Anthropogenic Climate Change Impacts on Africa

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Abstract

Anthropogenic climate change caused by excess carbon dioxide is a global threat to human and ecological health and biodiversity. Africa, whose countries produce the least amount of carbon emissions in the world, will suffer the most from climate change effects caused by carbon production from industrialized countries. Kyoto protocol 2012 goals call for global emissions to return to pre-1990 levels; instead, levels continue to increase. The UNFCCC has recognized Africa's unique adaptation needs. Decreased rainfall and extreme weather patterns are the most serious threats to sustainability in countries subject to drought, flooding and widespread land degradation. Socio-economic development is profoundly compromised by the scarcity of water resources that hold the continent in a cycle of poverty, malnutrition, and disease. The incidence of malaria and other infectious diseases is predicted to rise with the increase of favorable environments created by increased humidity, temperature changes, flooding, and migration of vectors to non-endemic areas. Adaptation and disaster prevention have been identified as the most important components of any climate change plan for Africa. The countries of the African Union are working toward a harmonized plan to address anthropogenic climate change. However, international assistance and co-operation will be required for long-term plans to be effective. ***Proszynski DM. Anthropogenic Climate Change Impacts on Africa. Med J Therapeut Africa. 2007;1:69-75.***

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Introduction

Carbon dioxide (CO_2) emissions are the primary

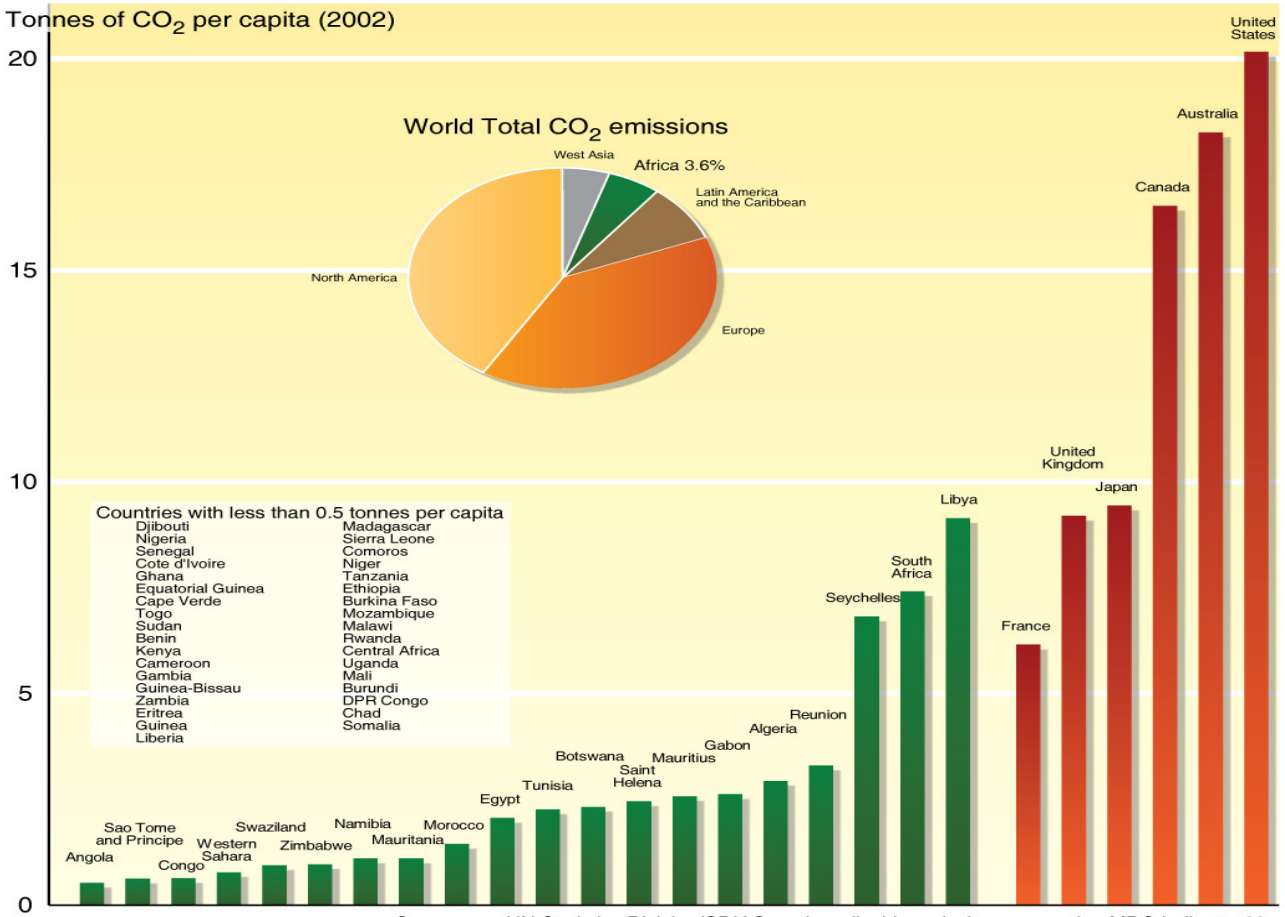


Figure 1. CO_2 emissions in African countries compared with the rest of the world.

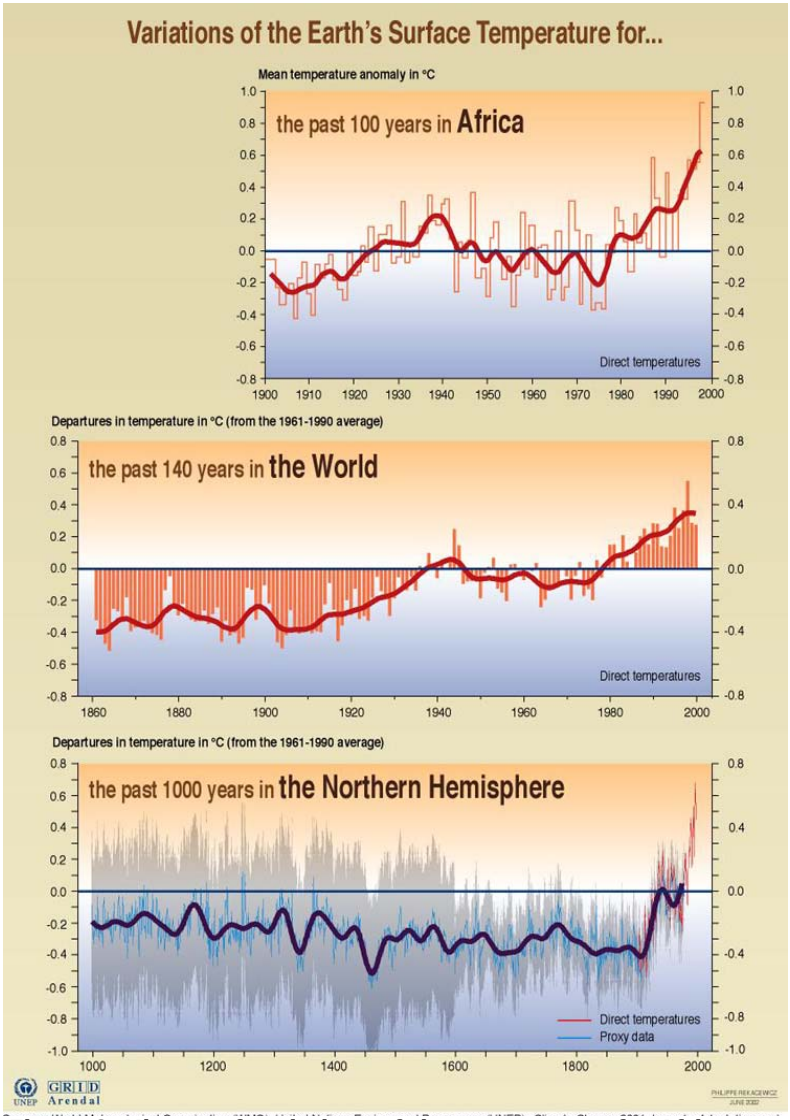


Figure 2. History of variations of the temperature for Africa in relation to the world

cause of anthropogenic climate change, more commonly known as global warming. Africa is home to about 14% of the world's population living on 20% of the world's total land area, and produces about 3.6% of the total yearly CO_2 emissions on the planet, Figure 1. As well as the ethical issues this poses for carbon-using industrialized countries, several critical points require consideration:

1.Because of constrained water resources, widespread poverty, underdevelopment, lack of technology, political conflict, and disease, Africa will suffer the most from anthropogenic climate change.(1)

2.Africa's climate system plays an important role in the global climate system due to its large size and high climate variability.(2)

3.Although most of Africa is still rural, its countries are undergoing the highest rate of urbanization in the world in addition to a high population growth and will need to confront and manage the negative effects of an increasing carbon load.

4.The situation is far more acute than was previously realized and a tightening of the Kyoto protocol 2012 goals for curtailing greenhouse gas (GHG) emissions may be required to meet the increased environmental threat.(2)

All poor and underdeveloped countries will suffer the most. Climate change has the potential to cripple sustainable development by adversely impacting the environment, human health, ecosystem health and diversity, food production and security, and economic activity. International responsibility to Africa's special adaptation needs regarding anthropogenic climate change have been noted since the adoption of the UN Framework Convention on Climate Change (UNFCCC) and numerous other climate change and socioeconomic programs since.(3) According to the second report on Africa and global warming from the Working Group on Climate Change and Development, the costs of adaptation to climate change are estimated to be from $10 to 40 billion per year but international funding and assistance have fallen far short of that requirement.(4) A concerted international effort to decrease GHG by up to 90% within this decade may be required to prevent the possibility of cataclysmic climate change, yet global emissions continue to rise.(4)

The Greenhouse Effect

The greenhouse effect is a natural phenomenon created by a balance of energy between absorbed visible radiation, or sunlight, and invisible infrared radiation emitted into space by the earth. Some of that infrared radiation is pushed back down into the atmosphere by water vapor, CO_2, methane, and other greenhouse gases, causing it to warm the surface of the earth and make it habitable.(5) However, the addition of excess carbon emissions and other pollutants into the atmosphere intensifies this effect by adding man-made CO_2, methane, and nitrous oxide to natural atmospheric CO_2 (thereby diluting it) and further warming the earth's surface.(5)

While the natural greenhouse effect enables life on earth, increased temperatures caused by human activity can threaten the sustainability of the planet. Anthropogenic climate change is a reality and its effects are being felt now. The average global temperature (near surface air temperature and sea surface temperature) has increased about 0.6°C since

1861 and in Africa the temperature increased 0.7°C during the 20th century, Figure 2.(5,2) Sea surface temperatures have also increased since the 1950s and the average sea level has risen 0.1 to 0.2 m during the 20th century.(6) The 1990s were probably the warmest decade globally and 2005 was the hottest year on record. In the Northern Hemisphere, the 20th century appears to have had the greatest temperature increase of any century in the past 1,000 years, Figure 2. Average global temperatures are expected to increase from 1.0 to 3.5°C by 2100; however, the mean surface temperature of Africa is projected to increase an additional 2 to 6°C by 2100, about twice the global rate.(7,2)

Natural factors cannot explain recent warming trends and rises in sea level. These changes can be simulated when anthropogenic factors are included.(5) Evidence continues to mount that human activity is responsible for increased global warming over the past 5 decades; anthropogenic climate change and its effects are expected to continue for centuries.(6) According to the 3rd assessment report of the Intergovernmental Panel on Climate Change (IPCC), "The atmospheric concentration of CO_2 has increased by 31% since 1750. The present CO_2 concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years. The current rate of increase is unprecedented during at least the past 20,000 years".(6)

Global climate trends and patterns have proven difficult to project because of the complexity and incomplete understanding of climate processes but methods continue to improve.(6) African trends in particular have been difficult to chart because most weather and temperature data have been recorded on paper, making the information subject to loss and dramatically limiting access to scientists.(2) Early warning systems will play an essential role in Africa's ability to adapt. The current Global Climate Observing System in eastern and southern Africa is inadequate at best - 200 automatic weather stations will be needed for effective weather forecasting but most of the existing stations are either non-functioning or barely functioning.(6)

Africa's Landscape and Weather Patterns

The continent of Africa is the largest tropical landmass on the planet yet it is the second driest region in the world. About half of the arable land on the continent is arid and semi-arid, and most of that is composed of desert soil.(2) Most of Africa receives under 500 mm of rainfall per year.(8) The continent is divided into 6 climatic zones based on rainfall patterns and measurements in mm per year: equatorial (1,500 to 3,200), savanna (500 to 1,500), semi-arid (250 to 500), arid (less than 250), highland (low precipitation), and Mediterranean (250 to 1,000).(8) The multivaried terrain is subject to strong weather patterns coming from the Atlantic and Indian Oceans, the El Niño Southern Oscillation (ENSO), and the Inter-Tropical Convergence Zone (ITCZ), among others. As a result, African weather tends toward extremes and is, at baseline, quite variable. This makes the continent more susceptible to natural disasters, Figure 3.

Although Africa has many rivers and lakes, some are seasonal and situated at higher elevations. The geographic distribution of water resources in Africa is unequal and the supply is often not available where there is demand.(2) The agricultural water supply is almost entirely rainfall dependent.(8) Freshwater is

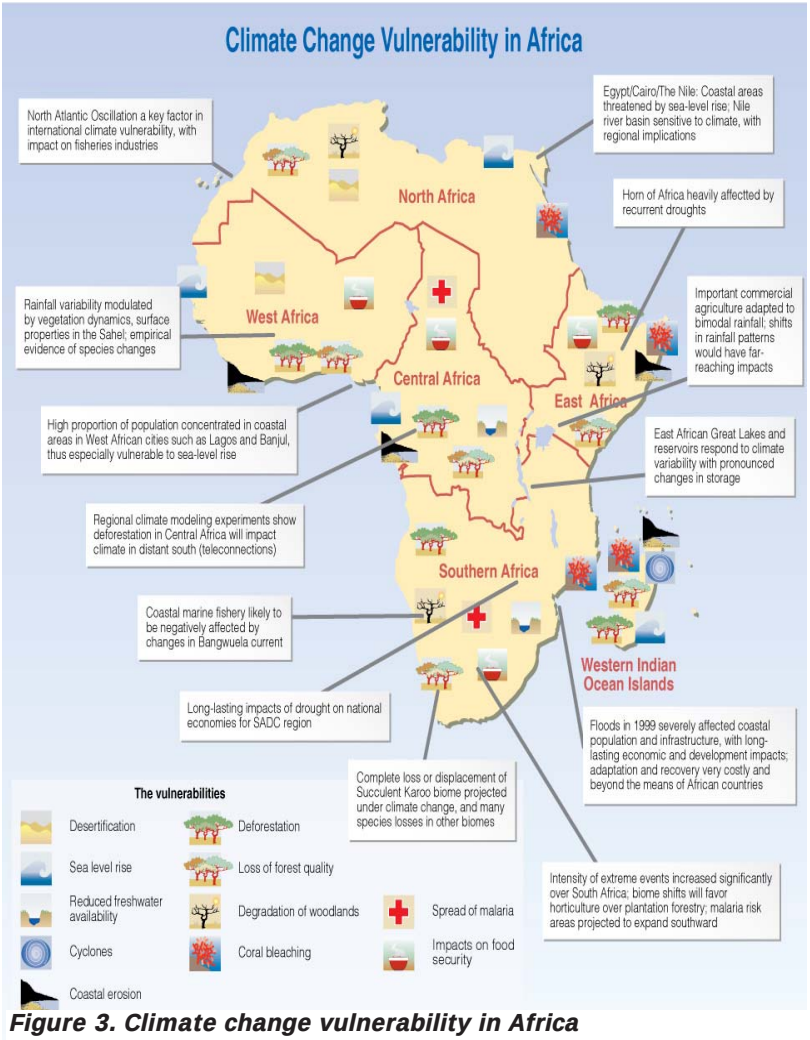


Figure 3. Climate change vulnerability in Africa

scarce; safe drinking water is even more so. Three quarters of the population use groundwater (15% of Africa's water supply) while only slightly more than half have access to safe drinking water.(2)

The most pressing concerns related to climate change in Africa pertain to rainfall variability, extreme weather patterns, and unpredictability. Average rainfall has declined since 1968, ocean temperatures have increased, and the frequency and severity of droughts and floods has increased.(8) Mountain glaciers in Africa have shrunk dramatically and many riverbeds have permanently dried as a result, decreasing water availability in those regions and possibly altering the ecosystems as well. The total glacier area on Mount Kilimanjaro in Tanzania has decreased by almost 85% from 1900 to 2000, Figure 4. The 2 main arid regions, the Sahara in the north and the Kalahari in the south are both expanding. Land degradation and desertification are increasing.

Regional Differences

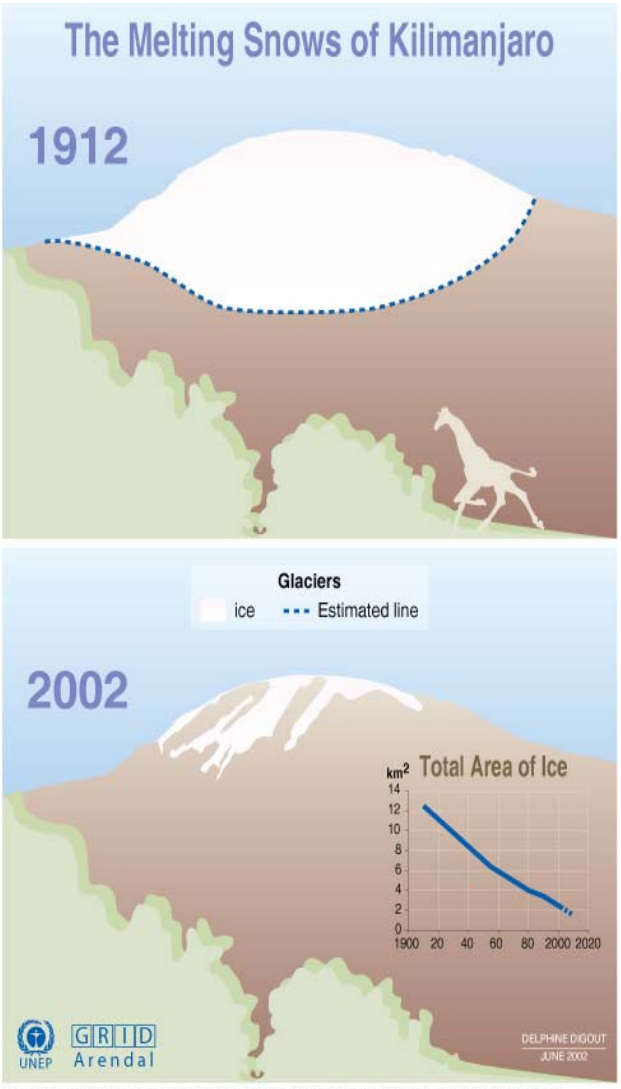
Eastern Africa (Ethiopia, Somalia, Kenya, Sudan, Uganda), with its Congo basin, inland lakes, and the eastern highlands, has a varied landscape and is influenced by a number of climatic factors, including ITCZ, the Atlantic and Indian Oceans, ENSO, cyclones, and jet streams.(8) This region has been the scene of recurring major disasters caused by long periods of drought that alternate with heavy rainfall and floods.(8) Dust storms are frequent. Decreasing rainfall in eastern Africa has been a trend since 1961.(8) Temperature increases have been most notable in the eastern highlands, in some areas up to 2°C in a matter of decades, leading to increased malaria epidemics at higher elevations.(8) Glaciers on the Ruwenzoris in Uganda and Mt. Kenya have been disappearing and seasonal mountain rivers have dried up on Mt. Kenya.(8) Eastern Africa is undergoing a high rate of urbanization with a concomitant increase in GHG emissions from transportation, industry, and household fuel, most notably charcoal production and use in Kenya.(8)

Northern Africa (Libya, Egypt, Tunisia, Morocco, Algeria) is the most industrialized region on the continent. CO_2 emissions have increased with continued urbanization and economic growth. Libya's per capita CO_2 emissions are the highest in Africa, Figure 1. Most oil refineries in Libya were built without environmental standards or pollution control systems; air pollution from industry and transport compound the situation.(8) Air pollution is up to 20 times the acceptable range in Cairo, Egypt where smog is a source of health problems. In Morocco, respiratory diseases due to pollution from traffic and industry have affected the economy through decreased worker productivity.(8) Dust is a natural air pollutant in this region.(8)

Southern Africa (Botswana, Tanzania, Mozambique, South Africa, Angola, Namibia, Lesotho, Zimbabwe) is susceptible to extreme wet and dry periods. The equatorial regions get more rain while the arid and semi-arid lands (ASAL) are particularly dependent on rainfall. Weather patterns are affected by ITCZ, which brings significant rainfall; El Niño/La Niña episodes that bring drought or increased rains; and tropical cyclones that originate in the Indian Ocean and bring heavy rains and flooding. Expected anthropogenic climate change-related effects for this region include rising temperatures that will negatively impact crop yields and a rising sea level that will invite the malaria-carrying Anopheles mosquito to non-endemic areas such as Namibia and South Africa.(8)

Western Africa has 4 climate zones that are influenced by the movement of 2 air masses:

1. the dry, hot northeasterly Harmattan that blows



Sources: Meeting of the American Association for the Advancement of Science (AAAS), February 2001 ; Earthobservatory.nasa.gov.

Figure 4. Melting snow on Mt. Kilimanjaro

through the Sahara

2. the humid southwestern monsoon that blows through the Atlantic Ocean.

The ICTZ controls the air movement of these winds and causes an unequal rainfall distribution throughout the 4 climate zones. The Sahel region (Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, and Chad) has essentially had drought since 1970. Increased dust resulting from drought has impacted the air quality of the region and possibly even the climate systems of the Caribbean and the coral reef ecosystem.(8) Climate variability in western Africa is affected by global GHG emissions far more than regional emissions, which are low, with the exception of air pollution in urban areas.(8) However, wasteful gas flaring in Nigeria and other oil producing countries in sub-Saharan Africa contribute significantly to CO_2 emissions in that region.(9) According to the Energy Information Administration, "Nigeria consistently leads sub-Saharan Africa in commercial energy consumption."(9) Oil pollution is a complex and controversial issue in the region because of the conflicting needs of economic development, the environment, and public health.(9)

The Western Indian Ocean Islands (Madagascar, Mauritius, Seychelles, Comoros) support a complex ecosystem of coastlands and coral reefs that is particularly vulnerable to the effects of climate change and human activity. Water is scarce as in the rest of Africa. The situation is exacerbated by increased urbanization and the demands of tourism, especially on Mauritius and Seychelles.(8) Malaria is a threat on Madagascar, which is subject to drought and torrential rain along with high summer humidity and stagnant flood waters.(8) These islands are affected by 2 climate systems, the ICTZ, which gives rise to tropical cyclones, and the Indian Ocean Dipole, which interacts with the increasingly prevalent ENSO to cause irreversible bleaching and destruction of the coral reef ecosystem.(8) Landslides, coastal erosion, saline contamination of freshwater sources, destruction of marine environments, natural disasters, and malaria are real threats to human life and health, agriculture, commerce, and biodiversity in this region.(8)

IMPACT ON HUMAN HEALTH

Life expectancy in Africa has been decreasing for the past 20 years, in contrast to the rest of the world where life expectancy continues to increase.(10) The World Health Organization (WHO) estimates have placed an annual toll of about 150,000 lives over the past 3 decades due to anthropogenic cli-

Disease	Vector	Population at risk (million)[1]	Number of people currently infected or new cases per year	Present distribution	Likelihood of altered distribution
Malaria	Mosquito	2,400[2]	300-500 million	Tropics and Subtropics	
Schistosomiasis	Water snail	600	200 million	Tropics and Subtropics	
Lymphatic Filariasis	Mosquito	1 094[3]	117 million	Tropics and Subtropics	
African Trypanosomiasis (Sleeping sickness)	Tsetse fly	55[4]	250 000 to 300 000 cases per year	Tropical Africa	
Dracunculiasis (Guinea worm)	Crustacean (Copepod)	100[5]	100 000 per year	South Asia, Arabian Peninsula, Central-West Africa	
Leishmaniasis	Phlebotomine sand fly	350	12 million infected, 500 000 new cases per year[6]	Asia, Southern Europe Africa, Americas	
Onchocerciasis (River blindness)	Black fly	123	17.5 million	Africa, Latin America	
American Trypanosomiasis (Chagas disease)	Triatomine bug	100[7]	18 million	Central and South America	
Dengue	Mosquito	1,800	10-30 million per year	All Tropical countries	
Yellow Fever	Mosquito	450	more than 5 000 cases per year	Tropical South America Africa	

1. Top three entries are population-prorated projections, based on 1989 estimates.
2. WHO, 1994.
3. Michael and Bundy, 1995.
4. WHO, 1994.
5. Ranque, personal communication.
6. Annual incidence of visceral leishmaniasis; annual incidence of cutaneous leishmaniasis is 1-1.5 million cases/yr (PAHO, 1994).
7. WHO, 1995.

Highly likely · Very likely · Likely · Unknown

GRID Arendal UNEP

GRAPHIC DESIGN : PHILIPPE REKACEWICZ

Source: Climate change 1995, Impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

Figure 5. Climate change and vector-borne diseases

mate change.(11) Malaria in Africa claims the lives of about 600,000 children each year.(10) Widespread illness further taxes already-overburdened economies and destroys the morale of communities.

Long-term climate change effects create favorable conditions for the spread of malaria and other vector-borne and water-borne diseases, Figure 5. The ENSO phenomenon is responsible for abnormal weather patterns that result in drought and floods and it has been linked to outbreaks of malaria in Africa, Asia, and South America.(7) In fact, the risk of a malaria epidemic increases 5 times in the year after an El Niño event.(12)

About 90% of malaria cases are in Africa. Longer breeding seasons and new habitats due to local land use changes, deforestation, changes in temperature, increased humidity, and sea level rise increase the risks for infectious disease.(13) Malaria is a preventable and treatable disease but about 70% of Africa's population lives in rural areas where mosquito control is difficult.(13) Drug resistance, host migration, misinformation, and lack of access to healthcare and preventive measures compound the problem.

HIV infection and AIDS are a serious health problem in Africa, as is tuberculosis. These immuno-compromised patients will be especially vulnerable to infectious diseases and other climate change-induced stresses. Water contamination, decreased access to already scarce safe drinking water, and increased malnutrition resulting from drought will further aggravate the already compromised health situation.(13) About 52% of the world's malnourished population already live in Africa.(6)

IMPACT ON AGRICULTURE AND BIODIVERSITY

Agriculture is Africa's main commodity. About 70% of Africans are employed in agriculture and about 90% of these workers are poor.(2) Erratic weather patterns and torrential rains, sea surface temperature (SST) increases, and deforestation have led to disruption of normal planting and growing rhythms, more drought and flooding, and further land degradation and desertification.(4) Almost 30% of global land degradation has occurred on the African continent, which comprises about 20% of the world's landmass.(2)

Increased SSTs associated with warming in the Indian Ocean and the southern Atlantic Ocean have been responsible for drought in southern Africa, severe drought in the Sahel region of central Africa and Ethiopia, and increased rainfall in the equatorial regions. Intensified ENSO patterns caused by increased warming in the central and eastern equatorial Pacific Ocean were responsible for severe drought in the Horn of Africa in 1982-83 and massive floods in eastern Africa in 1997-98 that were then rebounded by La Niña cooling activity that caused drought in the sub-region from 1998 to 2000.(4) Changes in rainfall patterns disastrously affected groundnut production in Niger, once the world's largest producer and exporter of ground nut, and Senegal faces the same risk with its groundnut industry.(8)

Overgrazing and outdated farming practices compound the problem.(2) Mono-farming leads to soil depletion; when fields are no longer viable more forest is cut down, leading to further land degradation and desertification. Deforestation is responsible for about 20 to 30% of GHG emissions.(4) More than 500,000 sq km of already constrained agricultural land in sub-Saharan Africa will become even more depleted as a result of anthropogenic climate change.(2)

Loss of plant and animal biodiversity may be irreversible and can lead to further long-range consequences for the environment and humans alike. When species are unable to migrate or adapt they become extinct and the ecosystem balance is altered, creating opportunity for more weedy plant varieties to proliferate and pathogens and destructive species to propagate without natural controls.(14) Anthropogenic climate change will potentially negatively impact over 80% of Africa's plant species with the possibility of eradicating over 40% of plant biomes by 2085.(2) African coastal areas that rely on tourism for their economies, fish populations already depleted by over-harvesting, coral reefs that play a vital role in the ecosystem, wetland areas such as the Okavanga Delta in Botswana, and montane regions will also be affected.(2)

Conclusions

Any successful climate change action plan for Africa will require the key components of adaptation, disaster prevention, and international involvement. Africa has many natural resources that can be channeled for renewable energy sources, such as solar and wind power and hydroenergy.(8) Small scale farming that uses a variety of planting methods, innovative farming practices, and the development of drought-resistant crop varieties are beginning to replace outmoded agricultural methods.(4) However, the scarcity of water for agriculture and human consumption maintains the continent in a state of crisis that prevents true socioeconomic progress.

The countries of the African Union are beginning to address the issues of anthropogenic climate change by initiating new programs and strategies, most notably the New Partnership for Africa's Development (NEPAD), which was adopted in 2001. Economic advances will bring increased GHG emissions and further environmental impacts. Unfair trade limitations, taxation practices that promote the use of dirty fuels, the importation of older cars, corruption, and lack of environmental standards and

controls for industry will compound the situation. Individual and collective governmental efforts will be required to set harmonized environmental standards and act on them. Even with continued progress the African contribution to GHG emissions will be a fraction of that incurred by the world's industrialized nations. The United States is the leading contributor of GHG emissions yet it continues to oppose the Kyoto Protocol. Many of the United States and their cities have responded to this refusal by initiating their own plans to decrease carbon emissions.

Africa will not be able to meet the threat of anthropogenic climate change without the cooperation and assistance of the international community. Assistance must meet the needs of individual communities and support "climate-proof development."(4) No progress will be made until the issues of poverty, disease, and malnutrition are addressed and resources are more equally distributed. Education, technology, and human resources will be required to develop a professional sector within Africa to study and research these issues and develop efficient systems to manage data and information.(15)

Anthropogenic climate change in Africa has the potential to effect changes in other parts of the world. Global warming is a global issue that requires global action.

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