FACTSHEET

EAST AFRICA

Climate & Development Knowledge Network

African Climate & Development Initiative

THE IPCC'S SIXTH ASSESSMENT REPORT

Impacts, adaptation options and investment areas for a climate-resilient East Africa

A farmer in Bugesera District, Rwanda. © Rwanda Green Fund

IN THIS FACTSHEET:

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IPCC confidence ratings and Africa's severe data constraints

The IPCC assigns a degree of confidence (high, medium and low confidence) to each key finding based on (1) the **robustness** (quality and quantity) of the available evidence, and (2) the **degree of agreement** among scientists. **High confidence** means that there is a high level of agreement as well as robust evidence in the literature. **Medium confidence** reflects medium evidence and agreement. **Low confidence** indicates that there is low agreement and/or limited evidence.

Africa faces severe data constraints due to under-investment in weather observation stations, research and data sharing. This hinders the analysis of regional change trends, the development of early warning systems, and climate impact and extreme event attribution studies[3]. From 1990–2019, Africa received just 3.8% of climate-related research funding globally. In Africa, scientific findings may be assigned 'low confidence' because there is relatively little data from a location and more data needs to be collected in order to strengthen the scientific assessment of a climate trend.

East Africa has already experienced widespread losses and damages from climate change

The climate has changed at rates "unprecedented in at least 2,000 years" due to human activity[1], finds the *Sixth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC).

Most African countries have contributed among the least to global greenhouse gas emissions causing climate change, yet have already experienced widespread losses and damages. East Africa is no different and is already facing loss of lives and impacts on human health, reduced economic growth, water shortages, reduced food production, biodiversity loss, and adverse impacts on human settlements and infrastructure as a result of human-induced climate change.

> **Limiting global warming to 1.5°C is expected to substantially reduce damages to damages to East African economies and ecosystems[2]**

Transformative adaptation – which includes climate risk reduction in every sphere of development – will contribute to achieving climate resilience in East Africa.

HOW EAST AFRICA'S CLIMATE IS CHANGING

The Earth's average surface temperature has already warmed by 1.09°C since pre-industrial times (1850–1900)[4]. However, East Africa's climate has warmed even more than the global average in the past few decades.

Temperature: The average annual surface temperatures over East Africa increased by 0.7°C–1°C from 1973 to 2013. Annual maximum and annual minimum temperatures have increased across the region, accompanied by significantly more warm nights, warm days and warm spells. The greatest increases are in the northern and central regions.[5]

Marine heat waves: The number of heat waves in the ocean doubled along the Somalian coastlines from 1982–20 with 90–100% probability this was the result of human-induced climate change.[6]

Rainfall: Over Equatorial East Africa, the short rains (October-November-December) became wetter from the 1960s until 2017. By contrast, the long rainfall season (March-April-May) became drier between 1986 and 2007. In the northern, summer rainfall region (June-September), there has been a rainfall decline since the 1960s, but the cause of the trend is uncertain.[7]

Extreme rainfall and flooding: East Africa has experienced strong rainfall variability and intense wet spells leading to widespread flooding events hitting most countries, including Ethiopia, Somalia, Kenya and Tanzania (medium confidence).[8]

Drought: Since 2005, drought frequency has doubled from once every six to once every three years. Drought has also become more severe during the long and summer rainfall seasons than during the short rainfall season. Several long droughts have occurred predominantly within the arid and semi-arid parts over the past three decades.[9]

Glaciers: Glaciers on Mount Kenya decreased by 44% between 2004–2016. On Kilimanjaro, glaciers declined by 4.8 km^2 in 1984 to 1.7 km^2 in 2011. On the Rwenzoris, they decreased from ~2 km^2 in 1987 to ~1 km^2 in 2003.[10]

EAST AFRICA'S FUTURE CLIMATE

The Earth's average surface temperature is expected to reach or surpass 1.5°C of warming above pre-industrial times in the near-term (up to 2040).[11]

Future scenarios (Table 1) measure warming as global averages, and warming at local and country level is expected to be higher than these averages. Most African countries are expected to experience high temperatures unprecedented in their recent history earlier this century than generally wealthier countries at higher latitudes (high confidence).[12]

> **Climate change has increased heat waves and drought on land, and doubled the probability of marine heat waves around most of Africa[13]**

Table 1 Changes in global surface temperature

Global warming scenario according to emissions levels, showing best estimate, °C (very likely range, °C[14]	Near-term, 2021–2040	Medium-term, 2041–2060	Long-term, 2081–2100
Very low emissions (net zero carbon dioxide emissions by 2050)	1.5°C (1.2–1.7°C)	1.5°C (1.2–2°C)	1.4°C (1.0–1.8°C)
Low emissions	1.5°C (1.2–1.8°C)	1.7°C (1.3–2.2°C)	1.8°C (1.3–2.4°C)
Intermediate emissions	1.5°C (1.2–1.8°C)	2°C (1.6–2.5°C)	2.7°C (2.1–3.5°C)
High emissions	1.5°C (1.2–1.8°C)	2.1°C (1.7–2.6°C)	3.6°C (2.8–4.6°C)
Very high emissions	1.6°C (1.3–1.9°C)	2.4°C (1.9–3.0°C)	4.4°C (3.3–5.7°C)

Note: Changes in global surface temperature are assessed based on multiple lines of evidence, for selected 20-year time periods and the five illustrative emissions scenarios considered. Temperature differences relative to the average global surface temperature of the period 1850–1900 are reported in °C.[15]

Temperature: At 1.5°C, 2°C and 3°C global warming, annual average surface temperatures in East Africa are projected to be higher than the global average. The highest increases are projected over the northern and central parts, and the lowest over the coastal regions.[16]

Extreme heat and heat waves: Hot days are projected to become more frequent and intense from 2°C global warming and above, with larger increases at higher warming levels. A 4.6°C global warming, a 2,000-fold increase in exposure to dangerous heat (over 40.6 °C) is projected for a number of East African cities, including Kampala. Children born in East Africa in 2020 will, under 1.5°C global warming, be exposed to 3–5 times more heat waves in their lifetimes than those born in 1960.[17]

Marine heat waves: Increases in the frequency, intensity, spatial extent and length of marine heat waves are projected for all Africa's coastal zones.[18]

Rainfall: Increased average annual rainfall, particularly in the eastern parts, is projected at 1.5°C and 2°C global warming. In other parts of East Africa, no significant trend is evident and there is low agreement in the evidence.[19]

Extreme rainfall: Heavy rainfall events are projected to increase at global warming of 2°C and higher (high confidence).[20]

Drought: Drought frequency, length and intensity are projected to increase in Sudan, South Sudan, Somalia and Tanzania, but decrease or not change over Kenya, Uganda and the Ethiopian highlands.[21]

Glaciers: Glaciers are projected to disappear by 2030 on the Rwenzoris and Mount Kenya, and by 2040 on Kilimanjaro (medium confidence).[22]

CLIMATE CHANGE IMPACTS WE HAVE ALREADY SEEN IN EAST AFRICA

The multiple dimensions of poverty and wellbeing – people's health, nutrition, education, security of food, water and shelter and economic development – are now all affected by climate change. The natural environment is also deeply affected. Addressing climate change effectively depends on viewing climate, people and biodiversity as interlinked systems.[23]

Human life and health

- Climate variability and change already affect the health of tens of millions of people in East Africa and across the continent, by exposing them to high temperatures and extreme weather, and increasing the range and transmission of infectious diseases (high confidence).[24]
- Recorded death rates have been above normal on days with raised temperatures in Kenya and Tanzania – most commonly because of cardiovascular disease. Respiratory, stroke and non-communicable diseases have also been linked with heat.[25]
- There are already large inequalities in people's health – due to their economic status, social behaviours, and where they live (rural people have worse access to quality healthcare services). Climate change magnifies these existing health inequalities. The health impacts of climate change disproportionately affect people with the lowest incomes and, in many cases, impacts differ by gender and age, too.[26]
- The most vulnerable are young children (younger than 5 years old), the elderly (over 65 years old), pregnant women, individuals with pre-existing illness, physical labourers and people living in poverty or affected by other socioeconomic determinants of health (high confidence).[27]
- The climate conditions are already optimal for transmission of malaria along the coast of East Africa. Malaria-bearing mosquitos have now expanded their range to higher altitudes in the region and are increasingly infected with *P. Falciparum*, the deadliest malaria strain (high confidence).[28]
- Malaria outbreaks in East Africa have been linked to both moderate monthly rainfall and extreme flooding.[29]

Ecosystems and biodiversity

- Increasing carbon dioxide levels are destroying marine biodiversity (high confidence). Impacts include repeated mass coral bleaching events in East Africa.[30]

- Increased carbon dioxide levels in the atmosphere and climate change are influencing the growth of natural vegetation across African landscapes. Woody plants (shrubs and trees) are expanding their range, particularly into grasslands and savannahs. This is a new area of scientific understanding and consensus since the IPCC's *Fifth Assessment Report* in 2014.[31]
- Human activity (tree clearance or planting) also plays a large role in modifying land-based ecosystems: 37% of changes mapped in Africa's vegetation cover are driven by climate change and increased carbon dioxide; the rest by direct land management.[32, 33]

- Vegetation changes affect animal species. For instance, bird, reptile and mammal species that depend on grassland habitats become rarer, as woody plants spread.[34]

- Small changes in the climate have had a large impact on freshwater ecosystems. Temperatures in East African freshwater bodies rose by 0.1–0.3°C in a decade; but with higher heating of 0.4°C per decade or more in lakes such as Lake Victoria and Lake Tanganyika.[35] Increases in temperature, changes in rainfall, and reduced wind speed altered the physical and chemical properties of inland water bodies, affecting water quality and productivity of algae, invertebrates and fish (high confidence).[36]

Food systems

- Climate change is reducing crop productivity in East Africa. Maize and wheat yields decreased on average 5.8% and 2.3% respectively across sub-Saharan Africa from 1974–2008, due to climate change.[37] Climate change has slowed the growth of agricultural productivity in Africa by 34% since the 1960s, the highest impact of any region. Two thirds of people across Africa perceive that climate conditions for agricultural production have worsened over the past ten years.[38] Africans are disproportionately employed in climate-exposed sectors: 55–62% of the sub-Saharan workforce employed is in agriculture and 95% of cropland is rainfed.[39]

- Encroachment by woody plants (shrubs and trees) on important grazing lands has reduced the availability of fodder for livestock.[40] Increased temperature and rainfall are contributing to the expanding range, in East Africa, of several tick species that carry economically-harmful livestock diseases.[41] Increased livestock mortality and livestock price shocks have been associated with droughts in Africa, as well as being a potential factor in localised conflicts.[42]

- Fish are the main source of animal protein and key micronutrients for approximately 200 million people in Africa. However, climate change poses a major threat to marine and freshwater fisheries and aquaculture. This is leading to changes in the productivity of fisheries, in abundance of fish in lakes and rivers and altered distribution of fish species in the oceans.[43]
- There are reduced fish catches in Lake Tanganyika, which are partly explained by warming air and water temperatures – causing reductions in or redistributions of primary productivity.[44]

- Droughts induced by the 2015–2016 El Niño, partially attributable to human influences (medium confidence), caused acute food insecurity in various regions, including eastern and southern Africa.[45]
- Between 2015 and 2019, an estimated 45.1 million people in the Horn of Africa and 62 million people in eastern and southern Africa required humanitarian assistance due to climate-related food emergencies. Children and pregnant women experience disproportionately greater adverse health and nutrition impacts (very high confidence).[46]

Water for people

- Rainfall and river discharge have been extremely variable in East Africa recently, as in the rest of Africa – between 50% above and 50% below historic levels. This has caused deep and mostly negative impacts across water-dependent sectors: from freshwater supply to people and agriculture, to availability of water for hydropower and tourism.[47]
- Water levels in Kenya's mostly shallow rift lakes have been rising since 2010, with some exceeding historical record high levels. This rising trend is partly attributed to increased rainfall and changing land uses.[48]

Economies

- Increasing average temperatures and lower rainfall have reduced economic output and growth in Africa, with larger negative impacts than other regions of the world (high confidence). As such, global warming has increased economic inequality between temperate, Northern Hemisphere countries and those in Africa.[49]
- In one estimate, African countries' GDP per capita was on average 13.6% lower over the period 1991–2010 compared to if human-induced climate change had not occurred (see Figure 1).[50]

Figure 1 Percentage change in GDP per capita in East African countries due to observed climate change (1991–2010)[51]

Human settlements and infrastructure

- East Africa's settlements are particularly exposed to floods (from both rain and river flows), droughts and heat waves. Other climate hazards are sea-level rise and storm surges in coastal areas, tropical cyclones and thunderstorms.[52]
- Economic opportunities, transportation of goods and services, and mobility and access to essential services, including health and education, are greatly hindered by flooding. People's exposure to flood shocks is associated with an increase in extreme poverty.[53]
- Severe impacts from tropical cyclone landfalls have been recorded in East and southeastern Africa.[54]

Education

- Low rainfall, warming temperatures or extreme weather events have reduced children's educational attainment. If bad weather reduces income in agriculture-dependent households, adults may withdraw children from school. Poor harvests or interruptions in food supply – due to extreme weather – may also lead to undernourishment in young children, which negatively affects their cognitive development and schooling potential.[55]
- In Uganda, low rainfall reduced primary school enrolment by 5% for girls. In rural Ethiopia, boys and girls achieved more in school when the main agricultural season had more rainfall and milder temperatures.[56]

Migration

- Climate-related displacement is widespread in Africa, with increased migration to urban areas in sub-Saharan Africa linked to decreased rainfall in rural areas, increasing urbanisation and affecting household vulnerability.[57]
- Over 2.6 million and 3.4 million new weather-related displacements occurred in sub-Saharan Africa in 2018 and 2019, with East Africa (1,437,7000) a hotspot in 2018.[58, 59]
- Migrants often move to informal settlements in urban areas located in low-lying coastal areas or alongside rivers, exacerbating existing vulnerabilities.[60]
- In Africa, most climate-related migration is currently within countries or between neighbouring countries, rather than to distant high-income countries (high confidence).[61]

Conflict

- There is growing evidence linking increased temperatures and drought to conflict risk in Africa (high confidence).[62] Agriculturally-dependent and politically-excluded groups are especially vulnerable to drought-associated conflict risk. However, climate is one of many interacting risk factors, and may explain a small share of any changes in conflict.[63]

Compound risks

- In Africa, including East Africa, risks intersect and cascade across sectors influenced by both climatic and non-climatic factors, such as socioeconomic conditions, resource access and livelihood changes, and vulnerability among different social groups.[64]
- These 'compound risks' are particularly evident in the urban context, where people living in coastal or low-lying areas in informal housing are exposed to multiple climate hazards (such as floods, extreme heat and sea level rise) while also experiencing poverty, unsafe housing, insecure jobs, amongst other drivers of vulnerability.[65]
- Climate change is already challenging the health and wellbeing of African communities, compounding the effects of underlying inequalities (high confidence).[66]

Heritage

- African cultural heritage is already at risk from climate hazards, including sea level rise and coastal erosion (high confidence).[67] This includes loss of traditional cultures and ways of life, loss of language and knowledge systems and damage to heritage sites.[68]

FUTURE CLIMATE RISKS IN EAST AFRICA

Human life and health

- Disruptions in water availability, such as during droughts or infrastructure breakdown, will jeopardise access to safe water and adequate sanitation, undermine hygiene practices and increase environmental contamination with toxins.[70] Cholera outbreaks are anticipated to impact East Africa most severely during and particularly after El Niño-Southern Oscillation events.[71]

- Above 1.5°C, risk of heat-related deaths rises sharply (high confidence), with at least 15 additional deaths per 100,000 annually across large parts of Africa.[72] Very high risk for human health is projected to occur from 2°C global warming (high confidence).[73] Climate change-related illness will strain healthcare systems and economies in East Africa.[74]
- Above 2.5°C, heat-related deaths reach 50–180 additional deaths per 100,000 people annually in North, West, and East Africa, and increase to 200–600 per 100,000 people annually for 4.4°C global warming.[75] (Some regions that currently experience cold-related deaths, as in the Ethiopian highlands, are projected to have lesser risk of heat-related death under warming scenarios.)
- Even under relatively low population growth scenarios, 27 million vulnerable people (under 5 and over 64 years of age) are expected to be exposed to heat waves in African cities at 1.8°C global warming. This increases to 440 million vulnerable people for more than 4°C global warming. A heat wave is defined as at least 15 days over 42°C. People in the large cities of Central, East and West Africa will be particularly at risk (very high confidence).[76]
- At 2°C, thousands to tens of thousands of additional cases of diarrhoeal disease are projected, mainly in Central and East Africa (medium confidence).[77] These changes risk undermining improvements in health from future socio-economic development (high agreement, medium evidence).[78]
- Tens of millions of East Africans will become exposed to malaria under future warming this century, as the climate suitability for the *Anopheles* mosquito expands to higher altitudes. Under mid- or high-warming scenarios, East African hotspots for malaria prevalence are expected to increase by as early as 2030.[79] The spread of *Aedes* mosquitos to higher altitudes, under global warming, could increase the risk of yellow fever and dengue fever in these areas.[80]

Projected impacts considered high risk include potentially lethal heat exposure for more than 100 days per year in East Africa at 2.1°C[69]


Coral reef off the coast of Kenya. At 1.5°C global warming, coral reefs are at high risk. © Shutterstock/Anna K Mueller

Climatic conditions favourable for mosquitoes, combined with the increase of animal trade, may result in the expansion of the geographic range of zoonotic diseases like Rift Valley fever, a threat for human and animal health with strong socioeconomic impacts[81]

- With every increment of global warming, the risk of biodiversity loss and species extinction increases across Africa, as shown here:

Table 2 Risk of biodiversity loss across Africa with increasing global warming[82]

Global warming potential (relative to 1850–1900)	Biodiversity at risk	% of species at a site at risk of local population collapse	Extent across Africa (% of the land area of Africa)	Areas at risk
1.5°C	Plants, insects, vertebrates	>10%	>90%	Widespread. Hot and/or arid regions especially at risk, including the Sahel
>2°C	Plants, insects, vertebrates	>50%	18%	Widespread
>4°C	Plants, insects, vertebrates	>50%	45–73%	Widespread

At 2°C global warming, over 90% of East African coral reefs could be destroyed by bleaching (very high confidence)[83]

In Kenya, the climatic suitability for tea production (compared to the year 2000) is projected to decrease in area by 27%, with yields declining 10%, at global warming of 1.8–1.9°C.[88] Under the same levels of global warming, the suitable area for tea production may reduce by half in Uganda.

In East Africa, the coffee-growing area is projected to shift to higher elevations as the average temperature increases. This is expected to lead to a decrease in suitable coffee-growing areas of 10–30% at 1.5–2°C of global warming.[89] Climatic suitability for an invasive and harmful species, the coffee berry borer, is expected to increase around Mount Kenya and in Uganda, as average temperatures increase.[90]

Woman harvesting coffee beans on a plantation.

- At 2°C global warming, over 90% of East African coral reefs could be destroyed by bleaching (very high confidence).[84]
- At 2°C global warming, 36% of African freshwater fish species are vulnerable to local population collapses, 7–18% of African land-based species assessed are at risk of extinction. Climate change is also projected to change patterns of invasive species spread.[85]
- The geographic distribution of major biomes across Africa, including forests, savannas and grasslands, are projected to shift from the greening effect of increases in atmospheric carbon dioxide and also from desertification effects from changes in aridity (high confidence). This will have severe consequences for species that depend on these biomes, such as savanna animals, and for livelihoods, such as pastoralism. There is high uncertainty about how these changes will affect specific locations. However, limiting global warming will reduce the chance of rapid changes from ecosystems reaching irreversible tipping points.[86]

Tipping point: A level of change in system properties beyond which a system reorganises, often abruptly, and does not return to the initial state[87]

Food systems

- Future warming will negatively affect food systems in Africa by shortening growing seasons and increasing water stress (high confidence).[91] At 1.5°C global warming, there will be a decline in suitable areas for growing coffee and tea in East Africa.[92]
- Global warming above 2°C will result in reduced yields of staple crops across most of Africa compared to 2005 yields, even if adaptation options are implemented.[93]
- Relative to 1986–2005, global warming of 3°C is projected to reduce labour capacity in agriculture by 30-50% in sub-Saharan Africa due to higher temperatures.[94]

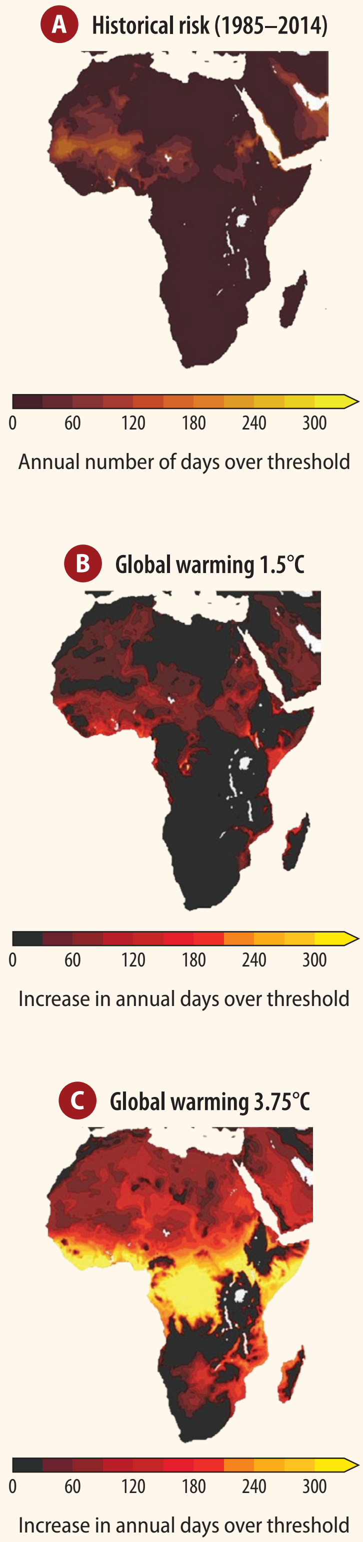
- Climate change threatens livestock production in East Africa (high agreement, low evidence).[95] This is through a combination of negative impacts on the availability and quality of animal fodder, availability of drinking water, direct heat stress on animals (see Figure 2), and the prevalence of livestock diseases.[96]
- Multiple countries in West, Central and East Africa are projected to be at risk from simultaneous negative impacts on crops, fisheries and livestock.[97]

- Ocean warming, acidification and de-oxygenation are projected to affect the early life of several marine food species, including fish and crustaceans.[100] The greater the warming, the more the Maximum Catch Potential of Africa's marine fisheries will decrease.[101] At 2°C of global warming, the risk to marine fisheries becomes very high and marine fisheries catch potential in the Horn of Africa region could decline by 10–30%.[102]
- Even at 1.7°C global warming, reduced fish harvests could leave up to 70 million people in Africa vulnerable to iron deficiencies, up to 188 million at risk for vitamin A deficiencies, and 285 million for vitamin B12 and omega-3 fatty acids.[103]
- Kenya and Tanzania are among the African countries whose people depend heavily on fish for nutrition and whose fisheries are at high risk from climate change.[104]
- For inland fisheries, higher levels of global warming are associated with a larger proportion of commercially-harvested fish species facing local population collapse. This means more countries will face food security risk, due to declines in commercial fish species.[105]
- For freshwater fisheries, areas where fish are caught mostly in lakes, such as the Great Lakes region, are less likely to experience reductions in fish catch than areas reliant on rivers and flood plains.[106] Nonetheless, climate change adaptation responses (such as hydropower and irrigation) that draw on freshwater resources pose a risk to freshwater fisheries.[107]

- Production will not be the only aspect of food security that is impacted by climate change. Processing, storage, distribution and consumption will also be affected.[108]

Figure 2 Severe heat stress duration for cattle in Africa with increased global warming[98]

KEY: (A) Number of days per year over heat stress threshold in the historical climate (1985–2014). **(B and C)** Increase in the number of days per year over heat stress threshold for global warming of 1.5°C and 3.75°C above pre-industrial levels (1850–2100). Heat stress is estimated using a high Temperature Humidity Index value (Livestock Weather Safety Index).[99]



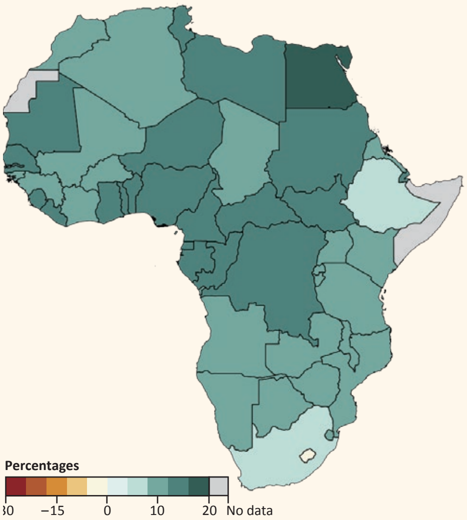


Figure 3 Differences in GDP per capita for African countries for the period 2081–2100, if global warming is limited to 1.5°C versus 2°C above pre-industrial temperatures.[115]

For example, the map shows that GDP per capita for many countries in East Africa is projected to be around 10% higher by 2100 at 1.5°C global warming, than it would be at 2°C global warming.

Rapidly growing cities and towns

Arid conditions to increase 700%[118]

High frequency flooding to increase by 2,600%

Populated coastal areas at risk of storm surging

CLIMATE CHANGE IS PROJECTED TO CAUSE

2,600%

Increase in flooding between years 2000–2030

Water for people

- There is increasing demand for water for agricultural and energy production in East Africa.[109] Climate change introduces significant risks to governments' plans: future levels of rainfall, evaporation and runoff will have a substantial impact. The biggest risk to the production of irrigated crops is in the eastern Nile. Here irrigation revenue could be 34% lower in the driest scenario and 11% higher in the wettest one, compared to a scenario without climate change .[110]
- The combination of increasing societal demands on limited water resources and future climate change is expected to intensify water-energy-food competition and trade-offs (high confidence).[111]

Economies

- Future climate change is projected to have a very large negative effect on African countries' economic output levels, but this effect is much lower at lower levels of global warming – as shown in Figure 3. Severe risks are more likely in hotter developing countries of Africa. Damages to GDP are projected across most future-warming scenarios.[112]
- The map shows the increase in GDP per capita for African countries if global warming is limited to 1.5°C versus 2°C above pre-industrial temperatures. Across nearly all African countries, GDP per capita is projected to be at least 5% higher by 2050 and 10–20% higher by 2100 if global warming is held to 1.5°C versus 2°C.[113] It is important to note that informal sector impacts are omitted from these GDP-based impacts projections. Informal sector activity and small- to medium-sized enterprises can be highly exposed to climate extremes.[114]

Human settlements and infrastructure

- Africa as a whole is the most rapidly-urbanising region in the world – with much of the urban expansion happening in small towns and intermediary cities. Sixty percent of Africans are expected to live in cities by 2050. Approximately 59% of urban dwellers live in informal settlements and this number is expected to increase.[116] These trends will increase the number of people exposed to climate hazards, especially floods, droughts and heatwaves – and especially in low-lying coastal towns and cities.

- Towns and cities are growing so rapidly in West, Central and East Africa that the area of urban land exposed to arid climate conditions will increase 700% between 2000–2030, even without further climate change. The urban area exposed to high-frequency flooding will increase by 2,600% in the same period.[117]

- Populations at risk from storm surge and/or sea level rise coincide with areas of high coastal ecosystem-based adaptation (EbA) potential on coastlines from Mozambique to Somalia.[119]

Education

- Future climate risks to children's and adolescents' educational attainment and life prospects need to be further researched. However, recognising that climate hazards can trap poorer households in a cycle of poverty, adaptation actions can be designed in ways that actively work to target the most climate-affected and reduce social inequality, whether it is inequality on the basis of gender, income, employment, education or otherwise.[120]

Migration

- Tens of millions of Africans are expected to migrate in response to water stress, reduced crop productivity and sea level rise associated with climate change.[121] In East Africa, the number of climate-related internal migrants (moving within countries) is projected to reach more than 10 million by 2050 for 2.5°C global warming.[122] Out-migration hotspots in the region include the coastal areas of Kenya and Tanzania, western Uganda and parts of the northern highlands of Ethiopia, with many moving to Kampala, Nairobi and Lilongwe.[123]

Compound risks

- Multiple African countries are projected to face compounding risks from: reduced food production across crops, livestock and fisheries; increasing heat-related mortality; heat-related loss of labour productivity; and flooding from sea level rise (high confidence).[124]
- The African population exposed to multiple, overlapping extreme events, such as concurrent heat waves and droughts or drought followed immediately by extreme rainfall, is projected to increase 12-fold by 2070–2099 (compared to 1981–2010), for a scenario of low population growth and 1.6°C global warming. Projections rise to 47-fold with high population growth and 4°C global warming. West, Central-East, northeastern and southeastern Africa will be especially exposed.[125]

Heritage

- Most African heritage sites are neither prepared for, nor adapted to, future climate change (high confidence).[126] Climate risk to African heritage has not been quantified, but preliminary studies have identified 10 cultural sites and 15 natural coastal heritage sites physically exposed to sea level rise by 2100, under the highest-warming scenario.[127] Watamu Marine National Reserve in Kenya is one of the natural coastal sites exposed on the continent.[128, 129]

After the rain, Kisenyi, Kampala. © Flickr/Slum Dwellers International

Compounding risks to multiple African countries

- Reduced food production across crops, livestock and fisheries
- Increased heat-related mortality
- Heat-related loss of labour productivity
- Flooding from sea level rise

EAST AFRICA'S POTENTIAL TO ADAPT

Climate change is already affecting all walks of life and aspects of the natural and built environment in East Africa. Impacts are projected to become more widespread and severe, further threatening people's lives and livelihoods, and damaging the region's economy and ecosystems.[130] East Africa's foremost options for adapting to climate change include:

- **Ecosystem-based adaptation** (see box on East Africa's increasing experience with ecosystem-based adaptation on page 17) uses biodiversity and ecosystem services to assist people to adapt to climate change. These solutions can reduce climate impacts and there is high agreement that they can be more cost-effective than traditional 'grey' infrastructure when a range of economic, social and environmental benefits are also accounted for.[131]

- **Investing in nature** (as described above) can provide many diverse benefits to society, far beyond climate benefits – but much of this potential depends on how nature-based adaptation is designed and managed.[132] Gender-sensitive and equity-based adaptation approaches reduce vulnerability for marginalised groups across multiple sectors in Africa, including water, health, food systems and livelihoods (high confidence).[133] Maintaining indigenous forest ecosystems has benefits for both biodiversity and emissions reduction. However, wrongly targeting ancient grasslands and savannas for afforestation harms water security and biodiversity, and can increase emissions from fire and drought.[134]

  Beyond 1.5°C of global warming, certain ecosystems – such as coral reefs, marshes and mangroves – will be irreversibly damaged and thus will contribute less to nature-based adaptation solutions.[135]

- In agriculture, there is potential to **boost farmers' and pastoralists' resilience to climate shocks and stresses**; for example, through the introduction of drought- and pest-tolerant crop and livestock varieties. Often farmers with the lowest incomes cannot afford these without assistance.[136]

  However, **adaptation limits for crops in Africa will increasingly be reached for global warming of 2°C** (high confidence), and in tropical Africa may already be reached at current levels of global warming (low confidence). The risk of no available genetic varieties of maize for adaptation is higher for East Africa and southern Africa than for Central or West Africa.[137]

- **There is a need to manage the competition among different water uses** – for example, among household users, farmers and energy producers (the 'water-energy-food nexus'). Effective approaches include working at river basin level to research and quantify the future sensitivity of crops and dams to changing rainfall, runoff, evaporation and drought. Integrating these perspectives and identifying cross-cutting adaptation options works better when decision-making involves a wide range of actors affected by decisions.[138]

> **Integrated water management measures including sub-national financing, demand management through subsidies, rates and taxes, and sustainable water technologies can reduce water insecurity caused by either drought or floods (medium confidence)**[139]

- People already make abundant use of their **local and indigenous knowledge** to cope with climate variability. This knowledge is very important for strengthening local climate change adaptation.[140]

- Social protection that is not climate-specific can improve resilience; however, **integrating climate adaptation into social protection programmes** – such as cash and in-kind transfers, public works programmes, microinsurance and healthcare access to help households and individuals cope in times of crisis – can go even further to increase people's resilience to climate change.[141]

- **Effective adaptation in human settlements relies on addressing climate risks throughout planning and infrastructure development** and can provide net financial savings. This needs to be done in an integrated, cross-cutting way.[142] There is scope for governments to better harness the role of the informal sector in mitigation and adaptation – through multi-level governance. This could include, for example, service providers, such as informal water and sanitation networks.[143]
- **Early warning systems**, targeting weather and climate information to specific users and sectors, can be effective for disaster risk reduction, social protection programmes, and managing risks to health and food systems (e.g., vector-borne disease and crops).[144]
- The ability of East African communities and sectors to pursue effective adaptation options to the full is **constrained by lack of finance.**[145]

> The greatest gains in wellbeing can be achieved by prioritising investment to reduce climate risk for low-income and marginalised residents including people living in informal settlements (high confidence)[146]

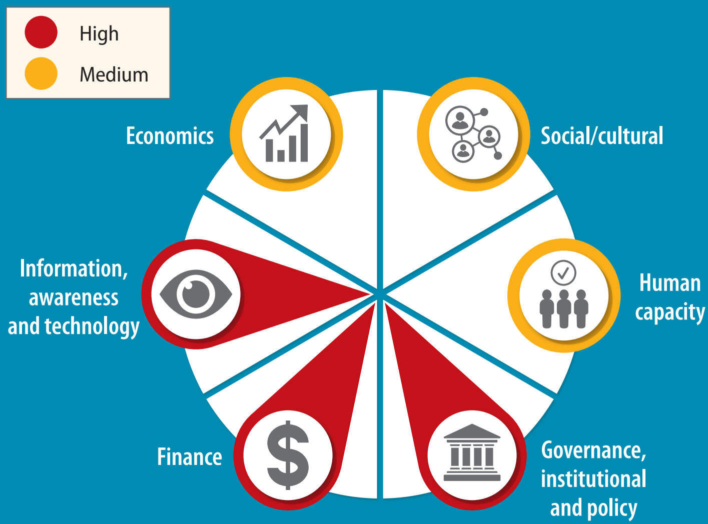


Figure 4 Constraints for the African continent that make it more difficult to plan and implement adaptation

Cattle drinking water, Kenya. © Curt Carnemark

Adaptation for the long term – and avoiding maladaptation

Designing adaptation policy under conditions of scarcity, common to many African countries, can inadvertently lead to trade-offs between adaptation options, as well as between adaptation and mitigation options, can reinforce inequality, and fail to address underlying social vulnerabilities.[147] Access to adequate financial resources is crucial (right).[148]

What is more, the long-term view is critical. Actions that focus on single sectors or single risks and prioritise short-term gains often lead to maladaptation for ecosystems and people if long-term impacts of the adaptation option and long-term adaptation commitment are ignored (high confidence).[149] These include infrastructure and institutions that are inflexible and costly, and increase risk and impacts (high confidence).[150]

Adaptation options that deliver strong development benefits and positive outcomes include: improving access to climate information, developing agroforestry systems and conservation agriculture, agricultural diversification and growing of drought-resistant crop varieties (when low-income farmers can access seeds). Climate-smart agriculture techniques such as drip irrigation, planting pits and erosion control techniques can all improve soil fertility, increase yield and household food security, while increasing farmers' resilience to changing rainfall and temperature patterns.

Examples of negative outcomes, also known as 'maladaptation', are when producing biomass for renewable energy displaces subsistence farming and food crops, and so threatens food security; or displaces biodiversity-rich areas that provide resilience. Overuse of fertilisers leading to environmental degradation is another form of maladaptation that undermines resilience.[151]

KEY INVESTMENT AREAS FOR A CLIMATE-RESILIENT EAST AFRICA

The IPCC *Sixth Assessment Report* identifies key areas for enabling climate-resilient development in Africa, where investment would have a catalytic effect on the continent's resilience to current and future climate change.

> **Climate-resilient development is a process of implementing greenhouse gas mitigation and adaptation measures to support sustainable development for all[152]**

Finance

Increasing public and private finance flows by billions of dollars per year, enhancing direct access to multilateral funds, strengthening project pipelines, and shifting more finance to implementation would help realise transformative adaptation in Africa.[153]

Annual finance flows targeting adaptation for Africa are billions of dollars less than the lowest adaptation cost estimates for near-term climate change, and adaptation costs will rise rapidly with global warming (high confidence).[154] Developed countries have fallen short of their Copenhagen target to leverage US$ 100 billion per year in climate finance for developing countries for mitigation and adaptation by 2020.[155]

Many African countries, particularly Least Developed Countries (LDCs), express a stronger demand for adaptation than mitigation finance. Compared to developed countries the costs of adaptation are much higher for developing countries as a proportion of national income, making self-financing adaptation more difficult (high confidence). Concessional finance will be required for adaptation in low-income settings (high confidence). However, from 2014–2018 a larger total of climate finance commitments for Africa were debts than grants and – excluding multilateral development banks – only 46% of commitments were actually disbursed.[156]

Aligning sovereign debt relief with climate goals could increase finance by redirecting debt-servicing payments to climate resilience.[157]

Climate services, literacy and research

Investing in climate information services that are demand-driven and context-specific combined with climate change literacy can enable informed adaptation responses.[158] Climate services are most effective when they offer geographic- and / or sector-relevant information (such as for agriculture or health) and information users understand the causes and consequences of climate change (known as 'climate literacy').[159, 160] However, this is hindered by low climate literacy rates ranging from only 28% to 62% (an average of 44%) in East Africa,[161] and limited weather and climate data.

Increased funding for African partners, and direct control of research design and resources can provide more actionable insights on adaptation in Africa.[162]

Climate-related research in Africa faces severe data constraints, as well as inequities in funding and research leadership that reduce adaptive capacity. From 1990–2019, Africa received just 3.8% of climate-related research funding globally. Of this, only 14.5% went to African institutions, while 78% went to EU and North American institutions to do research on Africa.[163]

> **From 1990–2019, research on Africa received just 3.8% of climate-related research funding globally**[164]

Somali women grow their own crops on the outskirts of Ifo Refugee Camp in Dadaab, Kenya. © Africa Practice/Kate Holt

Livestock market in Ethiopia. © Shutterstock/Ilia Torlin

Governance

Governance for climate-resilient development includes long-term planning, all-of-government approaches, transboundary cooperation and benefit-sharing, development pathways that increase adaptation and mitigation and reduce inequality, and the implementation of Nationally Determined Contributions (NDCs).[165] Making space for marginalised and diverse groups in policy processes, including women and indigenous communities, can catalyse inclusive action and transformational responses to climate change.[166]

There are multiple possible pathways to pursue climate-resilient development. Moving toward different pathways involves confronting complex synergies and trade-offs between development pathways, and the options, contested values, and interests that underpin climate mitigation and adaptation choices (very high confidence).[167]

Robust legislative frameworks that develop or amend laws are an important basis for mainstreaming climate change across government and society. Kenya is one of two countries in Africa that has enacted a climate change law (the other is Benin). Uganda also has a draft climate change bill in place, and two East African countries have integrated climate change considerations into existing law: Rwanda and Tanzania.[168]

Working across sectors and at transboundary levels can ensure that adaptation and mitigation actions in one sector don't exacerbate risks in other sectors, and cause maladaptation.[169] Cross-sectoral approaches provide significant opportunities for large co-benefits and/or avoided damages (very high confidence.[170] Examples of co-benefits include climate change adaptation supporting Covid-19 pandemic preparedness and 'One Health' approaches benefiting human and ecosystem health.[171] The close dependency of many Africans on their livestock and surrounding ecosystems demonstrates how integrated human and ecosystem health approaches are especially critical for addressing climate change risks to health.[172]

Restored mangrove forest in Ukunda, Kenya. © Climate Visuals Countdown/Anthony Ochieng

East Africa's increasing experience with ecosystem-based adaptation[173]

Nature-based solutions are also being deployed for mitigating and adapting to climate change, with demonstrated long-term health, ecological and social co-benefits. Nature-based solutions can also lengthen the life of existing built infrastructure. An increasing number of ecosystem-based adaptation projects involving the restoration of mangrove, wetland and riparian ecosystems have been initiated across Africa, a majority of which address water-related climate risks.

The Msimbazi Opportunity Plan (MOP) 2019–2024 (Dar es Salaam, Tanzania)

Enhancing urban resilience to flood risk by reducing flood hazard, and reducing people, properties and critical infrastructure exposed to flood hazard.

Tanzania Ecosystem-Based Adaptation (Dar es Salaam and five coastal districts, Tanzania)

Rehabilitation of over 3,000 hectares of climate-resilient mangrove species.

Green City Kigali 2016 (Kigali, Rwanda)

600-hectare planned neighbourhood that integrates green building and design, efficient and renewable energy, recycling and inclusive living.

Urban Natural Assets for Africa – Rivers for Life (Kampala, Uganda)

Preservation of natural buffers to enhance the protective functions offered by natural ecosystems that support disaster resilience benefit.

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About this factsheet

This factsheet is a guide to Working Group II's contribution to the IPCC's *Sixth Assessment Report* (AR6) for decision-makers and climate change communicators in southern Africa. It has been prepared by the Climate and Development Knowledge Network (CDKN), African Climate and Development Initiative (ACDI), SouthSouthNorth (SSN) and ODI. The IPCC *Sixth Assessment Report* provides the strongest-ever assessment of evidence on how climate change is impacting the African continent and its sub-regions. This factsheet distils data, trends and analysis most relevant to southern Africa from the Africa Chapter of the *Sixth Assessment Report*. In doing so, we hope to make the IPCC's important material more accessible and usable to southern African audiences.

The team, comprising CDKN researchers and communicators as well as IPCC Coordinating Lead Authors and Lead Authors of the Africa Chapter, has extracted the southern Africa-specific information directly and solely from the *Sixth Assessment Report*.

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Since this factsheet has not been through the official IPCC review process, it has not been endorsed by the IPCC.

Our publication is part of a suite of materials sharing IPCC AR6 evidence for Africa's five sub-regions: Central Africa, East Africa, North Africa, southern Africa and West Africa.

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CDKN supports decision-makers in developing countries in designing and delivering climate compatible development. We do this by combining knowledge sharing, research and advisory services in support of locally owned and managed policy processes. CDKN works in partnership with decision-makers in the public, private and non-governmental sectors nationally, regionally and globally.

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