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Risk Expands, But Opportunity Awaits

EMERGING EVIDENCE ON CLIMATE CHANGE AND HEALTH IN AFRICA

April 2017
This document was produced for review by the United States Agency for International Development. It was prepared by Chemonics International through the ATLAS Task Order.

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April 2017

Prepared for:
United States Agency for International Development
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS)

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Key Messages

With variable food security, uneven water and sanitation infrastructure, fragile health systems, and a range of socioeconomic challenges, Sub-Saharan Africa is particularly vulnerable to the health risks of climate change. Key risks such as undernutrition, malaria and diarrheal diseases – already leading causes of morbidity and mortality – are likely to grow as temperatures warm and rainfall becomes more variable.

Climate change is already having a significant impact on Sub-Saharan Africa, threatening efforts to meet the growing needs of the most vulnerable. Temperatures have increased by over 0.5°C or more during the last 50 to 100 years. The increase in extreme weather events such as droughts, floods and cyclones is well documented. While claiming lives, these events also foster undernutrition and catalyze outbreaks of diseases such as cholera and viruses. Their continuing likelihood is a certain impediment to development. Current evidence also shows that the ranges of some species and ecosystems are shifting due to elevated carbon dioxide and other climate change drivers, with significant implications for the incidence of malaria and other diseases. The situation is compounded by a complex variety of underlying physical, social, economic, political and cultural forces and trends operating on local, national and international scales.

Since the release of the Intergovernmental Panel on Climate Change 5th Assessment Report (IPCC AR5) in August 2015, researchers have continued to build evidence of the links between health and weather and climate. This evidence paints an increasingly detailed picture of likely declines in health across Sub-Saharan Africa, with regression on health indicators, an increase in the burden of undernutrition and disease, and, ultimately, a growing number of people at risk of poor health outcomes.

Drawing on the recent research, this report captures several important insights:

Climate change threatens progress on health and development investments.

Over the last two decades, many African countries made significant progress in reducing child mortality, increasing life expectancy, managing food security risks, and strengthening health services and systems.

Climate variability threatens to reverse those gains and trigger growth in the disease burden. In particular, the major strides made in reducing malaria, cholera and meningococcal meningitis may be lost as the corresponding vectors or pathogens respond to anticipated changes in temperature and precipitation.

With climate change, Africa's leading health challenges are likely to persist and even grow, resulting in declining outcomes.

Undernutrition, and stunting in particular, will continue to be a pressing concern. Staple crops such as maize and wheat are currently growing at their thermal tolerance; potential temperature increases may reduce yields and increase food insecurity. In addition, the increasing use of less nutritious, short-cycle crops, coupled with high levels of carbon dioxide in the air, may reduce the availability of nutrients in crops, catalyzing an increase in micronutrient deficiencies.

Malaria's range is likely to expand, putting more people at risk. Changing temperature and rainfall patterns could make more regions suitable to malaria, with the greatest increase in disease prevalence likely in highland areas, where resistance is low. Certain lowland areas, however, may see less malaria.

Dengue fever, frequently misdiagnosed as malaria, may become more prevalent. The anticipated risk is unevenly distributed and more widespread than previously suggested. Increasing urbanization exacerbates the complex biological and environmental factors that will influence its distribution and prevalence.

Heat stress is a growing concern, with significant mortality possible depending on factors such as age and overall health, but with children and older people at the greatest risk. It is also likely to have negative socioeconomic effects, such as decreased worker productivity and lower incomes among those whose livelihoods depend on crops and livestock.

The close association of disease outbreaks with weather conditions – such as heavy rainfall or persistent winds – adds urgency to the need for investment in systems linking weather and climate forecasting to health early warning.

Cholera, a leading killer of children under 5, may be a priority for such an early warning system, as incidence appears to be associated with warming events and low precipitation – likely climate change outcomes in many regions of Africa.

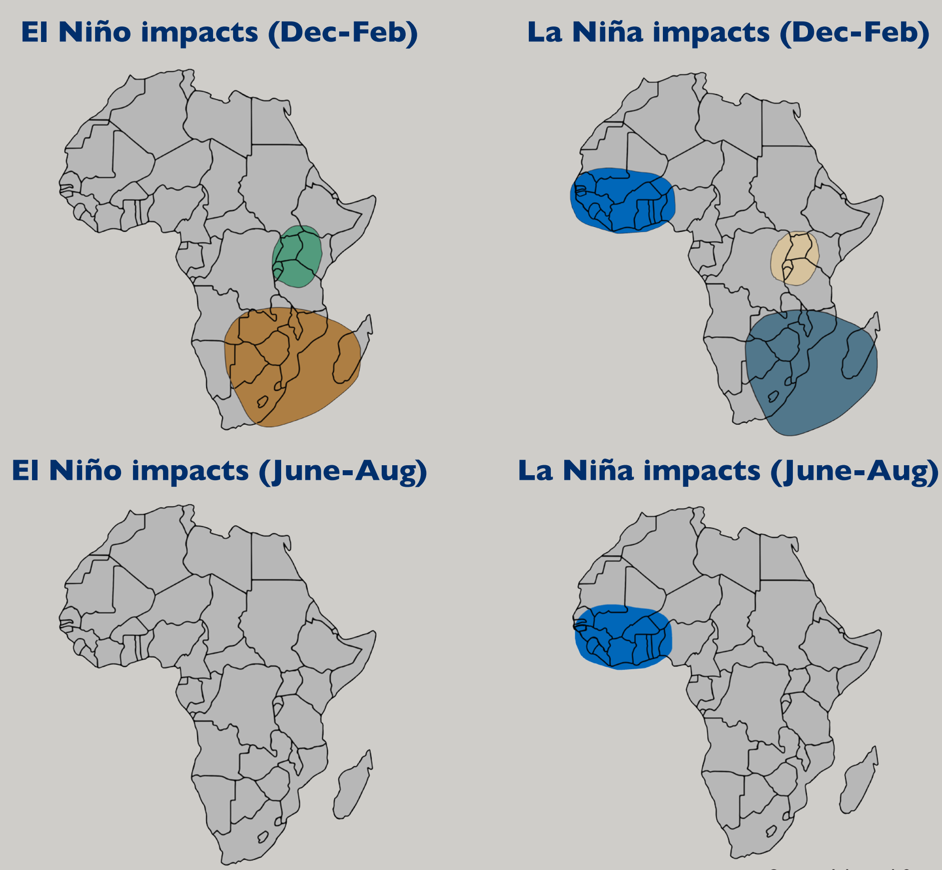
Evidence remains inconclusive on whether climate change will increase the severity of El Niño Southern Oscillation (ENSO) events, but further study should be a priority as strong El Niños and La Niñas may be associated with outbreaks of cholera, Rift Valley Fever and meningococcal meningitis.

In many countries, preparation in the health sector is lagging; more national and international support is needed.

The countries expected to experience the greatest increases in climate-driven health outcomes

ENSO effects across Africa by season

Both the El Niño and La Niña phases of ENSO cause changes in weather and climate that have significant repercussions for water- and vector-borne diseases, communicable diseases, undernutrition, fatalities/injuries from extreme events, and a range of health system disruptions.



Source: Adapted from NOAA

are also those whose health systems have the least capacity to manage additional challenges.

Regions with the triple combination of high exposure to climate change impacts, extensive poverty and dense populations are likely to face a major adaptation challenge. Malawi, Mozambique, Zambia, Zimbabwe and the Lake Victoria region in East Africa are examples.

Whether these risks become realities depends on the level of preparedness of national ministries of health, health care systems and health care professionals, together with the public's awareness of the risks. Currently, these agencies, institutions and individuals are not planning systematically for the specific effects of climate-induced challenges.

International frameworks set global standards for decision making. These include the Libreville Declaration and the World Health Organization's Adaptation to Climate Change in Africa Plan of Action for the Health Sector. To advance national policy processes, key interventions might include health components in National Adaptation Plans as well as specialized assessments of health impacts, vulnerability and adaptation options.

Adaptive management could be a viable approach to dealing with the multiple uncertainties and complexities. One promising initiative is the World Health Organization's collaboration with the Government of Kenya in piloting a multifaceted adaptive management program linking weather forecasting, disease surveillance and response.

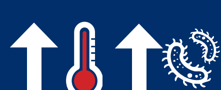
With the challenges come opportunities for action.

In most countries, the immediate health challenges are not new; policies and programs are in place to address them. The challenge at hand is to strengthen planning and policy, scale up existing programs and expand health system capacity.

Priority health system actions should include: early warning systems; improved surveillance and data collection; investments in water and sanitation infrastructure; and more research on disease outbreaks, concurrent disease burdens (e.g., diarrheal disease and undernutrition), land use change and drug resistance.

Decisions on how to manage the risks of climate variability and change in other sectors – including water, agriculture, energy and infrastructure – have direct consequences for health. Cooperation across sectors is vital to reducing risk.

Recent findings suggest...



Of the 7 abnormally warm El Niños between 1978 and 2008, 6 coincided with an increase in reported cases of **cholera** in Burundi, Rwanda, Democratic Republic of Congo, Tanzania, Uganda and Kenya.

Within a certain range of higher temperatures, mosquitoes digest more rapidly and bite more frequently, potentially increasing **the spread of disease.**

In tropical regions, cereal crops are growing near their thermal tolerance. Increasing temperatures are likely to **reduce yields** of maize, wheat, rice and sorghum.

Many short-cycle crops are helpful in increasing food production, particularly in areas where rainy seasons are starting later or becoming shorter, but research shows that these crops may offer lower levels of nutrients. This finding may indicate the possibility of greater **micronutrient deficiencies**.

Some climate adaptation interventions, such as irrigation dams, increase the risk of waterborne diseases by providing habitat, for example, for snails that carry **schistosomiasis.**

How to Use this Report

This report summarizes a desk review of recent evidence for climate risks to the health sector. As a starting point, it is helpful to understand key Africa-specific findings of the Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC AR5), published in 2014.

Likely climate impacts by 2050 in Africa

Increased temperature

Increase of 2°C to 6°C over much of Africa

Rate of increase is faster than the global average

Interior regions, especially arid areas, to warm faster than coastal regions

Minimum temperatures likely to rise faster than maximum temperatures, with warmer nights

More variable rainfall

Decreased precipitation in Southern Africa and parts of the Horn of Africa

Decrease of 5 percent in Equatorial Africa

Increase of 15 percent in areas of the Sahel

More extreme rainfall, especially in highland areas

Other effects

Increase in sea surface temperatures by 0.6°C to 0.8°C, less than the global average

Increased sea level rise 25 centimeters on average

Increased evaporation of surface water and moisture in soil and plants

Africa-specific health impacts

Likely to increase the burden of specific diseases, climate change will also act as a multiplier of existing health vulnerabilities, such as poor water and sanitation, food insecurity, and limited access to health care and education. Climate change is likely to aggravate an already poor health situation:

Now: Malaria deaths have declined since the mid-2000s, but it remains a leading cause of mortality across the continent.
Future: Increased malaria in highland areas, especially in East Africa where as many as 45 to 65 million more people may be at risk by 2050.

Now: Most virulent in Africa, meningococcal meningitis epidemics can reach 800 cases per 100,000 people, compared to a rate of 3 cases per 100,000 in industrialized nations.
Future: Increased risk of meningococcal meningitis outbreaks as up to 8 percent of Africa becomes more arid and more suitable to the bacteria that causes the disease (by 2080).

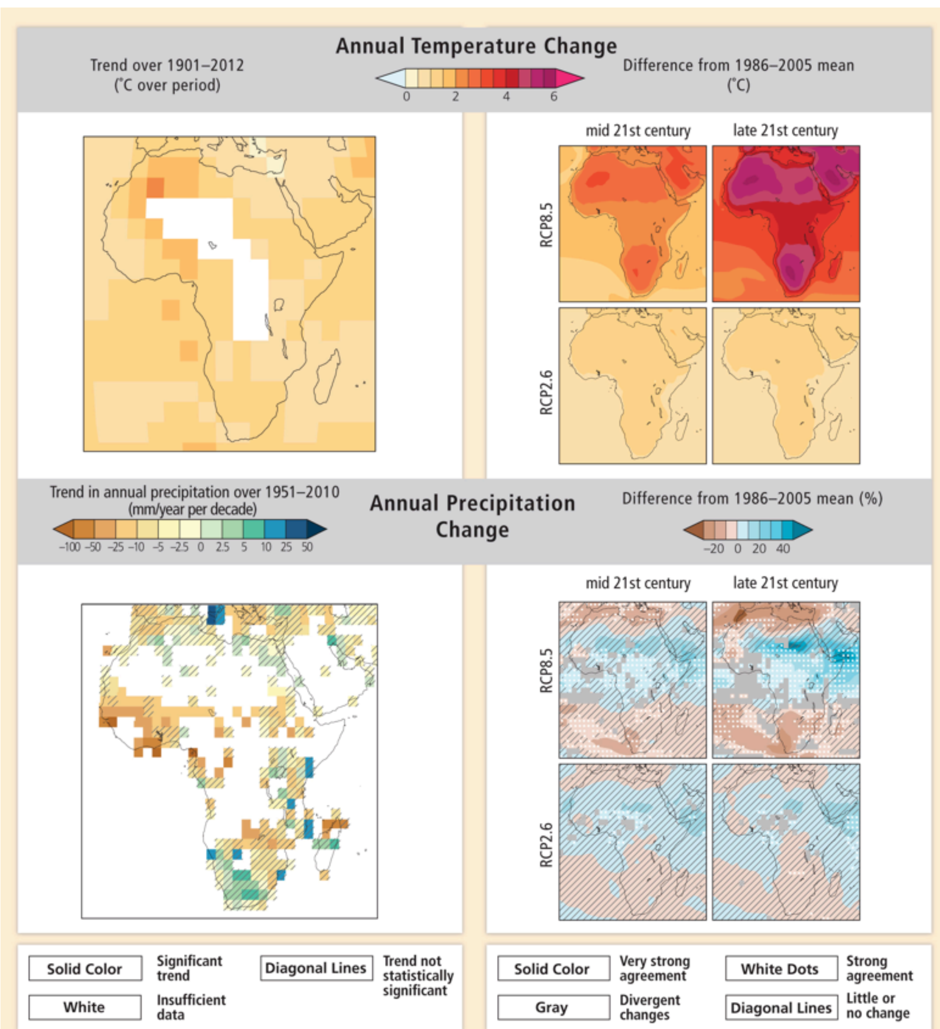
Now: Children in Sub-Saharan Africa are 14 times more likely to die before age 5 than children in developed regions.
Future: 10 million more children under age 5 at risk from undernutrition as a result of climate change.

Understanding the Basics, Part 1: Climate Projections in Africa

Climate scientists draw upon a suite of models to describe future climate changes. The primary sources of information are Global Climate Models (GCMs), Regional Climate Models (RCMs) and downscaling techniques, both empirical and statistical. The models comprise simplified but systematically rigorous mathematical descriptions of physical and chemical interactions governing climate, including the role of the atmosphere, land, oceans and biological processes.

The new IPCC scenarios offer valuable insights into the future of the climate system. These scenarios, termed Representative Concentration Pathways (RCPs), describe four scenarios on how the planet might change in the future, considering emissions, climate, environmental change and vulnerability. These include: RCP8.5, RCP6, RCP4.5, and RCP2.6. The numbers refer to radiative forcing, a measure of how greenhouse gases in the atmosphere change the Earth's normal energy balance. The timescale is by the year 2100. This information is translated through models of climate dynamics and used to make projections of how much the Earth will heat as a result of increased greenhouse gases.

New evidence provides a summary of the available climate projections for Africa *(Figure 1)*. Use of these data in a decision-making context requires careful examination of the relevant spatial and temporal scales.



Observed and projected changes in annual average temperature and precipitation

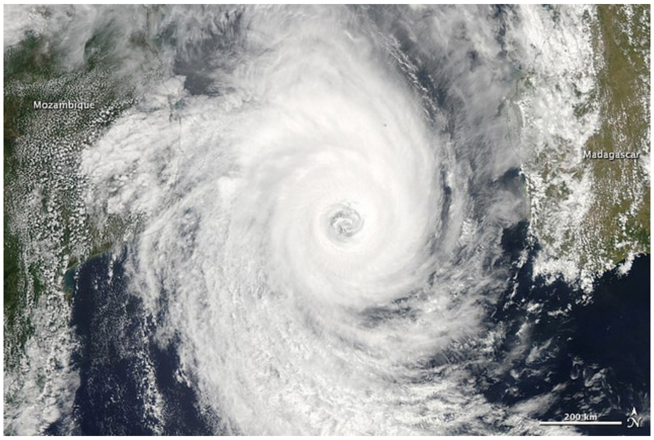
(Top panel, left) Map of observed annual average temperature change from 1901–2012.

(Bottom panel, left) Map of observed annual precipitation change from 1951–2010. White areas indicate areas where insufficient observations exist, other colors areas where trends are significant at the 10% level. Diagonal lines denote areas where trends are not significant.

(Top and bottom panel, right) CMIP5 multi-model mean projections of annual average temperature changes and average percent changes in annual mean precipitation for 2046–2065 and 2081–2100 under RCP2.6 (best-case scenario) and 8.5 (worst-case scenario) relative to 1986–2005.

Source: IPCC AR5

Why are we confident that climate is changing?



Source: NOAA

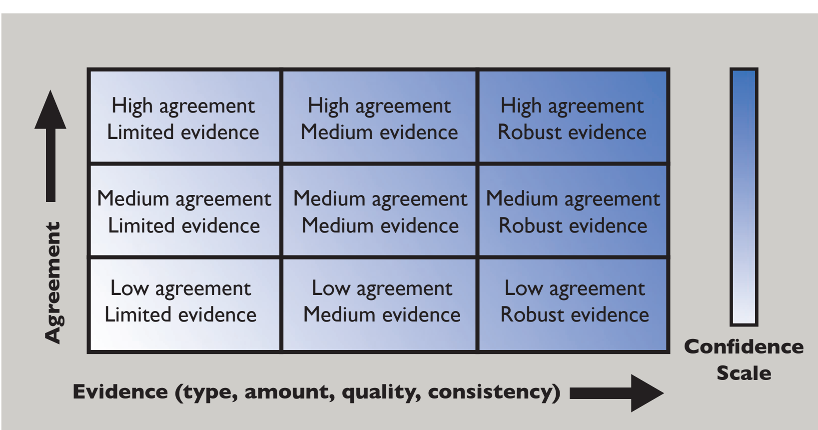
By nature, the projections, models and scenarios used to forecast climate change impacts carry some level of uncertainty. The particular uncertainty associated with climate change and health in Africa relates to a combination of factors linked to the clarity of the climate models as well as the unpredictability of natural events and human decision making. Some of these factors include: natural variability, human impacts such as future emissions and land use, imperfect scientific knowledge, and the reliability of modelling tools. The uncertainty of the science has multiple dimensions tied to the lack of historical and current data, a limited understanding of regional climate dynamics, and challenges in scaling down global models into regional models.

To manage this uncertainty, IPCC AR5 devised a standardized approach to analyzing available evidence and communicating about its findings. This standardization brings rigor and consistency to the process, enabling the comparison of a wide diversity of research, data and other information. To support decision making, IPCC describes its findings with a common language. In particular, AR5 relies on two metrics to express certainty:

- Confidence in a finding is based on the type, amount, quality and consistency of evidence, together with the degree of agreement. Confidence is expressed qualitatively. (*Figure 2*).
- Uncertainty is quantified and expressed as a probability. (*Figure 3*).

This terminology is particularly important in understanding AR5's use of scenarios on possible future events. Each of these scenarios is discussed with a confidence rating.

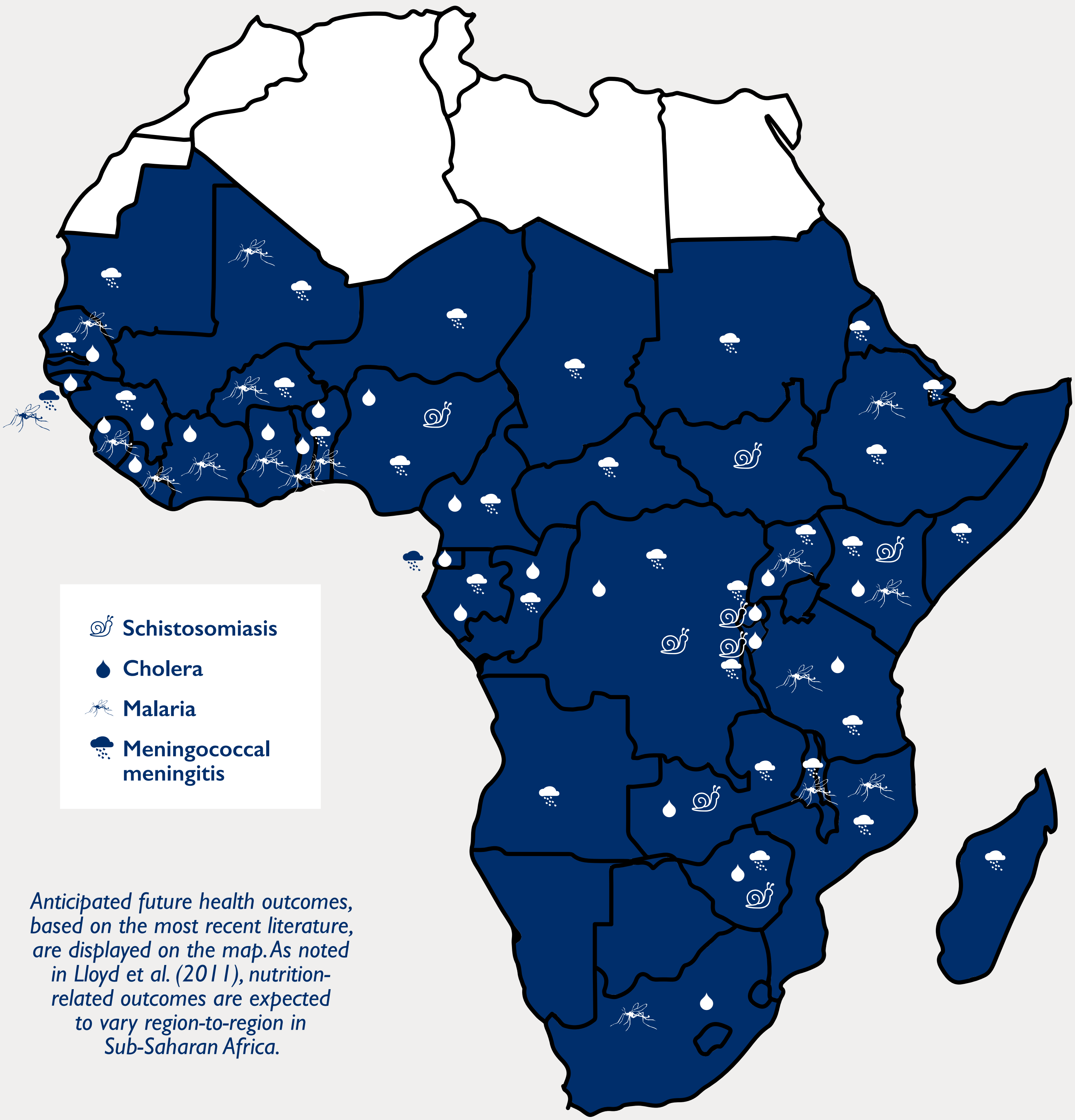
IPCC's framework for expressing confidence



IPCC's framework for expressing certainty

Likelihood Terminology	Likelihood of the occurrence/outcome
Virtually certain	> 99% probability
Extremely likely	> 95% probability
Very likely	> 90% probability
Likely	> 66% probability
More likely than not	> 50% probability
About as likely as not	33 to 66% probability
Unlikely	< 33% probability
Very unlikely	< 10% probability
Extremely unlikely	< 5% probability
Exceptionally unlikely	< 1% probability

Health Risks of Climate Variability and Change in Sub-Saharan Africa



Anticipated future health outcomes, based on the most recent literature, are displayed on the map. As noted in Lloyd et al. (2011), nutrition-related outcomes are expected to vary region-to-region in Sub-Saharan Africa.

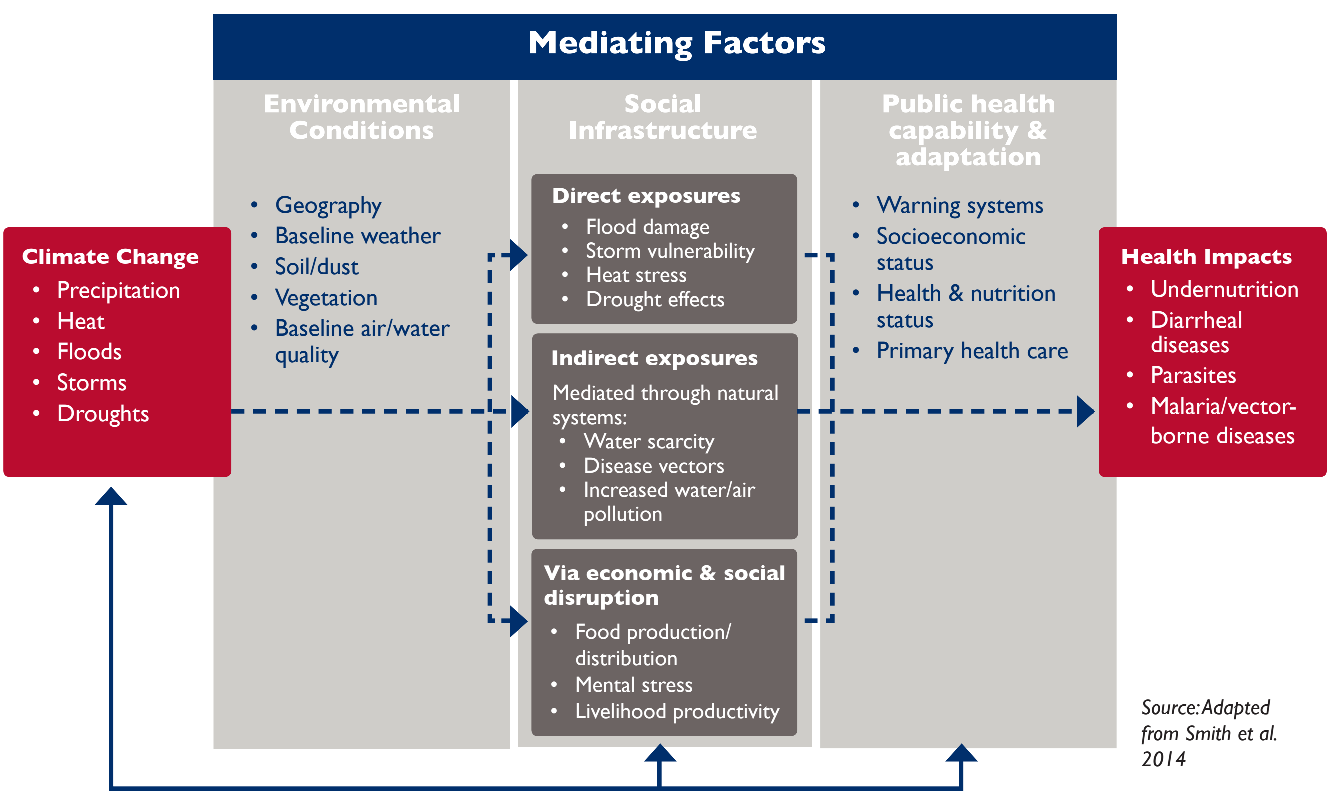
Understanding the Basics, Part 2: Climate Change and Health Vulnerability

The health impacts of climate change will vary depending on the strength of the health system in meeting and adapting to the needs of the people it serves, and the broader context for human health, with its great diversity of environmental, social and economic drivers.

A strong health care system brings together an ample force of qualified health workers, reliable financing mechanisms, evidence-based health policies, best scientific practices, well-maintained facilities, requisite supplies of medicines and technologies, and adequate infrastructure to deliver those medicines and technologies. And because of the increasingly globalized nature of disease dynamics, an effective health system also needs capacity to control and respond to emerging public health threats, such as epidemics and changing disease prevalence.

The intersection of the health system and the socioeconomic and environmental context produces a range of complex, cross-sectoral challenges. For example, cholera may be linked to excessive rainfall, but outbreaks will occur primarily in areas with weak water and sanitation systems. To be effective, efforts to combat cholera would also need to address 1) direct health impacts of the outbreak and 2) the underlying economic and development situation that catalyzes the spread of disease.

A systematic response to improving a population's health status begins with a coherent framework for assessing and analyzing all of the factors described above. The framework below specifically considers the health-specific impacts of climate change applied to the African context. With the environmental and socioeconomic context as a backdrop, it shows how likely climate impacts will directly and indirectly affect populations, how the health system may respond, and what those responses may mean for health outcomes.



Source: Adapted from Smith et al. 2014

Health Risks in Detail

Source: World Bank Photo Collection

Undernutrition

Recent scientific studies suggest that climate change is likely to have direct, negative effects on nutrition in Africa.

Key points

Across Sub-Saharan Africa, climate change is expected to increase health risks related to food security and nutrition. In recent decades, investments in agriculture, provision of clean water, maternal health, child care practices and other sectors have helped reduce chronic food insecurity and micronutrient deficiencies in many countries. However, new research shows that climate variability and extreme events are likely to undermine those gains.

The potential implications of climate change for food systems require evaluation of a complex set of climate, environmental and socioeconomic factors. Here are some key points from recent studies:

- Increasing temperatures and changes in precipitation are very likely to reduce cereal crop productivity, with strong negative

Hotspots of climate change risks to agriculture in the 2080s

A recent study on drivers of agricultural productivity identified climate change hotspots across Africa, finding that climate conditions will worsen across Sub-Saharan Africa by the end of the 21st century, with dry periods likely to increase in most places except portions of East Africa.

Along with an additional risk of floods, a drop in crop yields is likely in many areas of Sub-Saharan Africa, with considerable risk in portions of West, East and Southern Africa. Areas of particular concern are those that carry a triple burden of high exposure to climate change impacts, extensive poverty and population density.

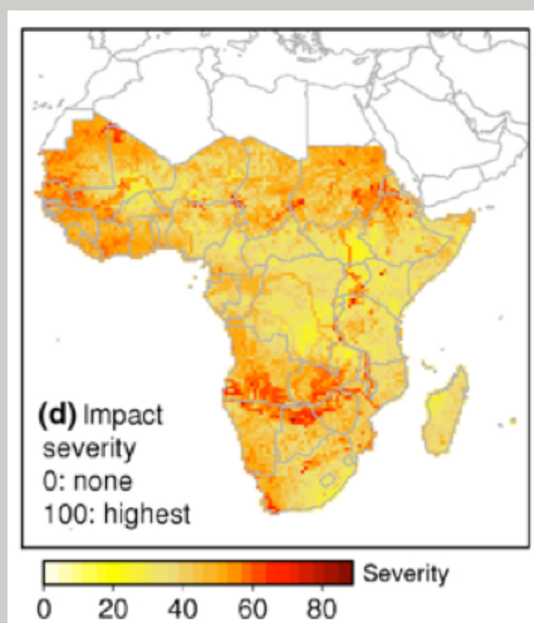
The study found "very high agreement" across 80 scenarios considering six climate change drivers including:

- freshwater availability
- flooding probability
- drought/dry periods
- irrigation water requirements
- ecosystem productivity
- crop yields

Key hotspots included the western and eastern Sahel, the Lake Victoria region, and parts of the Congo, Niger, Nile, Okavango and Zambezi River basins. This designation was based on a combination of the likelihood of negative impacts across the six drivers, the possibility of extreme impacts such as flooding and the likelihood that negative impacts are strong on average.

High population density and widespread poverty make Malawi, Mozambique, Zambia, Zimbabwe and the Lake Victoria area of particular concern. The study suggested these should be priority areas for adaptation planning, including measures such as increased irrigation, rainwater harvesting and improved water storage.

Source: Müller et al., 2014

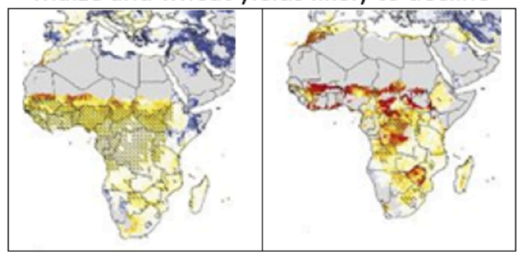


impact on food security. While much attention is devoted to the incidence of drought, increasing seasonal temperatures and heat stress are also major influences on crop and livestock performance. Models for major grains show yield losses in the range of 2.5 to 16.0 percent for every 1°C increase in seasonal temperature. Across the Sahel, this effect has led to poor performance of maize, sorghum and millet.

- Stunting in children under 5 is projected to increase in most of Africa even when considering socioeconomic change. This is because key staple crops such as maize and wheat are growing close to their thermal tolerance; continued increases in temperature are expected to reduce yields and increase food security challenges. In addition, higher carbon dioxide concentrations in the air reduce zinc and iron concentrations in wheat and rice, diminishing their nutritional value. This may contribute to increasing numbers of children with micronutrient deficiencies.
- New challenges are emerging with continuing urbanization and increasingly globalized food chains. Over the last 20 years, African cities have grown at an annual rate of 4 percent. Understanding food and livelihood security requires analysis of the drivers and shocks specific to both urban and rural contexts.

Photo: Neil Palmer, CIAT

Maize and wheat yields likely to decline



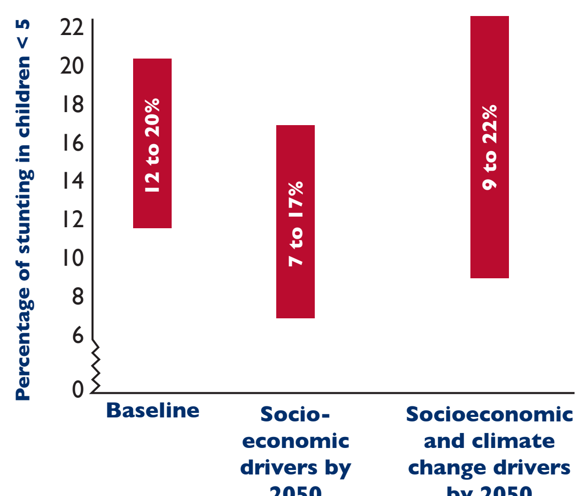
Maize Wheat

Percentage change in yield of maize and wheat under a high greenhouse gas emission scenario (RCP8.5) for 2070-2099 compared with 1980-2010.

Source: IPCC AR5

Many African countries have a high burden of micronutrient deficiencies, particularly of vitamin A, iodine, iron and zinc. These public health problems are likely to increase with climate change. One factor is the likelihood that higher carbon dioxide concentrations in the atmosphere will reduce the micronutrient content of key staple grains, namely wheat and rice.

Climate change disrupts progress on child undernutrition



Source: Lloyd et al., 2011

Climate change will have significant effects on future undernutrition, even when the beneficial effects of economic growth and improved livelihoods and services are taken into account. This is particularly true for severe stunting, which, according to one study, is projected to increase by 55 percent in Sub-Saharan Africa. Another study, referenced above, used scenario data to project future child undernutrition in 2050 in four regions in Sub-Saharan Africa considering socioeconomic causes and climate change. The study used severe stunting to represent undernutrition.

Vector-borne diseases: Malaria, Dengue Fever, Rift Valley Fever, Schistosomiasis

Malaria

With a child dying every minute from malaria, Sub-Saharan Africa continues to bear the brunt of the global burden of this disease. Rising temperatures and changing rainfall patterns associated with climate change will complicate matters further, expanding vector ranges into previously unsuitable regions such as those at higher elevations, and significantly increasing the number of people at risk of the disease.

In 2015, of the estimated 214 million people who contracted malaria, 438,000 died. Some 88 percent of those deaths occurred in Africa, a majority among children under age 5.

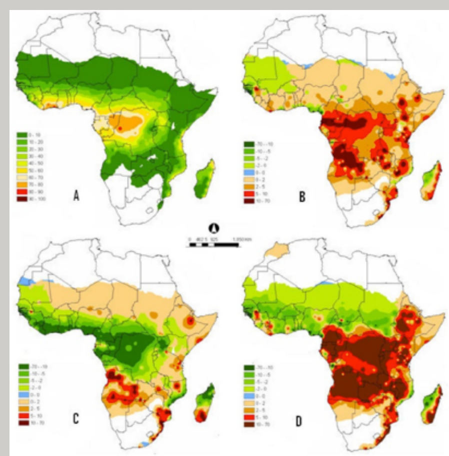
(WHO 2016)

At a glance:

- Climate change is already altering the geographic range of malaria, particularly along the current edges of its distribution. It will continue to do so, exposing millions more at risk from the disease.
- Consensus is growing that highland areas, especially in East Africa, will experience an increase in the number of malaria epidemics. Areas above 2,000 meters, which currently have nighttime minimum temperatures too low to support mosquito reproduction, may become suitable breeding areas. As previously unexposed populations typically have low resistance, expansion of malaria into new regions is associated with high morbidity and mortality.
- The distribution and seasonal transmission of malaria is affected by climate, as both vector and parasite are sensitive to temperature. Nighttime temperatures, in particular, limit the suitability and range of mosquito vectors that carry *Plasmodium falciparum* ma-

The risk of malaria infections will change, expanding and contracting across the continent in response to increasing temperatures and altered rainfall patterns.

Malaria is transmitted by female mosquitoes of the genus *Anopheles*. Temperature, rainfall and relative humidity combine to create a conducive living environment for these mosquitoes. Working knowledge of the suitable values for these variables where malaria vectors occur is essential to developing control programs. For example, cool nighttime temperatures limit mosquito survival and reproduction. As nighttime temperatures warm, new areas will offer suitable conditions for these vectors, exposing millions of additional people to risk from the disease. The other extreme is also true, as temperatures higher than 35°C also limit mosquito reproduction, which may translate to reduced risk in some lowlands. Clearly, these risks will have a seasonal distribution, and with changes in rainfall patterns, the timing and application of mosquito control measures may need to be altered.



Anopheles *breeding and survival as determined and characterized by rainfall and humidity. In relation to several scenarios of climate change a) under current climate, b) assuming a 0.1°C rise in summer and winter maximum and minimum temperatures per degree of latitude, and a 10% increase in rainfall in summer, and 10% decrease in winter, c) assuming a rise of 4°C Africa-wide temperature, and 20% increase of summer rainfall and 20% decrease in winter rainfall, d) distribution of* A. arabiensis *illustrating species ranges shifts under climate change scenario.*

Source: Tonnang et al., 2010

laria. Mosquito survival depends on a host of other variables including rainfall and relative humidity, all of which will be altered under a changing climate.

- Early warning systems designed to detect and respond to malaria outbreaks are essential to mediate the projected changes. Nevertheless, the establishment of these systems is challenging due to the complex nature of determining causality: climate is only one parameter. Other barriers to effective early warning include the lack of information at appropriate temporal and spatial scales of incidence and outbreaks, and the exploratory nature of analytic approaches currently in use. New research is revealing the potential for these systems to provide timely evidence to support improved responses.

Projections suggest that the population at risk of malaria will increase in Central, Southern and East Africa, and slightly decrease in West Africa. In East Africa especially, significant increased risk is expected, with models consistently projecting that highland areas will become more suitable for malaria transmission.

(Caminade et al., 2014)

Source: DFID

Numerous publications since IPCC AR5 are shaping our understanding of the country- and region-specific relationship between weather patterns outbreaks, as well as offering insight on how climate change will impact the geographic range, seasonality and incidence of malaria.

Ghana: An estimated 44 percent of all outpatient illnesses and 36 percent of all hospital admissions for children are attributable to malaria. Temperature and humidity are associated with malaria prevalence; annual rainfall was found to be less predictive but nevertheless remains an indicator of prevalence (Adu-Prah et al., 2015).

Benin: Risks from malaria modelled using field and remotely sensed data suggest that the health and extent of vegetation – indicated as a "greenness" value – is associated with greater malaria prevalence. (Greenness is a proxy for moisture availability, derived from a normalized difference vegetation index, or NDVI.) These important seasonal and spatial variations point to the risk of human contact with the vector, and could help in the planning of vector control strategies (Moiroux et al., 2013).

Burkina Faso: A similar study showed that higher NDVI values were associated with higher malaria prevalence, especially when coupled with lower than average monthly rainfall and lower population densities (Samadoulougou et al., 2014)

West Africa: A regional study on malaria incidence and climate reinforced the links between malaria rates and average annual temperatures and total annual precipitation. As temperatures rise and rainfall increases, either in tandem or individually, malaria risk increases (Arab et al., 2014).

Ethiopia: A longitudinal study of malaria incidence in Amhara across the rainy season found that temperature and precipitation may be important constraints on malaria at the beginning of the rainy season in highland areas. Temperatures limit the growth and biting rates of *Anopheles* mosquitoes. In contrast, in the drier eastern districts, soil moisture can limit availability of potential breeding sites, slowing the development of larvae and decreasing mosquito abundance. These results point to the importance of combining early detection with early warning information (Midekisa et al., 2015).

Kenya, Tanzania and Uganda: Using temperature and rainfall data, a model was developed to forecast malaria risk with a lead time of two to four months across two highland ecosystems. Generally, epidemics were triggered once temperatures reached 2°C above normal for the month that preceded the rains. Models such as these offer valuable information in the early detection and prevention of malaria epidemics (Githeko et al., 2014).

Malawi: Finetuning spatial associations between malaria risk, climate variables (temperature and precipitation) and other compounding socioeconomic factors improved existing predictive models of malaria risk by 41 percent, particularly at higher altitudes where transmission rates are irregular (Lowe et al., 2013).

Dengue Fever: Often unrecognized – but a growing threat

A largely urban disease generally viewed as a greater health risk to Asia and the Americas, dengue fever may expand across Africa as the climate changes. Currently, 16 percent of the global cases reported annually derive from the continent, but experts suggest this may be due to misdiagnosis of the disease as malaria, as many of the symptoms of these diseases–such as fever in children–are shared.

The continent has a high diversity of closely related vector species that have the potential to redistribute themselves to new habitats made suitable by the changing climate, resulting in new disease patterns.

A growing body of evidence suggests that rising temperatures and changing precipitation patterns associated with climate change could catalyze an expansion of dengue-carrying mosquito vectors to new areas. Factors that could affect transmission in Africa include vector efficiency, viral infectivity, host vulnerability and urbanization (Were 2012).

Although research on the disease and weather associations in Africa is limited, recent evidence from South America suggests that mean potential transmission intensity could be expected to increase by a factor of 2 to 5 under conditions with a 2°C rise in temperature.

Dengue cases are poorly understood, generally, because:

- A low proportion of people with dengue seek health care
- National surveillance systems are not designed to capture all symptomatic cases, and
- Symptoms may be confused with other diseases that cause high fevers, such as malaria.

Better surveillance is needed to understand the current burden of dengue across Africa, and to project how climate change could affect the geographic range, seasonality and incidence of the disease.

A 2013 study in Mombasa, a coastal city in Kenya, found that 13 percent of people in the sample tested positive for dengue, but most who received medical care were treated for malaria.

(Ellis et al., 2013)

Rift Valley Fever: A Threat to people and livestock

More devastating for livestock than humans, Rift Valley Fever is expected to become more prevalent with climate change, potentially increasing food insecurity in pastoralist environments. A disease endemic to East and West Africa, Rift Valley Fever outbreaks have been linked to altered rainfall patterns resulting from large-scale climate dynamics such as ENSO and La Niña events, and elevated Indian Ocean temperatures that cause heavy rainfall and flooding. As a result, habitats become suitable for vector reproduction, particularly *Aedes* and *Culex* mosquitoes, the primary vectors (Niang et al., 2014).

Forecasting can predict climatic conditions that are frequently associated with an increased risk of outbreaks, and may improve disease control.

A recent study of Rift Valley Fever outbreaks in Kenya between 2005-2006 showed that soil characteristics, rainfall and NDVI greenness values before the outbreak were associated with increased risk of outbreaks. Regions with soils on plains, in densely bushed areas, at lower elevations and in the Somalia acacia ecological zone offered more suitable moisture conditions for vector reproduction (Hightower et al., 2012).

A 2013 study on Rift Valley Fever incidence in humans in Mozambique linked infection rates to periods of heavy rainfall and flooding. The study found that that 67 percent of cases were misdiagnosed (and treated) as malaria, reinforcing the need for improved diagnostic tools and increased awareness of the risks from the disease (Gudo et al., 2016).

What is Rift Valley Fever?

- A viral disease affecting both humans and livestock that can cause mild to severe symptoms, including death.
- Transmitted by infected animals to humans through direct contact with the blood or organs of infected animals or mosquitoes.
- Endemic to pastoral and agropastoral regions of Central and East Africa, though outbreaks have occurred across the continent.
- Outbreaks in sheep and cattle can cause "abortion storms" with 70 percent of females losing their pregnancies, as well as 20 to 30 percent mortality in adult animals.
- Human cases generally resolve without treatment but complications may include blood-related illnesses such as hepatitis, retinitis, delayed-onset encephalitis or hemorrhagic syndromes.

Photo: Caroline Granycome

Transmission in Senegal

The mosquitoes that carry Rift Valley Fever, principally *Aedes vexans* and *Culex poicilipe* are very sensitive to environmental conditions, which determine their presence, biology and abundance. Using data from a dense network of temporary ponds, proxies for mosquito breeding sites in Senegal's Ferlo Valley, a mosquito population model was developed to predict vector abundance and Rift Valley Fever outbreaks using climate variables. Results suggest that vector reproductive success and Rift Valley Fever outbreaks depend on start-of-season rainfall intensity rather than total season amounts. These results reinforce similar findings from studies conducted in East Africa (Soti et al., 2012).

Schistosomiasis

Schistosomiasis, also known as bilharzia, is a tropical and subtropical disease caused by parasitic worms found in Africa, Asia, the Middle East, South America and the Caribbean. An estimated 90 percent of those treated for the disease annually live in Africa, with 62 million treated cases in 2014 alone. Water management infrastructure, such as dams and irrigation schemes, offer breeding grounds for snails carrying the disease. As water temperature and quality affect vector lifecycles, increasing temperatures projected for Africa could change disease patterns, potentially expanding risk into new areas and/or reducing risk in known areas of endemism.

- Cool water and ambient temperatures currently limit suitable habitat for the snails that carry schistosomiasis. Current trends and projected increases in temperature for the continent will open new areas for snail populations, increasing risk.
- Poor sanitation and lack of access to clean water have been linked to the spread of schistosomiasis, particularly among children who play in contaminated ponds and puddles.
- In spite of being categorized as a neglected tropical disease, schistosomiasis is second only to malaria among parasitic diseases with the greatest economic impact in tropical countries.
- Schistosomiasis response reinforces the critical importance of close cooperation across sectors when addressing climate and health concerns. One study suggests that actions promoted in the water resource sector to respond to climate risks, such as certain types of irrigation, can increase human vulnerability by creating habitats conducive to the snails that carry schistosomiasis (Niang et al., 2014).

Zimbabwe: Snails thrive and die with a changing climate

Projections in Zimbabwe suggests that climate change will alter the suitability of the habitats of snails that transmit schistosomiasis. Rising temperatures–which affect the rate that parasites develop–could reduce the number of habitats for host snails, with one important exception: *Bi. pfeifferi*, the host of intestinal schistosomiasis.

The research, using maps of snail presence and a high resolution climate model, compared host suitability across three time periods: 1980-1999, 2046-2065 and 2080-2099. The results projected several importance changes. For example, the climate suitability of *Bi. pfeifferi* snails, restricted in the 1990s to the highveld and eastern highlands, will extend to the whole of Zimbabwe by 2050. Yet a reversal occurred beyond specific temperature thresholds, suggesting reduction in *Bi. pfeifferi*-suitable zones toward the end of the century, except in the central highveld, where habitat was projected to remain suitable (Pedersen et al., 2014).

Photo: CDC Global

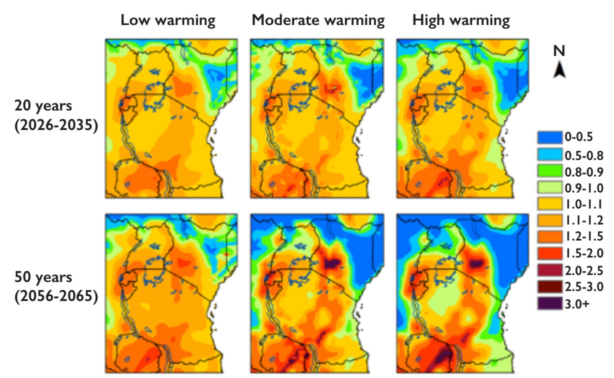
East Africa: Schistosoma parasite to shift

A modeling exercise suggested that rising temperatures alone may increase the risk of schistosomiasis by 20 percent in coming decades, with the parasite declining in some areas and expanding in others. Understanding the complex interplay between parasite-host dynamics and climate is critical when designing interventions.

Photo: US Army Africa

Looking at the temperature-sensitive stages of *Schistosoma mansoni* and lifecycles of typical host snails, the model points to increased risk in Rwanda, Burundi, southwest Kenya and eastern Zambia, with the parasite becoming newly endemic in some areas. The model was run using best, business-as-usual and worst-case scenarios of warming, representing increases in temperature of 0.34°C, 0.42°C and 0.66°C, respectively,

Median projected change in *S. mansoni* risk in East Africa in 2026-2035 and 2056-2065 compared with 2006-2015

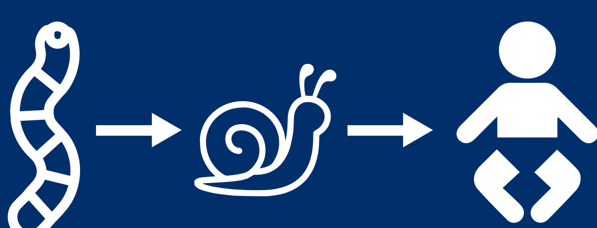


Source: McCreesh et al., 2015

and eight scenarios of air and water temperature combined with snail mortality rates. Projections for the next 20 and 50 years show similar outcomes.

Over the next 20 years, projected increases in temperatures appear to reach a critical threshold where snail habitat could be reduced, decreasing risk from schistosomiasis by more than 50 percent in parts of north and east Kenya, southern South Sudan and eastern Democratic Republic of Congo (McCreesh et al., 2015).

Schistosomiasis transmission pathways



Some 90 percent of the 261 million people who required schistosomiasis treatment globally in 2013 were in lesser developed areas of Africa (WHO 2015). In West Africa, prevalence of schistosomiasis among children and young adults under age 20 was estimated at nearly 51 million.

(Schur et al., 2011)

Meningococcal Meningitis

Africa's meningococcal meningitis "belt" stretches from Senegal to Ethiopia, but a majority of the deaths and reported cases from the disease occur in the dry seasons in the Sahel region of West Africa. A well-known relationship exists between the seasonal cycle of meningococcal meningitis and climate: meningitis onset is associated with the Harmattans, the dry and dusty northeasterly trade winds that blow from the Sahara into the Gulf of Guinea. Transmission peaks are associated with periods of low humidity driven by these storms, ending with the onset of the rains (Niang et al., 2014).

Intensive surveillance and vaccination efforts over the last decade have significantly reduced the incidence of meningococcal meningitis. As of June 2015, more than 220 million Africans under age 29, residing in 15 countries of the so-called "Meningitis Belt" received the meningococcal A conjugate vaccine. During the 2014 epidemic season, 19 African countries reported nearly 12,000 suspected cases and 1,146 deaths – the lowest numbers since 2004.

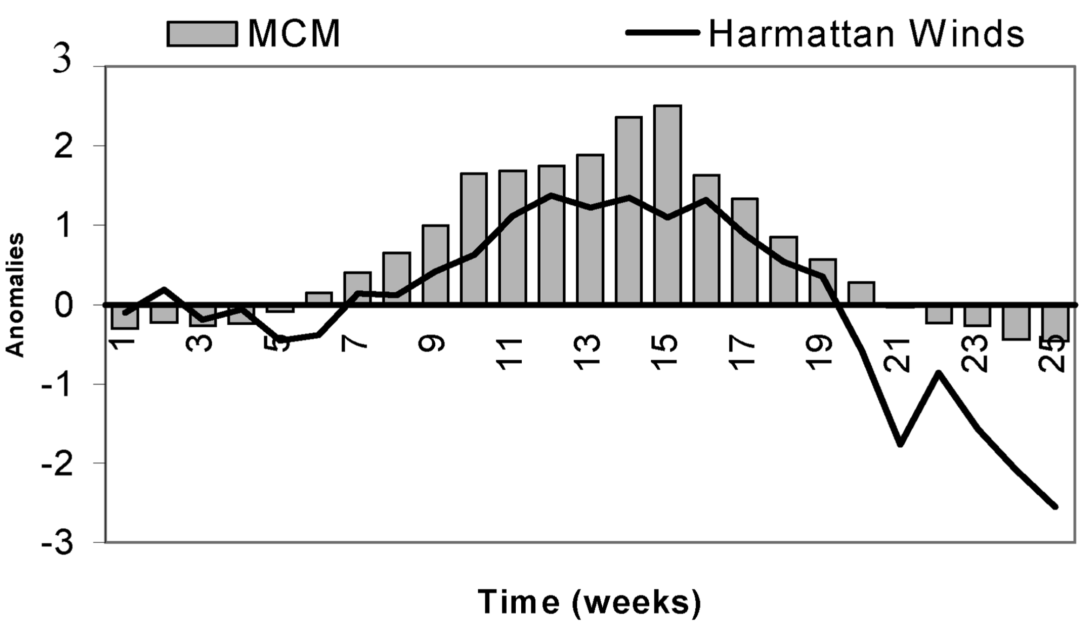
(WHO 2015)

Niger: Wind and dust patterns used to forecast meningitis risk

Research in Niger considered the early season incidence of meningococcal meningitis together with wind, dust concentrations and population density, suggesting a basis for statistical forecast modeling of meningitis risk. The analysis point the way to an early warning system alert for conditions potentially conducive to an epidemic (Perez Garcia-Pando et al., 2014).

Meningitis and weather patterns

Forecasts related to ENSO and the Pacific Decadal Oscillation (PDO), a recurring pattern of ocean-atmosphere climate variability centered over the mid-latitude Pacific basin, may help predict meningococcal meningitis outbreaks in Africa. Researchers analyzed meningitis incidence within a season, between years and over decades in the context of ENSO and PDO events, looking specifically at related rainfall anomalies. Meningitis outbreaks were associated with a warm climate regime and strong El Niño events, when rainfall totals were lower than normal. The research points to the potential value of using satellite-derived data and observations of weather patterns to provide early warnings for meningitis outbreaks (Oluwole 2015).



Temporal patterns of epidemics and climate

Weekly means of the Harmattan wind index over the 1994-2002 period and mean seasonal pattern of the number of cases of meningococcal meningitis (MCM). Increased winds correlated with an increase in MCM cases.

Source: Sultan et al., 2005

Cholera and Diarrheal Disease

Cholera

Cholera, a waterborne illness largely eliminated from industrial countries by water and sewage treatment over a century ago, still remains a significant cause of illness and death in many African countries. Cholera transmission is closely linked to inadequate environmental management. Typical at-risk areas include peri-urban slums, where basic infrastructure is not available, as well as camps for internally displaced persons or refugees, where minimum requirements of clean water and sanitation are often not met.

The rapid urbanization taking place across the African continent, often through poorly planned settlements and limited services, will continue to exacerbate cholera risks.

Research since the release of IPCC AR5 details the significant influence of weather and climate on the frequency of outbreaks. Specifically, the research points to important links between El Niño events and cholera outbreaks. ENSO, the periodic flow of warm sea water across the surface of the central and eastern Pacific Ocean, can lead to higher atmospheric temperatures and heavy rains in some areas. When these conditions are coupled with a rise in temperatures caused by climate change, ideal conditions are created for the bacterium that causes cholera to multiply, increasing the risk of outbreaks.

Nearly every year since 1977, outbreaks have occurred in Burundi, Rwanda, Democratic Republic of Congo, Tanzania, Uganda and Kenya (Bompangue et al., 2011). Between 1978 and 2008, during seven abnormally warm El Niños, all but one coincided with an increase in cholera outbreaks. Most of these were focused on hotspots along the shores of Lakes Kivu, Albert, Edward, Victoria and Tanganyika, Between these events, cholera risk either decreased or remained stable, clearly demonstrating the increased burden from cholera during El Niño events.

Cholera in coastal cities

Cholera is often imported from coastal estuaries, lagoons, mangrove forests and islands to coastal cities. Outbreaks start in densely populated slum areas before spreading to adjacent urban regions. The seasonality of cholera incidence is linked to heavy rainfall and floods, which brings contaminated water and sewage into sources used for drinking, bathing and washing. Seasonal activities such as fishing may also increase the incidence. Yet lulls lasting several years are repeatedly recorded, even in high-risk coastal areas, suggesting other factors are also at play in increasing disease burden.

Photo: European Commission DG ECHO

Research Snapshots

Senegal: Early warnings using sea surface temperatures and rainfall anomalies show promise

A week of heavy rains during Senegal's deadly 2005 cholera outbreak correlated with a substantial increase in cholera cases. Researchers compared rainfall patterns between 2002 and 2005 with sea surface temperatures in the Atlantic Ocean and precipitation over Senegal to understand the 277 mm of abrupt and heavy precipitation received in the greater Dakar area. The number of reported cases jumped from 15 to 123 per day during this period. Approximately 32,000 people contracted cholera; 458 of them died. A cross-correlation analysis showed a strong link between rainfall intensity and the increase in cases, with cases appearing 23 days later. The authors concluded that high-resolution rainfall forecasts at sub-seasonal time scales could provide the basis for an early warning system for cholera outbreaks (de Magny et al., 2012).

Zanzibar: Forecasting outbreaks

Cholera outbreaks were statistically linked to rainfall and temperature dynamics in this small island that forms part of Tanzania. A model based on surveillance reports from 1997-2006 and remotely and locally sensed environmental data showed also that a time lag exists between temperature and rainfall thresholds and disease outbreak.

For example:

- A 1°C increase in temperature over a 4-month lag translated into a two-fold increase in the number or reported cases.
- An increase of 200 mm of rainfall > 2-month lag > translated into a 1.6-fold increase in the number of reported cases.
- Temperature + rainfall interactions > 1-month lag > showed a significant statistical association with the number of reported cases (Reyburn et al., 2011).

Diarrheal disease

A comparison of health data from 1974-2003 with climatic variables suggested a cyclical pattern for diarrheal diseases in Botswana, with peaks in the wet season (March) and dry season (October). Rainfall, minimum temperature and vapor pressure (an indicator of evaporation) predicted diarrheal outbreaks with a one-month lag. Diarrheal case incidence during the dry season was on average 20 percent higher than the yearly mean. The results suggest that hot, dry conditions, which are projected to begin earlier in the season in Botswana and last longer, may increase dry season diarrheal disease, while incidence would likely decline in the wet season (Alexander et al., 2013).

Photo: European Commission DG ECHO

A study on Tanzania found that 1°C rise in temperature increases cholera risk by 15 to 29 percent, and that based on climate change projections, by 2030, Tanzania may see a rise in costs associated with cholera equivalent to 1.4 percent of GDP.

(Trærup et al., 2011)

Heat Stress

Recognized as a leading cause of weather-related deaths in the developed world, heat stress has begun to garner attention as a significant health risk for the African continent. Heat-related health effects are of growing concern as temperatures rise for the foreseeable future under a changing climate. Higher ambient temperatures have been linked with increased mortality, particularly in children and the elderly, across Ghana, Burkina Faso and Kenya (Niang et al., 2014).

Mortality rises due to prolonged exposure to excessive heat and/or the worsening of chronic conditions such as cardiovascular and respiratory diseases. Heat stress can also cause disabilities from heat stroke, exhaustion and diseases due to dehydration, such as kidney disease.

Historically, it was assumed that people in tropical climates were better adapted to heat stress than those living in more temperate zones. But recent research shows that the metabolic effect of excessive heat exposure is the same regardless of where humans live, even when adjusted for acclimatization. According to one study, even modest global warming could expose a significant percentage of the world's population to unprecedented heat stress. The findings suggest that because a human's core body temperature – approximately 37°C – is the same globally regardless of climate, prolonged exposure to high heat would have the same effect in disrupting the body's ability to cool itself (Sherwood and Huber 2010). This has important implications for Sub-Saharan Africa, where heat waves, seasonal temperatures and warmer nights are expected overall.

The socioeconomic impacts of heat stress related to declines in worker productivity and reduced agricultural livelihoods are likely to have spillover health effects. In fact, research suggests that the impact of heat stress on human health and workplace productivity is a neglected yet potentially major negative effect of climate change, particularly in low- and middle-tropical countries. One study estimated hourly productivity at various levels of exertion by mapping increasing heat exposure against measures of occupational heat stress. Using a widely-accepted U.S. Army standard known as the Wet Bulb Globe Temperature (WBGT), the study found that work capacity rapidly declines as WBGT exceeds 26°C-30°C. A worker engaged in heavy or very heavy work at a WBGT of 31.5°C or 31°C would be able to work for 15 minutes of every hour. To maintain economic and social development in affected countries, preventive measures would be required in workplaces and in planning. But that type of adaptation is likely to be difficult in outdoor environments (Kjellstrom et.al, 2009).

Just as it affects the human body, heat stress has deleterious effects on livestock and wild game, both of which contribute significantly to livelihood resources across much of Africa. As noted earlier in this report, excessive heat also lowers crop production. Both of these are significant in terms of potential decreases in food supply and household incomes, critical drivers of undernutrition on the continent.

Photo: Carsten ten Brink

The human body is designed to maintain a core body temperature of 37°C. A person engaged in physical activity generates heat inside the body. The temperature of the skin is typically a few degrees less than core temperature, around 35°C, enabling the body to release heat via sweat to cool itself. With sustained skin temperatures over 95°C, an individual may experience cramps or heat stroke. When skin temperatures reach 37–38°C, even acclimated and fit individuals would be at risk of death. Recent research concluded that extended exposure to high temperatures, causing skin temperature to exceed 35°C for sustained periods, would be intolerable.

Response Opportunities

Source: European Commission DG ECHO

Policy Response

In view of the growing evidence for the health impacts of climate change, how should governments respond?

Climate change is fueling changes in temperature and precipitation patterns, and in the frequency and intensity of extreme weather and climate events. These changes are already increasing morbidity and mortality, with many disease burdens expected to increase as the climate continues to change. Yet the magnitude and pattern of future health outcomes will depend not just on how the climate evolves but also on the extent to which health systems are prepared to manage these changes.

In theory, national health systems should be well-positioned to manage changing patterns of climate-sensitive health outcomes because most of the concerns are tied to existing challenges. For example, extensive policies and programs are already in place across the African continent to manage malaria, diarrheal disease, undernutrition and other infectious diseases. However, few countries are planning for the specific health impacts arising from climate variability and change. For example, disease-specific national action plans pay little or no attention to how climate change could alter future patterns of risks. Adding to the concern, the countries expected to be hit hardest by climate-driven health declines are also those whose health systems already face significant challenges. Nevertheless, experiences are emerging from pilot initiatives that provide lessons on how to build resilience to climate risks in the health sector. Two examples are pilot programs in Kenya and South Africa's experience in integrating climate risks into their national strategy.

A significant level of effort and expertise has been placed in developing the framework resources required to support national governments and to build political will for action on climate risks. Adaptation projects funded under the United Nations Framework Convention on Climate Change and through bilateral agreements are helping countries build the internal collaborations needed to develop key surveillance mechanisms and early warning systems. Kenya, for example, deployed a malaria early warning system as a result of this work. As more countries conduct vulnerability assessments and engage in adaptation pilots, best practices and lessons learned in the African context will emerge, offering a guide to other countries on how best to manage the health risks of climate change.

A climate-resilient health system is...

A system that is able to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stress, and to bring sustained improvements in population health, despite an unstable climate.

Climate resilience requires:

- Reducing vulnerability by providing universal access to essential services
- Building capacity to understand and manage health risks of climate change
- Considering short-, medium-, and longer-term perspectives of climate and development
- Implementing adaptive management approaches, a structured and iterative process of decision making, and information systems to understand and manage health risks and
- Enabling community-based partnerships and participation.

Frameworks for Action

At the International Level...

Libreville Declaration

In 2008, AMCEN, the Africa Ministerial Conference on Environment, reaffirmed member countries' commitment to all conventions and declarations relevant to health and environment, specifically recognizing the risks that climate change, industrial expansion and new technologies imply for the continent. The Libreville Declaration aims to leverage law and policy, national strategies, binational and regional cooperation, and budget processes in support of improved governance and action related to health and climate. While progress on implementation has been slow, the declaration offers an overarching framework for countries to design policies on climate and health.

WHO Action Plan

The Adaptation to Climate Change in Africa Plan of Action for the Health Sector 2012-2016 (WHO Africa Regional Office of 2012) outlines a series of goals for countries to focus on with regard to strengthening core national health capacities in the short and long term to respond to climate change threats to human health, build the evidence base and share lessons learned.

ClimHealth Africa (www.climhealthafrica.org)

Supported by the WHO's Africa Regional Office, ClimHealth Africa is a network of institutions working on climate change and health. The group holds annual meetings with the aim of building capacity, expanding network partnerships, reviewing key priorities and opportunities to showcase climate and health research in Africa.

Operations Framework for Building Climate Resilient Health Systems (WHO 2015)

This framework is designed to help ministries of health enhance the capacity of health systems in the face of climate variability and change. Several focus areas are highlighted, including: how to help health professionals and other key stakeholders understand and prepare for climate-related health risks; identifying the health system functions that need strengthening; and developing and implementing the health components of a national adaptation plans (H-NAPs).

At the National Level...

Health-National Adaptation Plans (H-NAPs)

National Adaptation Plans, which articulate goals and policies for preparing for and managing the risks of climate change, are increasingly tailored to address health effects. WHO is using the UN's 2012 guidance on NAPs to support ministries of health in Malawi and Tanzania to develop H-NAPs through the Global Framework for Climate Services (http://www.who.int/globalchange/projects/gfcs/en/).

Vulnerability and Adaptation Assessment

A methodological series of tools that support the identification of current and future vulnerabilities of the health sector to a changing climate, offering policies, programs and projects to avoid, prepare for and respond to risks. Both the WHO (2012) and European Centre for Disease Prevention and Control (2010) offer guidance on conducting health-centered vulnerability and adaptation assessments.

Health Impact Assessment

A method used to evaluate the potential health effects of a proposed plan, project or policy (WHO 2015b). Adapted from the transport, agriculture and housing sectors, the method has been used to develop recommendations on increasing positive and minimizing adverse health outcomes. A small but growing body of literature advocates for these assessments as a decision-support tool over vulnerability assessments based on the familiarity of many ministries of health with health impact assessment processes (Brown et al., 2011; Brown et al., 2014; Patz et al. 2008; Turner et al., 2013).

Situation Analysis and Needs Assessment (SANA)

Used by many African ministries of health to identify priority needs, this tool is being adapted to evaluate climate change risks. In Kenya in 2009, a SANA was used to support climate change and health work under the Libreville Declaration. It covered environmental risks to human health and ecosystems, the national framework for environmental impacts, inter-sectoral programs related to poverty reduction, national capacities, knowledge management, surveillance, monitoring and evaluation, advocacy and resource mobilization and allocation.

Country Experiences

Nigeria: Momentum at the federal level

Nigeria has made progress in developing a National Adaptation Policy, Strategy, and Plan of Action that details climate-related impacts on human health (Doumbia et al. 2014). For example, within the health and sanitation section of the plan, climate change is mentioned in terms of more research, improved prevention and treatment, increased disease surveillance, and specific efforts to improve wastewater and solid waste management and reduce heat impacts. Some states are piloting a "cool communities" program to counter rising temperatures, involving tree planting and heat-reducing architecture strategies for homes and work spaces.

South Africa: Action on many levels

South Africa has taken the policy response to climate change seriously, with policies including a National Climate Change Response, two provincial climate change policies (KwaZulu Natal and Western Cape), and two municipal plans in cities within those provinces (Durban and Cape Town).

Among these strategies are several ambitious goals:

- Reduced respiratory diseases through better air quality
- Inclusion of nutritional policies, health care infrastructure and education in all health adaptation strategies
- Public awareness campaigns on the health risks of high temperatures as well as malaria and cholera
- "Heat-Health" action plans
- Improved surveillance and data collection
- Improved bio-safety of malaria control
- Increased study of the costs of climate change
- Increased pressure on political leader to champion climate-health policy

In 2012, researchers reviewed the public health impact of these policy responses, concluding that they were still at an early stage of development at all levels of government. They recommended increased use of data for decision making and priority attention to research on the associations between weather variables and health outcomes and policy development for the climate-sensitive health outcomes causing the largest disease burdens.

AfricaInteract (www.africainteract.coraf.org)

This platform aims to provide information to policy makers on successes and lessons learned in enhancing the resilience of vulnerable populations. Key questions relate to policy maker knowledge of climate change adaptation in the health sector, availability and use of health-specific evidence for decision making, major research gaps, and stakeholder engagement in research and policy on climate change adaptation in the health sector. Reviews were conducted related to research and policies on climate change adaptation in West, Central, Southern and East Africa (Amis et al., 2014; Doumbia et al., 2014; Githeko et al., 2014; Sogoba et al., 2014).

Ongoing challenges

Experience is lacking

Few health professionals have the knowledge and training to incorporate climate change into their national health strategies and disease-specific policies and plans.

Where to start?

Countries often need help prioritizing the range of climate-sensitive health outcomes in the context of national strategies and ongoing policies and programs.

Not at the table

While other sectors may be forging ahead, health ministries may not participate in national climate change teams. Or they may have a limited history of coordination and collaboration with meteorological services and decision makers in agriculture, water and other sectors whose adaptation and mitigation decisions could yield health benefits—or harms.

Looking ahead:

Gaps in knowledge and capacity on health and climate

This report illustrates climate threats to health and development investments and highlights opportunities to achieve health targets in Sub-Saharan Africa in the face of climate change. Proactive and effective interventions in climate-sensitive health areas will likely result in decreased risk of morbidity and mortality. The recommendations below, structured around three categories of investments, aim to increase the resilience of health systems in Sub-Saharan Africa to climate variability and change. The two-fold task of understanding climate impacts on human health and integrating this information into decision-making is in its infancy. Future work must build on the research reported here and elsewhere.

Prioritizing research and resources

- ***To succeed in responding to and avoiding adverse impacts, critical knowledge gaps must be closed.*** When compared to other parts of the world, research on Africa-specific climate impacts and vulnerability is lagging. Without a major expansion of the evidence base – particularly on key burdens such as vector and water borne diseases – health specialists will continue to lack the technical knowledge, skills and institutional know-how required to address health-specific climate change impacts.

- ***Tested and reliable means are needed to map and identify hotspots of risk for specific health problems.*** Climate variability and change clearly threaten human health. Nevertheless, given the many demands for resources to address basic health care, it is not possible to invest in responses to these risks in every location across the continent. Regions that face greater health-related risks from climate variability and change should be prioritized. To choose where to focus investments, decision-makers need a way to visualize the location of climate-related health risks, such as hotspot mapping.

Source: European Commission DG ECHO

Responding to the risk

- ***Climate issues should be considered early in the process of development planning and project design in the health sector.*** A strong knowledge base of how climate variability and change can impact human health will provide a foundation for decision-making to reduce related risks. This approach yields a clear context for interventions, which can be incorporated into decision-support tools, priorities and planning early enough to be effective later. Experience to date suggests that "soft" investments focused on predictive tools to inform early warning initiatives, capacity building and institutional strengthening can be just as important as "hard" investments, such as overhauling water resource infrastructure.
- ***Decision support tools that integrate climate into health sector actions need to be developed and disseminated.*** Many adaptation strategies that aim to reduce the risks posed by climate variability and change on health systems may look similar to "good" development measures; for example: improving access to care, developing treatment guidelines, delivering timely and appropriate interventions and training staff. The climate lens, however, may shift priorities in important ways, placing more emphasis on surveillance and targeted response than before. Nevertheless, there are clear cases where climate risks will force even the most resilient health systems to explore new responses. In either case, real challenges remain when operationalizing these risks and addressing potential opportunities. For example, earth observation systems are now able to provide timely information on regional weather patterns that can potentially exacerbate or spread disease. The challenge is how to use this information to determine the ways in which investments in vector surveillance and treatment, for example, could become more effective and efficient in deploying already limited resources.

Promoting adaptation

- ***Promising approaches to adaptation should be widely shared.*** A diverse and increasing range of innovative measures to respond to climate risks are being piloted across the continent. By and large, these are unknown to those not directly involved in their implementation. Helping to catalyze learning about what works and does not work in different African contexts, communities, nations and regions is key for successfully limiting the risk of climate change on human health continent-wide. More effort is needed to promote the upscaling and use of promising responses to shared or similar challenges

Source: US Army Africa

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