When you look at school children, you will find that the lost school time is a lot. This impacts people negatively on their school performance. I know this might surprise very many people because people have been believing that one recovers completely from cerebral malaria. It has now been proven beyond reasonable doubt that serious malaria causes brain damage and leads to mental deficiency. That could explain some of the problems we are having in this country."[127]

The Assistant Minister for Livestock Development, Mr. Duale, further reported, "To be specific, 170 million working days are lost due to malaria. It is not even hours. The projection of our population of 2009 was about 40 million. Researchers are saying that 20 million Kenyans are exposed to malaria."[128]

Kenya's ineffective healthcare system stems from its overall poor governance. In March 2012 and February 2013, nurses protested against the Ministry of Health and demanded better pay and working conditions.[129] Protests routinely occur over the government's inadequate provision of social services. In 2011, hundreds of demonstrators took to the streets in Nairobi and the coastal city of Mombasa, "vent[ing] their anger at the government, arguing that Kenya's leaders were spending the states resources on themselves and not the people."[130]

Disease-induced deterioration of social and economic conditions threatens to exacerbate such unrest. However, the consequences of worsening social and economic conditions is heightened due to existing ethnic tensions, the growing influence of violent extremist group al Shabaab, and the importance of Kenya for regional economic and political stability.

Compounding Ethnic Tensions

Competition over access to scarce and inadequate resources, including natural resources such as land, capital, and health facilities is a driver of ethnic tensions in Kenya.[131] Ethnic tensions pervade Kenyan society, and have been a consistent source of conflict, most

notably in the violent aftermath of the 2007 elections. Donald Steinberg, deputy president of the International Crisis Group, asserts that conflict will likely continue in Kenya until the country's latent social and economic inequalities are resolved.[132] In 2012 alone, there were 71 violent events between competing ethnic groups, which resulted in 196 deaths.[133] Historically, disease burdens have not been a direct source of conflict. However, further demand for already weak health infrastructure threatens to exacerbate tensions.

Climate-sensitive diseases will also interact with ethnic divisions due to geography. The third largest ethnic group, the Luo, suffer from 10 percent more cases of malaria than the largest ethnic group, the Kikuyu.[134] In addition, geneticists at Harvard University found a higher frequency of protective immunities to malaria in Luo than the Masai.[135] They hypothesize that geographic differences drive this difference— the Masai live in higher altitudes with a lower malaria environment, as opposed to the Luo who live in a low-land endemic area.[136] Climate change, however, will spread malaria to higher elevations and subtly exacerbate socioeconomic divides.

Disease may more directly fuel tensions through exacerbating economic inequalities, which is linked to ethnic divisions. Fifty-seven percent of Kenyans live below the poverty line and health infrastructure further compounds this inequality.[137] Despite poor public health infrastructure, Kenya has a strong private health care system, providing those with money access to adequate pharmacies and hospitals.[138] Thus, ethnic groups such as the Luo, who have historically been politically and economically marginalized, may be disproportionally impacted by malaria than other groups.[139]

Social unrest also has increased disease burdens. For example, a cholera outbreak occurred during post-election violence in 2008. Staff and supply shortages occurred at hospitals due to the unrest, causing unusually high mortality rates.[140]

Intensifying Violent Extremism

Climate-sensitive diseases threaten to contribute to marginalization that drives extremism among Muslim populations in Kenya. Muslim populations live predominantly on the coast, which has traditionally been one of the more marginalized regions of Kenya. Populations in this region have even formed a new political movement, the Mombasa Republican Council, as a means to give "a new voice to long-standing grievances about the region's perceived marginalization and lack of state investment."[141] The Somali based terrorist group, al-Shabaab, has taken advantage of this marginalization. Preceding the recent elections, al-Shabaab called on Kenyan Muslims to boycott the vote, citing their low economic conditions:

> "Your regions are the least developed in Kenya and have the least facilities. You have been misled by the false promises of the presidential candidates and the same empty promises are repeated on every election campaign."[142]

Furthermore, researchers affiliated with the University of Texas at Austin found that "growth in violent Islamist activity in Kenya increasingly involves recruitment of Swahili-speaking Kenyan nationals, as opposed to ethnically Somali Kenyans."[143]

An increasing malaria burden threatens to deteriorate socioeconomic conditions in Muslim areas, which fuel popular grievances. According to the WHO, rising temperatures are expected to increase the transmission intensity and lengthen the transmission season in the area.[144] Sixty-five percent of the population in the coastal region is employed in labor-intensive sectors that malaria has an acute impact on, including agriculture, fishing, and mining sectors.[145] In 2010, the assistant Minister to Health in Kenya highlighted the current impact of malaria on the Coastal economy:
8

> "When you look at the problem at the Coast, the level of absenteeism by school children because of malaria is almost 50 percent. This means that 50 percent of children in Nyanza and in particular in Coast Province are not able to go to school to pass and get good grades so as to join universities…. When you look at the loss of man hours in those endemic areas and the epidemic areas of Coast and Nyanza, you will realize that 17 million man hours, which translates into a six percent GDP growth loss, are actually lost because of malaria."[146]

Furthermore, Kenya's National Environment Management Authority (NEMA) projects warming sea surface temperatures off the Coastal Province, which threatens the region with increases in water-borne diseases.[147] During a cholera outbreak in 2010, the WHO noted that the area lacked a cholera preparedness plan, there were inadequate pharmaceutical supplies, and inadequate funds to support logistical operations.[148] Sixteen schools were shutdown in an attempt to slow the disease.[149] Other economic impacts are more indirect. Tourism contributes 45 percent to the economy in the coastal province.[150] As one parliamentary minister said, "we have tourists running away from this country because they are afraid of carrying cholera to their home areas; they are afraid of being attacked by cholera. While at the same time we are having difficulties with finances; yet, one of the sources of our finances is being shy-frighted away."[151]

Weakening Regional Leader

Kenya is a regional hub for trade, finance, transportation, aid, and a lynchpin for regional security. A rising disease burden that both heightens domestic tensions and erodes the government's financial capital threaten their regional influence.

During parliamentary sessions in 2008, ministers noted how malaria causes the government to divert resources from other sectors. "Malaria [affects] our agricultural sector. It also affects our economy. If malaria did not exist, we would be collecting a lot of revenue and directed resources to other very important areas like roads and other infrastructure."[152]

Further economic contraction from malaria may decrease Kenya's willingness to participate in regional initiatives and hurt neighboring economies. Kenya works to prevent violence in Somalia from spreading outside the state, providing shelter to a quarter of million refugees, such as Ugandans who have fled the Lord's Resistance Army (LRA).[153] Furthermore, David Steinberg of the International Crisis Group listed Kenya as "a key anchor for the long-term stabilization of Rwanda, Uganda, and Burundi."[154] In 2010, the Kenyan Minister of State for Provincial Administration and Internal Security highlighted that Kenya has been "shying away from allocating substantial resources to our own security agencies," leaving them without the resources to be effective.[155] Declining resources and growing domestic problems may detract from regional efforts, undermining regional stability.

Furthermore, rising political instability would hurt the regional economy. Over 80 percent of Uganda's imports and almost all of Rwanda's exports travel through Mombasa, a rapidly growing port city in the Coastal Province.[156] The UN World Food Programme also transports over 1,000 tons of food through Mombassa, which 7 million refugees and displaced people depend on for survival.[157] Further destabilization along the coast, partly driven by rising disease burdens, would threaten the economic use of the port. Military analysts in Kenya have warned that "al-Shabaab might interfere with the operations at the port of Mombasa."[158] Furthermore, previous political instability in Kenya has hurt neighboring economies. Economic disruption caused by violence following the 2007 elections slowed GDP growth in Uganda, Tanzania, Burundi, and Rwanda by at least 1.5 percent.

Responding to the Threat: Utilize Natural Resource Revenues

The overlap of disease and economic, demographic, and political trends is not all negative. While disease burdens will particularly add to stressors in East Africa, this region is an emerging leader in natural gas and oil production. Historically, resource wealth has fueled corruption and hurt other economic sectors, causing health conditions to deteriorate. However, if invested effectively, natural resource revenues can bolster health programs, thus ensuring states are prepared for burgeoning disease threats.

To combat the emergence of climate-driven diseases, health and environment ministers across Africa have highlighted the need to bolster collaboration between health and environmental stakeholders across the government and civil society. Fortunately, programs to foster such intersectoral collaboration are usually designed to be insulted from direct government control. This is because they often draw from leaders outside of the government. Thus, such programs provide ideal places to invest natural resource revenues, as resource wealth often fuels corruption.

The international community should work with countries to bolster or establish health programs that encourage intersectoral collaboration, and encourage natural resource investment into such initiatives. In addition, encouraging investment of natural resource

wealth ultimately bolsters domestic ownership of health programs, which is a key tenant of United States global health policy.

Kenya is an ideal starting point for the international community to encourage natural resource investment into health programs. First, Kenya has recently discovered significant amounts of oil. Second, government officials have expressed concern over the potential ramifications of natural resource findings, and thus would be open to assistance. Third, Kenyan legislatures have already proposed a health plan to address emerging disease trends that is ideally suited to take in and manage natural resource revenues.

Natural Resource Findings

East Africa has been touted as a new frontier of natural gas and oil.[159] The U.S. Geological Survey reports that up to 253 trillion cubic feet of natural gas lie off the coast Kenya, Tanzania, and Mozambique.[160] Africa Oil Chief Executive Officer Keith Hill noted, "Now the world has woken up to East Africa. I've never seen [an oil] basin of this magnitude."[161] The Anadarko Petroleum Corporation reports $800 billion of gas off of Mozambique alone.[162]

Bloomberg Businessweek touts Kenya as the "center of East Africa's emerging oil industry."[163] Tullow Oil, a UK oil company, estimates that Kenya's Great Rift Valley could yield 10 billion barrels of oil, "enough to supply Kenya for three centuries."[164] In addition, while commercially viable natural gas remains to be found, Energy Minister Kiraitu Murungi has expressed optimism about the prospects of natural gas in Kenya.[165]

Dangers of Natural Resources

The "resource curse" refers to the pattern of deleterious consequences poorer states face when they discover vast natural resources. The capital-intensive resource industry creates few jobs, and hinders economic diversification by raising exchange rates, which makes other sectors uncompetitive.[166] Resource wealth can also fuel corruption and further distance leaders from the needs of the populous.[167]

Consequences of the resource curse extend to health conditions. Using data from 137 countries over ten years, researchers at the Norwegian University of Science and Technology and the University of Essex found that the prevalence of HIV/AIDS increases with higher amounts of natural resource wealth.[168] Furthermore, the National Intelligence Council suggests that natural resource wealth and health burdens may work synergistically to hinder economic diversification. States benefiting from large reserves of natural resources may face major challenges "in diversifying their economies away from extractive industries towards more highly-skilled and labor-intensive work due in part to health burdens."[169]

Government leaders in Kenya have expressed concern, and even fear, over oil prospects. Parliamentary member Dr. Godana gravely noted, "given the rapacity with which the elites in this country have become corrupt, and knowing what the impact of massive oil production as a new economic resource has meant in the rest of Africa, I think Kenyans should pray that they never become an oil power."[170] The Minister for Commerce and Industry, Mr. M'Mukindia, urged the government to develop plans to ensure resources are effectively managed. "There is a big danger that this country may discover huge amounts of oil. Is that going to be a curse or a blessing? … Leaving this to the Permanent Secretary and the Minister is exposing them to very dangerous times either to them at a personal level or as a Ministry. We must debate this matter and adopt what is good for this country."[171]

Resource Investment into the Health Sector

To avoid the negative consequences of resource findings, developing states have approached countries that have effectively managed resource wealth for assistance in strengthening their own management capacity. Norway, an oil rich state that has provided assistance to a number of African countries, including Mozambique, Ghana, Uganda, and Timor-Leste, reports not being able to keep up with demand for assistance.[172] Separately, health and environmental ministers across Africa have called for assistance in building health capacity. The international community should concurrently heed these calls through (1) assisting the development of health initiatives with the capacity to manage health resources and (2) encouraging natural resource investment into such programs. In addition, natural resource companies have an interest in maintaining a healthy workforce and would likely invest in health initiatives.

- *Establishing Health Initiatives*

  To ensure health initiatives effectively use resource revenues, health initiatives should be established according to two characteristics: (1) they should draw together leaders from multiple sectors, and (2) they should be insulated from government corruption that often results from resource wealth. In addition, investing revenues into sector-specific health programs may help to avoid past pitfalls where schemes to effectively use resource revenues have failed.

  Promote Intersectoral Collaboration. At an inter-ministerial conference on health and the environment in 2008, ministers across Africa highlighted that collaboration between health and environmental sectors is weak and leads to conflicting politics. They encouraged establishing health programs that strengthened intersectoral collaboration among governments and civil society. [173]

  In 2010 Kenyan parliamentary members drafted legislation establishing the framework for an institute with the intent of building collaboration to address emerging disease threats. Voicing his support for the creation of the Institute, Secretary-general Dr. Eseli said:

> "With the setting up of a Malaria Prevention and Control Institute, we would be able to coordinate all these activities of the research institute, Ministry of Public Health and Sanitation, Ministry of Roads and any Ministry that is involved… This is because when all these activities are coordinated under one roof, we are bound to see results…. You will find that with climate change, even in areas which were the highlands, where you did not expect transmission in the course of a year or a decade, now it is almost turning to be endemic because of the climate change. Now, with those challenges coming on, then we need an institute that can actually co-ordinate all these activities of malaria control taking into account the climate change and all those issues that are also encouraging the increase in malaria transmission."[174]

Insulate from Government Corruption. Historically, schemes aimed at promoting intersectoral collaboration have been independent of the government. For example, the legislation for the Malaria Prevention Institute established the institute to be legally separate from the government. Insulation from the government would protect funds devoted to the institute from corruption that could result from resource wealth. A managing board was outlined to include relevant government ministers, medical practitioners, and representatives of universities and research institutions.[175] The board was given direct control of funds that were given to the institute, thus making the funds legally separate from regular government spending.[176] Funds could only be used for purposes of the institute.

Benefits of Sector-Specific Investment. Past efforts to use resource revenues to promote development initiatives have failed due to lacking clear focus and autonomy from governments.[177] Directing revenues into health initiatives that are guided by an independent, multisectoral board would ensure funds are given focus, thus avoiding these pitfalls.[178]

For example, in 2003, Nigeria created the Excess Crude Accounts (ECA) to control state and federal spending of oil revenues.[179] However, it quickly devolved into a repository allowing for "ad hoc and discretionary" spending by state and federal policymakers, and no long-term objectives were accomplished from the program.[180] Adam Dixon of the University of Bristol and Ashby Monk of Stanford University argue that one of the driving reasons for the failure of the ECA was that it was not "underwritten by a firm set of governance principles establishing operational guidelines, a clear mission, and relative autonomy from bureaucratic and political encroachment."[181]

- *Investment from Governments.*

In working with states to establish health initiatives, the international community should encourage states to earmark a small portion of resource revenues for health programs. States such as Kenya may be open to investing a portion of resource

revenues, as government leaders have expressed interest in both avoiding the pitfalls of resource wealth and bolstering health initiatives.

However, some states may be reluctant to invest a portion of revenues into programs that are ultimately insulated from direct government control.[182] In these cases, international donors could directly incentivize investment into health initiatives. For example, donors could match a portion of funds that countries themselves invest in health initiatives. Donors could match funds up to a certain amount (i.e. match funds up to $1 million dollars) or for a certain time period (i.e. match all funds for up to three years). In 2011, the United States distributed $6.4 billion in foreign aid to Africa.[183] Setting aside a small amount to encourage investment of a portion of revenues that could accrue from the over a trillion dollars worth of natural resources is a smart investment.[184]

- *Investment from Natural Resource Companies.*

  Revenues also could come from natural resource companies. Natural gas and oil companies have an interest in protecting workers from disease, and have supported regional health programs before. In Mozambique, the Anadarko Petroleum Corporation has already partnered with local health NGOs to combat malaria near their operation sites.[185] Furthermore, oil companies in Ecuador continue to devote a portion of revenues to a National Environment Fund, which resembles the framework for the Malaria institute because it is insulated from the government and directed by a multisectoral board of directors.[186]

At the inter-ministerial in 2008, ministers across Africa called on regional and international partners to provide technical guidance and financial resources to "develop, implement, monitor, and evaluate national actions plans in support of the strategic alliance for health and environment."[187] The international community should heed these calls, helping to establish programs that could effectively take in and manage resource revenues. Furthermore, while Kenya's Malaria Prevention and Control Institute remains to be implemented, it provides an ideal model of a program that could be reinvigorated in Kenya or used to inform the establishment of health initiatives elsewhere. Resource revenues would both directly benefit and facilitate the creation of such health initiatives. In debating the creation of the institute, legislators criticized the legislation for not denoting a direct funding source. The legislation merely suggested that funds would come from gifts, grants, or donations, or "monies from any other source provided for the Institute."[188] Natural resource revenues could be this other source.

Alignment with Global Health Policy

Encouraging investment of natural resource revenues to improve health conditions ultimately fosters national ownership of health programs, which is a key tenant of President Obama's Global Health Initiative.[189] Greater ownership promotes local innovation and domestically driven policies.

USAID has found that some of the most innovative development ideas stem from local stakeholders.[190] Furthermore, while donors' funds provide substantial benefits for developing countries, disagreements over the use of funds can arise. For example. Secretary General Dr. Eseli argued to the Kenyan Parliament, "The Bill Gates Foundation and other bodies are going to give us money to buy expensive anti-malaria drugs. Maybe, they could just give us that chemical [DDT] to spray, and we will be safe. We will not need the high cost drugs, because we will reduce malaria transmission by 60 per cent."[191] Donors investing resources into multisectoral collaboration schemes would foster debate among relevant stakeholders and allow spending to better reflect domestic priorities.[192]

Conclusion

Climate change and the spread and amplification of climate-sensitive diseases threaten to interact with existing socio-political trends to provoke hotspots of disease-induced instability. An increased health burden may stunt economic growth, provoke unrest, amplify political tensions, and facilitate the spread of violent extremist groups of concern to the international community.

However, the overlap of disease and underlying trends is not all negative. Many countries in East Africa emerge as both disease hotspots and leaders in natural gas and oil production. Historically, resource wealth has fueled corruption, causing health conditions to deteriorate. The international community should therefore partner with states to ensure resource revenues are effectively invested into health initiatives, thus ensuring states are prepared for emerging diseases powerful enough to instigate political instability.

Appendices

Figure 3. Economic, Demographic, and Political Conditions[193]

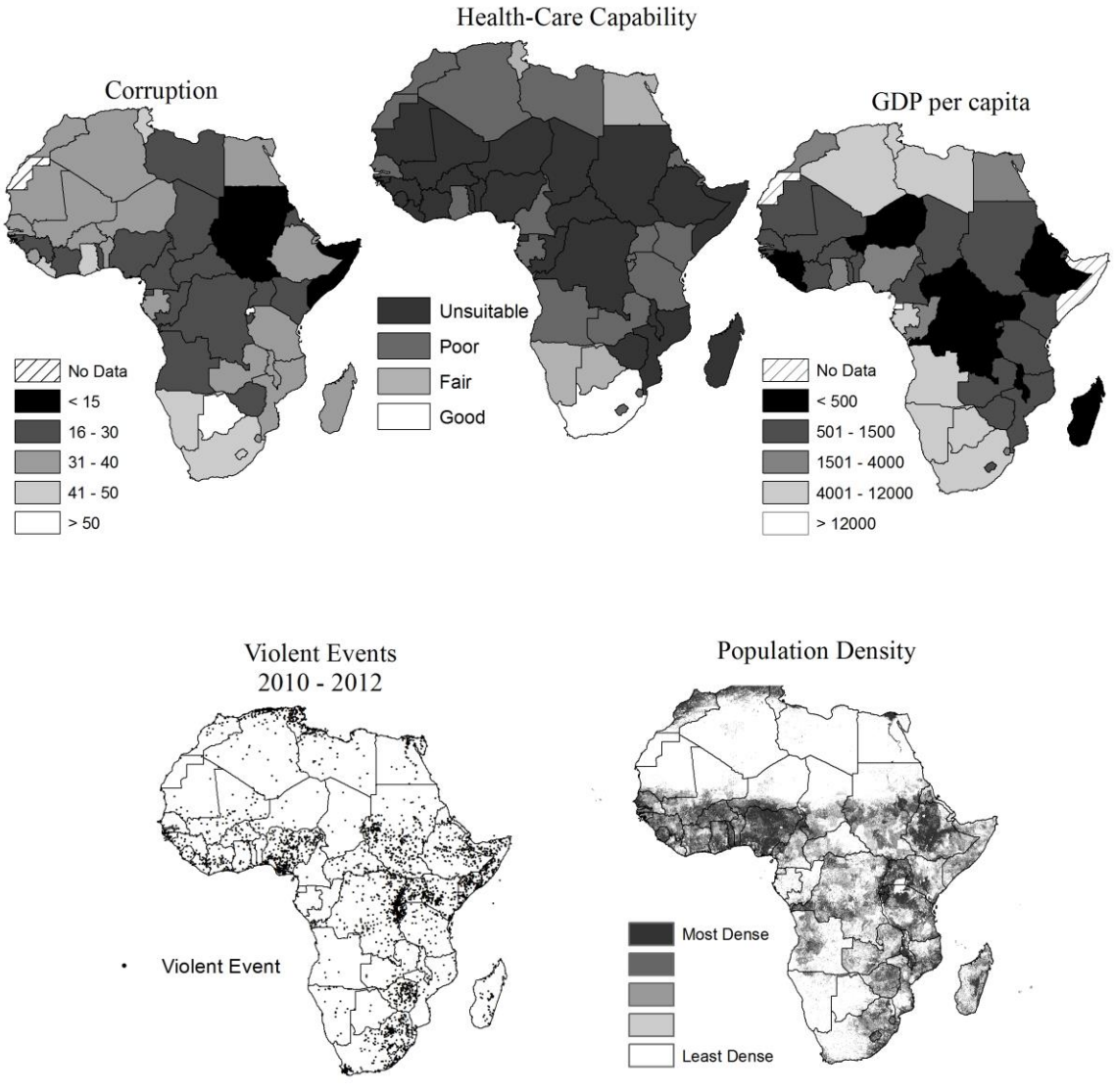
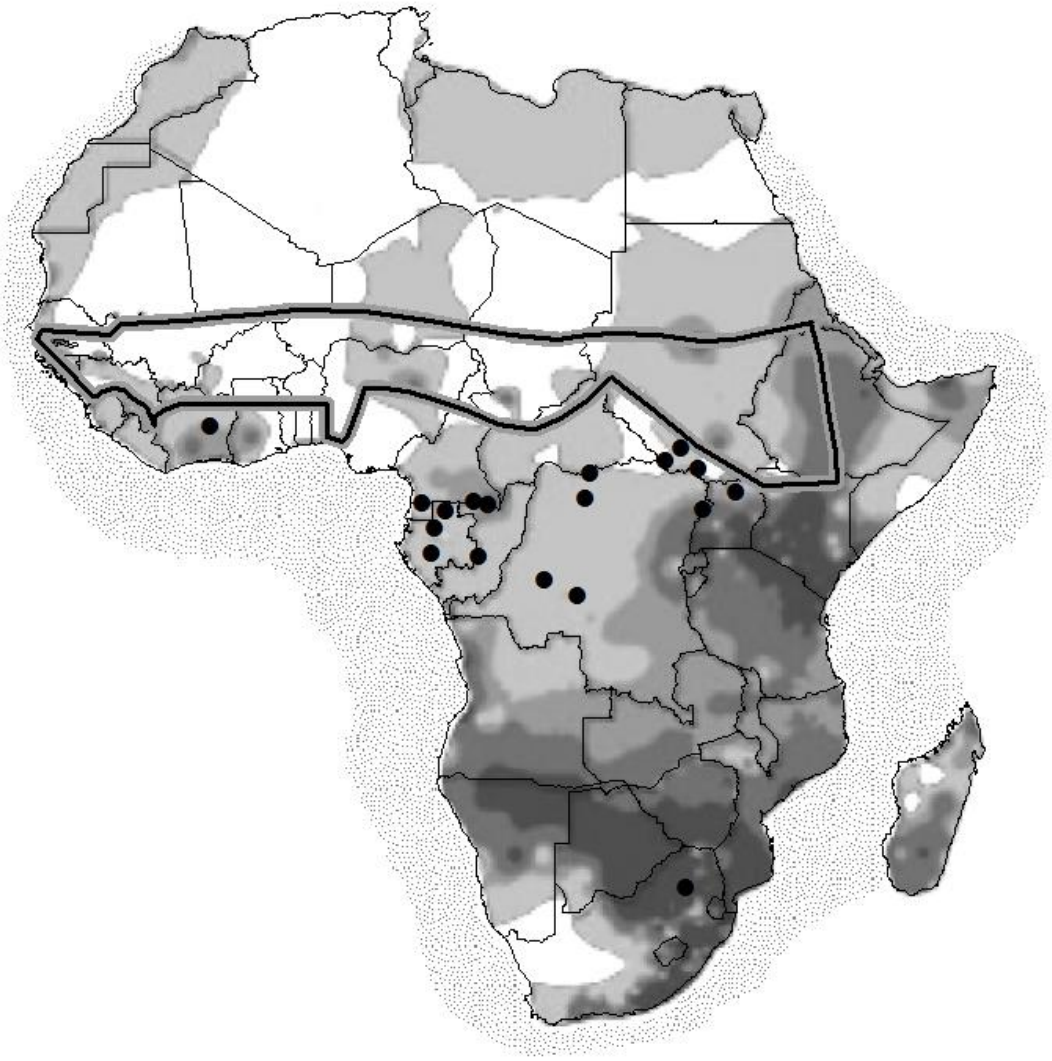


Figure 4. Climate-Driven Disease Trends[194]



Increase in Malaria

Large Increase

Slight Increase

Warming temperatures and increasing preciptiation will amplify and spread malaria.

Increase in Water-Borne Diseases

Warming and Rising Sea Water

Warming and rising sea waters will increase the risk of water-borne diseases, especially to coastal populations.

Expanding Meningitis Belt

Current Boundary of the Meningitis Belt.

Changing drought conditions are predicted to expand the meningitis belt southward.

Increased Frequency of Ebola Outbreaks

Past Locations of Ebola Outbreaks

Ecolological disturbances resulting from climate change will increase the frequency of ebola outbreaks.

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[178] For an example of a successful sector-specific program, see: Mark Buntaine, Nima Raghunathan, and Benjamin Skolnik, "Stakeholder Commitment, Technology and Conservation Financing: Solutions to Minimize Impacts of Oil Development in Yasuní National Park, Ecuador," *Sustainable Development and Conservation Biology* (2005), 45.
[179] Ibid.
[180] Ibid.
[181] Ibid.
[182] The World Bank has previously used incentive schemes to encourage certain behavior. For example, the World Bank financed the Chad-Cameroon oil pipeline in an attempt to incentivize effective resource management. Thomas I. Palley, "Lifting the Natural Resource Curse," *Foreign Service Journal*, December 2003, http://www.globalpolicy.org/component/content/article/198/40112.html.
[183] USAID, "Bureau for Africa." Last modified March 06, 2013. http://www.usaid.gov/who-we-are/organization/bureaus/bureau-africa.
[184] Fred Katerere, "Mozambique Revising Petroleum Law to Include Gas, Bias Says," *Bloomberg*, February 24, 2012. http://www.bloomberg.com/news/2012-02-24/mozambique-revising-petroleum-law-to-include-gas-bias-says-2-.html. Over $800 billion worth of natural gas have been found off the coast of Mozambique alone.
[185] Al Walker et al., *Profile: Anadarko Petroleum Corporation Mozambique Profile*, Anadarko Corporation, 2012, http://www.anadarko.com/SiteCollectionDocuments/PDF/Mozambique/Anardarko_WorldPetroleum.pdf.
[186] *Organizational Profile: Fondo Ambiental Ecuador*, The Nature Conservancy and USAID, September 2006, http://toolkit.conservationfinance.org/sites/default/files/documents/start/organizational-profile-2006-fan-ecuador.pdf.
[187] *Libreville Declaration on Health and Environment in Africa.* August 29, 2008,16.
[188] Ibid.
[189] The White House Office of the Press Secretary, *Fact Sheet: U.S. Global Development Policy*, September 22, 2010, http://www.whitehouse.gov/the-press-office/2010/09/22/fact-sheet-us-global-development-policy.
[190] U.S. Agency for International Development, "The International Development Innovation Network," February 22, 2013, http://www.usaid.gov/hesn/mit.
[191] "Parliamentary Debates July 9, 2008," 1712.
[192] *Health Security through Healthy Environments: First Interministerial Conference on Health and Environment in Africa* (Libreville: WHO Regional Office for Africa, 2009), 1-88. At the Libreville Conference, health and environmental ministers have highlighted the importance of multisectoral debate on health programs, highlighting how, "dynamic intersectoral collaboration between the two sectors would allow the impact of development projects to be debated and anticipated throughout their planning and implementation phases."

[193] GDP per capita data from: The World Bank Group, "GDP per capita (current US$)." Last modified 2013. http://data.worldbank.org/indicator/NY.GDP.PCAP.CD; Conflict data from ACLED database. All events that occurred from 2010 to 2012 were included. "Armed Conflict Location & Event Dataset;" Health-Care Capacity data from: "*Strategic Implications of Global Health;"* Corruption data from: "Corruption Perceptions Index 2012;" Population density data from Climate Change and African Political Stability (CCAPS) data. The Robert S. Strauss Center, "Climate Change and African Political StabilityClimate Change and African Political Stability." Last modified 2013. http://www.strausscenter.org/ccaps/data.

[194] Malaria data from: Henri Tonnang et al., "Predicting and mapping malaria under climate change scenarios: the potential redistribution of malaria vectors in Africa," *Malaria Journal* 111 (2010): 1-10. While all models have limitations, results are in accord with IPCC projections. Namely, that Eastern and Southern Africa will see increases in malaria. However, regional or country level sources are used in identifying and discussing hotspots; Meningitis belt map derived from map from the CDC: Cohn, Amanda, and Michael Jackson. Centers for Disease Control and Prevention, "Meningococcal Disease." Last modified July 21, 2011. http://wwwnc.cdc.gov/travel/yellowbook/2012/chapter-3-infectious-diseases-related-to-travel/meningococcal-disease.htm; Ebola outbreak data from: Hemorrhagic Fever Distribution Map." Last modified July 31, 2012. http://www.cdc.gov/ncidod/dvrd/spb/mnpages/dispages/ebola/ebolamap.htm.