FACTSHEET

SOUTHERN 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 southern Africa

IN THIS FACTSHEET:

Daily life at Lake Malawi. Temperatures have risen by 0.1°C per decade in the lake.

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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.[5] From 1990–2019, Africa received just 3.8% of climate-related research funding globally.[6] Of this, only 14.5% went to African institutions, while 78% went to EU and North American institutions to do research on Africa. 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.

Meteorological, hydrological and agricultural drought

There are different types of drought. A **meteorological drought** is when there is an abnormal lack of rainfall. A **hydrological drought** affects water supplies and can take place downstream from where a meteorological drought occurred, and is also influenced by poor water resource management. An **agricultural drought** impacts crop production during an agricultural growing season.[14]

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

The climate has warmed 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.[2] Southern 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.[3]

> **Limiting global warming to 1.5°C is expected to substantially reduce damages to southern African economies and ecosystems.[4]**

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

HOW SOUTHERN AFRICA'S CLIMATE IS ALREADY CHANGING

The Earth's average surface temperature has already warmed by 1.09°C since pre-industrial times (1850–1900).[7] However, southern Africa's climate has warmed more than the global average in the past few decades:

- **Temperature:** Southern Africa's average annual surface temperatures increased by between 1.04°C and 1.44°C from 1961 to 2015.[8]
- **Heat waves:** The annual number of hot days has increased in southern Africa over the last four decades due to human-induced climate change. The occurrence of cold extremes, including frost days, has decreased.[9]
- **Marine heat waves**: Heat waves in the ocean doubled and increased in intensity along the southern African coastline from 1982–2016: with 90–100% probability this was the result of human-induced climate change.[10]
- **Rainfall:** There has been a decrease in mean precipitation over southern Africa since the 1980s, except in the north-western parts, which shows an increasing trend over this period.
- **Extreme rainfall:** The number and intensity of extreme rainfall events have increased in southern Africa over the last century (medium confidence).[11]
- **Drought:** Agricultural drought increased over 1961–2016, and meteorological drought frequency has increased by between 2.5 to 3 events per decade since 1961.[12] The reduced rainfall that caused the 2015–2017 Cape Town drought was three times more likely because of human-induced climate change.[13]

SOUTHERN 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 (1850–1900) in the near term (up to 2040), according to the IPCC's most recent assessment.[15]

Future scenarios (Table 1) measure warming as global averages, and warming at local and country level is expected to be higher than these averages. The IPCC finds that 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).[16]

> Climate change has increased heat waves and drought on land, and doubled the probability of marine heatwaves around most of Africa[17]

Table 1 Changes in global surface temperature

Global warming scenario according to emissions levels, showing best estimate, °C (very likely range, °C)[18]	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.[19]

Temperature: At 1.5°C, 2°C and 3°C global warming, average annual surface temperatures in southern Africa are projected to be higher than the global average.[20]

Heat waves: The annual number of heatwaves is projected to increase in southern Africa by between **2–4** (at 1.5°C), **4–8** (at 2°C) and **8–12** (at 3°C). There is 99–100% probability hot and very hot days will increase under 1.5°C and 2°C global warming.[21] Children born in southern Africa in 2020 will, under 1.5°C global warming, be exposed to 3–4 times more heatwaves in their lifetimes than those born in 1960.[22]

Marine heat waves: Increases in the frequency, intensity, spatial extent and length of marine heatwaves are projected for all coastal zones of Africa.[23]

Rainfall and drought: At 1.5°C global warming, the frequency and length of droughts is projected to increase over large parts of southern Africa. At 2°C, unprecedented extreme droughts are projected to emerge. Above 3°C global warming, average annual rainfall is projected to decrease by 10–20% in the summer rainfall region, particularly in the western parts.[24] The length of meteorological droughts is also projected to double from 2 to 4 months.[25]

Extreme rainfall: Heavy rainfall events will become more frequent and intense at all levels of global warming (except in the southwestern region), increasing exposure to flooding (high confidence).[26, 27]

Tropical cyclones: In southern Africa, tropical cyclones making landfall are projected to become less frequent, but have more intense rainfall and higher wind speeds at increasing global warming (medium confidence).[28]

CLIMATE CHANGE IMPACTS WE HAVE ALREADY SEEN IN SOUTHERN 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.[29]

> **Recent estimates suggest that human-induced climate change was responsible for almost 44% of heat-related deaths in South Africa (1991–2018)[32]**

Human life and health

- Climate variability and change already affect the health of tens of millions of people in southern 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).[30]
- Recent estimates suggest that human-induced climate change was responsible for almost 44% of heat-related deaths in South Africa (1991–2018). In many of South Africa's districts, this equates to dozens of deaths per year.[31]
- There are already large inequalities in people's health – due to their economic status, social behaviours, and where they live (e.g. 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 some cases, impacts differ by gender and age, too.[33] 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).[34]

> **Small changes in the climate have had a large impact on freshwater ecosystems[36]**

Ecosystems and biodiversity

Small changes in the climate have had a large impact on freshwater ecosystems. Temperatures in southern African freshwater bodies have risen by 0.1–0.3°C per decade; and by 0.1°C per decade in Lake Malawi.[35] Increases in temperature, changes in rainfall, and reduced wind speed have altered the physical and chemical properties of freshwater bodies, affecting the water quality and productivity of algae, invertebrates and fish (high confidence).[37]

Increased carbon dioxide levels in the atmosphere and climate change are influencing the growth of natural vegetation across African landscapes.[38] Woody plants (trees and shrubs) are expanding their range, particularly into grasslands and savannas. This is a new area of scientific understanding and consensus since the IPCC's *Fifth Assessment Report* in 2014. Vegetation changes affect wild animal species and people's livelihoods. For instance, bird, reptile and mammal species that depend on grassland habitats become rarer, as woody plants spread.[39]

In southern Africa, shifting geographic distributions of anchovy, sardine, hake, rock lobster and seabirds have been linked to climate change.[40]

The Kalahari desert, Namibia. Higher temperatures are reducing the foraging efficiency and body mass of wild animals in the Kalahari.

Climate change is behind the losses in southern Africa's unique flora and fauna

For hot and dry regions, such as the Kalahari desert, there is strong evidence that higher temperatures reduce the foraging efficiency and body mass of wild animals. Extreme heat events have caused mass deaths among birds and bats.[41] An increase in the frequency and intensity of hot, dry weather after wildfires has led to a long-term decline in the diversity of South Africa's Fynbos species since the 1960s. Increasing temperatures may have contributed to the declining abundance and range of South African birds too, including the Cape Rock Jumper and Protea Canary, because of increased risk of reproductive failure. Extreme heat days have increased across South African national parks since the 1990s. This reduces animals' movements and the chance for people to see animals. Tourists and employees also fear heat stress. Reduced tourism activities means less revenue for national parks.[42]

Food systems

Climate change is reducing crop productivity in southern Africa. Maize and wheat yields decreased on average by 5.8% and 2.3% respectively across sub-Saharan Africa due to climate change from 1974–2008.[43] A majority of people perceive that climate conditions for agricultural production have worsened over the past ten years.[44] 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.[45]

Encroachment by woody plants – shrubs and trees – on important grazing lands has reduced the availability of fodder for livestock.[46] Woody plants have increased by 10% on subsistence grazing lands and 20% on economically-important grazing lands in South Africa in the last 60 years – increasing carbon dioxide in the atmosphere and climate change are partly to blame. Increased temperature and rainfall are contributing to the expanding range, in southern Africa, of several tick species that carry economically-harmful livestock diseases.[47]

Fish are the main source of animal protein and key micronutrients for around 30% of Africans (approximately 200 million people). However, climate change poses a major threat to marine and freshwater fisheries and aquaculture – leading to changes in the productivity of fisheries, abundance of fish in lakes and rivers, and altered distribution of fish species in the oceans.[48]

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.[49] Between 2015 and 2019, an estimated 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).[50]

> Climate change is already negatively affecting tourism in Africa (high confidence)[51]

> The 2015–2016 drought disrupted hydropower generation in Zambia, resulting in the lowest rate of real economic growth in over 15 years[53]

Water for people

- Rainfall and river discharge have been extremely variable in southern 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.[52]
- In southern Africa as a whole, river flows mostly decreased (high confidence) from 1970–2010.[54]
- The 2015–2016 drought disrupted hydropower generation in Zambia, resulting in the lowest rate of real economic growth in over 15 years.[55] In a rural town in South Africa, over 80% of businesses (both formal and informal) lost over 50% of employees and revenue due to agricultural drought.[56]

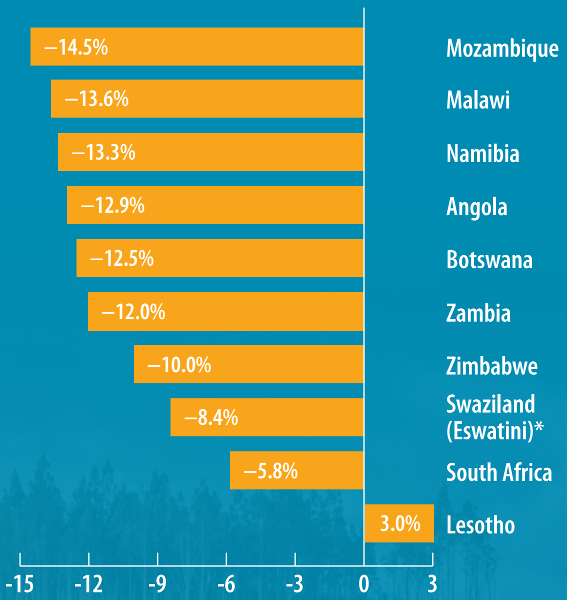


Figure 1 Percentage change in GDP per capita for countries in southern Africa due to observed climate change (1991–2010)[59]

* Country name was changed in 2018, from Swaziland to the Kingdom of Eswatini. In this factsheet the appropriate country name is used as at the time period being referred to.

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.[57]
- 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).[58]

Human settlements and infrastructure

- Southern Africa's human settlements, especially people living in informal settlements, are particularly exposed to floods (from 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.[60]
- Flooding greatly hinders economic opportunities, transportation of goods and services, and mobility and access to essential services, including health and education. People's exposure to flood shocks is associated with an increase in extreme poverty.[61]
- Severe impacts from tropical cyclone landfalls have been recorded in East and southeastern Africa. Cyclones Idai and Kenneth in early 2019 caused flooding of districts in Mozambique, Zimbabwe and Malawi, with substantial loss and damage to infrastructure in the energy, transport, water supply, communication services, housing, health and education sectors.[62]

Education

- Low rainfall, higher 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 harms their cognitive development and schooling potential.
- In rural Zimbabwe, adolescents who experienced drought conditions during the first few years of life went on to complete fewer grades at school. This translates into a 14% reduction in lifetime earnings.[63]

Migration

- In Africa, most climate-related migration is currently within countries or between neighbouring countries, rather than to distant high-income countries (high confidence).[64] Over 2.6 million and 3.4 million new weather-related displacements occurred in sub-Saharan Africa in 2018 and 2019.[65] Urbanisation has increased when rural livelihoods were negatively impacted by low rainfall.[66] Migrants often move to informal settlements in urban areas located in low-lying coastal areas or alongside rivers, exacerbating existing vulnerabilities.[67]

> **Over 2.6 million and 3.4 million new weather-related displacements occurred in sub-Saharan Africa in 2018 and 2019[68]**

Conflict

- There is growing evidence linking increased temperatures and drought to conflict risk in Africa (high confidence). 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.[69]

> **African cultural heritage is already at risk from climate hazards, including sea level rise and coastal erosion (high confidence)[70]**

Heritage

- African cultural heritage is already at risk from climate hazards, including sea level rise and coastal erosion (high confidence).[71] This includes loss of traditional cultures and ways of life, loss of language and knowledge systems and damage to heritage sites.[72]
- Across Africa, there are 800 recorded exceptional rock art sites, but limited research on the direct climate change impacts on rock art across Africa. Underwater heritage includes shipwrecks, and 41 of the 111 shipwrecks documented off African shores are in South Africa.[73]

> **Climate change is already challenging the health and wellbeing of African communities, compounding the effects of underlying inequalities (high confidence)[74]**

Compound risks

- In Africa, including southern 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.[75]
- 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 (floods, extreme heat, sea level rise) while also experiencing poverty, unsafe housing, insecure jobs, amongst other drivers of vulnerability.[76]

FUTURE CLIMATE RISKS IN SOUTHERN AFRICA

> Global warming of 1.5°C is projected to cause the spread of vector-borne diseases, exposing tens of millions more people to potential illness – and escalating the loss of life, especially in southern and East Africa (high confidence)[78]

Human life and health

- Global warming of 1.5°C is projected to cause the spread of vector-borne diseases, exposing tens of millions more people to potential illness – and escalating the loss of life, especially in southern and East Africa (high confidence).[77] The population at risk of malaria and dengue fever is projected to increase sharply at 1.5°C global warming.
- Very high risk for human health is estimated to occur from 2°C global warming (high confidence).[79] Climate change-related illness will strain healthcare systems and economies in southern Africa.[80]

Ecosystems and biodiversity

- 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[81]

Global warming level (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 Kalahari
>2°C	Plants, insects, vertebrates	>50%	18%	Widespread
>4°C	Plants, insects, vertebrates	>50%	45–73%	Widespread

- At 2°C global warming, 36% of African freshwater fish species are vulnerable to local population collapses, and 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.[82]
- 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 desertification effects from changes in aridity (high confidence).[83] 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 as ecosystems reach irreversible tipping points.[85]

> Tipping point: A level of change in system properties beyond which a system reorganises, often abruptly, and does not return to the initial state[84]

Food systems

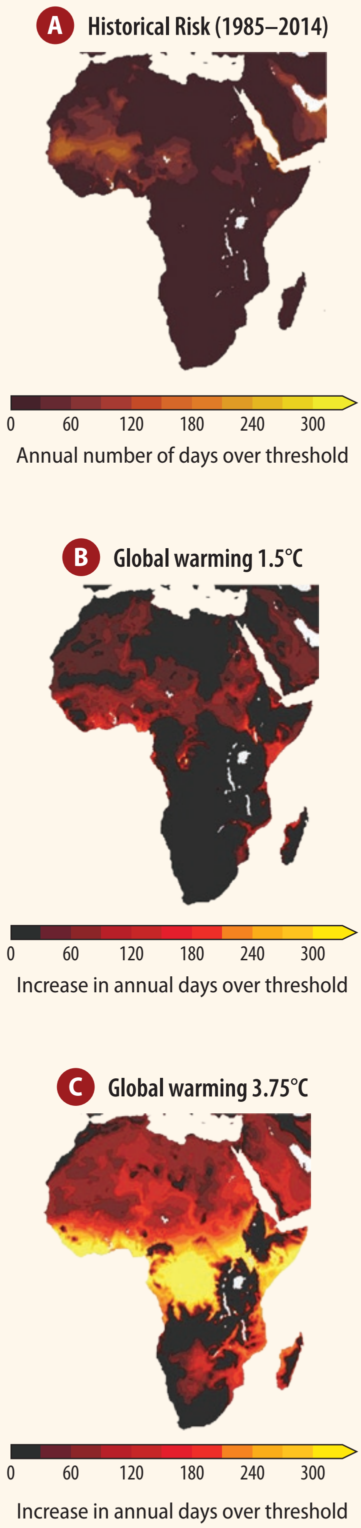
- Future warming will negatively impact African food systems by shortening growing seasons and increasing water stress (high confidence).[86] Wheat yields in southern Africa are projected to decline by over 50% by 1.5°C global warming, even with adaptation. Global warming above 2°C will result in reduced yields of staple crops across most of Africa compared to 2005 yields, even with adaptation options being implemented.[87]
- 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.[88] Research on regionally-important cash crops, such as sugarcane, remains limited.

- Climate change threatens livestock production in southern Africa (high agreement, low evidence)[89] including 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.[90]
- Rangeland net primary productivity is projected to decline 37% for southern Africa over the 2000–2050 period, under a high warming scenario.[91]

- Non-cultivated species in Africa are vulnerable to current and future climate change, too.
- Communities in the Kalahari and Zimbabwe report the growing scarcity of wild foods (such as wild meat and fruit) and perceive this to be, at least partly, due to drought and climate change.[92]

- Ocean warming, acidification and de-oxygenation are projected to affect the early life of several marine food species, including fish and crustaceans. Warming will impact the southern Benguela ecosystem and several important fishery resources by 2050.[94]
- The greater the warming, the more the Maximum Catch Potential of Africa's marine fisheries will decrease.[95] Angola, Namibia and Mozambique are countries with high dependency on marine fisheries for dietary nutrients, whose Maximum Catch Potential is threatened by future climate change.[96, 97] Under 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 by mid-century.[98]
- At 2°C global warming, the risk to southern African fisheries becomes very high and marine fisheries catch potential is projected to decline by 10–30%.[99] 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.[100]

- Production will not be the only aspect of food security impacted by climate change. Processing, storage, distribution and consumption will also be affected.[101]



KEY: (A) Number of days per year with severe heat stress in the historical climate (1985–2014). **(B and C)** Increase in the number of days per year with severe heat stress 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).

Figure 2 Severe heat stress duration for cattle in Africa with increased global warming[93]

Water for people

- There is increasing demand for water for agricultural and energy production in southern Africa. Governments are responding with ambitious plans to expand irrigation and hydropower infrastructure – especially in the Zambezi River basin. Climate change introduces significant risks to these plans: future levels of rainfall, evaporation and runoff will have a substantial impact. However, climate models disagree on whether climates will become wetter or dryer in this river basin.[102]
- One study found that hydropower revenues in the driest climate scenarios could be 58% lower in the Zambezi River basin, the highest risk of any river basin, and 30% lower in the Orange River basin by 2050, compared to revenues under current climate conditions. In the wettest modelled climate scenario, hydropower revenues could be more than 20% higher in the Zambezi River basin and 50% higher in the Orange River basin than they would be in the current climate.[103] 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).[104]
- The likelihood of severe climate conditions, such as the reduced rainfall that caused the multi-year drought in Cape Town, has increased due to human-induced climate change.[105]

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.[107] With current population and GDP trends, the extent of urban land in arid zones is projected to increase around 180% in southern Africa, even without further climate change.[108]
- These trends will increase the number of people exposed to climate hazards, particularly floods, droughts and heatwaves – and especially in low-lying coastal towns and cities.[109] Mozambique is among countries with the largest projected population at risk from future sea level rise.
- The exposure of urban populations to tropical cyclones in southeastern Africa is projected to increase: warmer sea surface temperatures will lead to longer, more intense cyclones.
- Expected damages to transport infrastructure from river flooding could exceed US$ 400 million per year in Mozambique by 2050 under high-warming scenarios.[110] Expected aggregate damages from sea level rise are US$ 650–980 million in Maputo and US$ 110–170 million in Cape Town by 2050, with the higher end of these estimates for higher-emissions scenarios.[111]

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.[106]

Migration

- Climate change is projected to increase migration in Africa, especially internal and rural-to-urban migration.[112] By 2050, 0.9 to 1.5 million people in southern Africa could be migrating internally (that is within countries) or between neighbouring countries – as a consequence of climate impacts on water stress, crop productivity and sea level rise.[113]

Economies

- Future climate change could 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, as in much of Africa. For Africa, damages to GDP are projected across most future warming scenarios.[114]
- 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.[115]
- 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.[116]

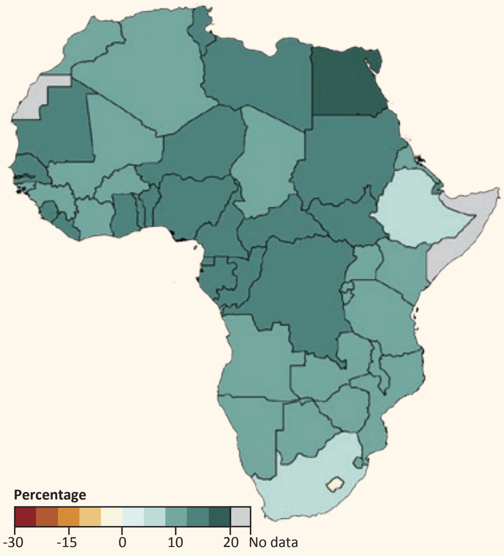


Figure 3 Differences in GDP per capita for African countries for the period 2081–2100, if global warming is limited to 1.5°C versus 2°C above pre-industrial temperatures.[117]

For example, the map shows that Namibia's GDP per capita would be 10% higher at 1.5°C global warming, than it would be at 2°C global warming.

Heritage

- Most African heritage sites are neither prepared for, nor adapted to, future climate change (high confidence).[118] 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.[120]
- Two of the exposed natural sites in southern Africa are: Marromeu Game Reserve in Mozambique and Seal Ledges Provincial Nature Reserve in South Africa.[121, 122]

> **Most African heritage sites are neither prepared for, nor adapted to, future climate change (high confidence)[119]**

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).[123]
- 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 for a scenario of low population growth and 1.6°C global warming by 2070–2099 (compared to 1981–2010). 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.[124]

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

SOUTHERN AFRICA'S POTENTIAL TO ADAPT

As described here, climate change is already affecting all walks of life and aspects of the natural and built environment in southern 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.[125] Southern Africa's foremost options for adapting to climate change include:

- **Ecosystem-based adaptation** uses biodiversity and ecosystem services to assist people to adapt to climate change. Sometimes it is also described as 'nature-based solutions 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.[126]

- **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.[127] 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).[128] For example, maintaining indigenous forest ecosystems has benefits for both biodiversity and emissions reduction. However, wrongly targeting ancient grasslands and savannas for afforestation harm water security and biodiversity, and can increase emissions from fire and drought.[129]

> **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)[130]**

Beyond 1.5°C 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.[131]

- 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 – but often farmers with the lowest incomes cannot afford these without assistance.[132] However, **adaptation limits for crops in Africa will increasingly be reached for global warming of 2°C** (high confidence). There is a risk that there will not be genetic varieties of maize available that are sufficiently adapted to southern Africa's changing climate.[133]

- **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 work better when decision-making involves a wide range of actors affected by decisions.[134]

- 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.[135]

- **Even 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.[136]

- **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.[137] There is scope for governments to harness the role of the informal sector better in mitigation and adaptation through multi-level governance. This could include, for example, service providers such as informal water and sanitation networks.[138]

- **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 (such as vector-borne disease and crops).[139]

- The ability of southern African communities and sectors to pursue effective adaptation options to the full is **constrained by lack of finance.**[140]

> **The greatest gains in wellbeing can be achieved by prioritising finance to reduce climate risk for low-income and marginalised residents, including people living in informal settlements (high confidence)[141]**

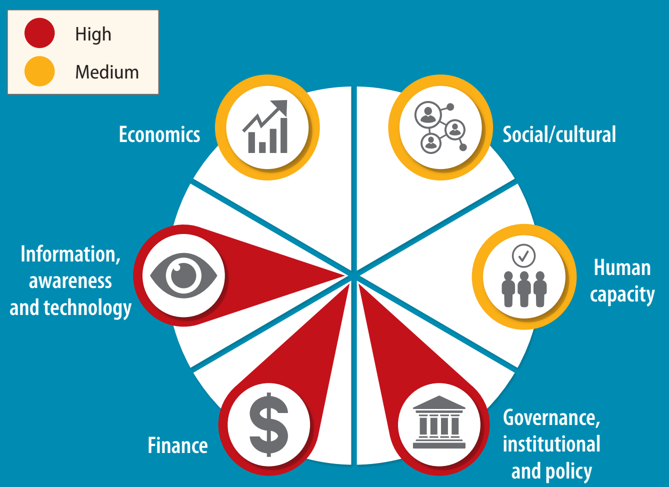


Figure 4 Constraints for the African continent that make it more difficult to plan and implement adaptation[142]

Informal settlement in Luanda, Angola. © Shutterstock/Adriana Mahdalova

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. This can reinforce inequality and fail to address underlying social vulnerabilities.[143] Access to adequate financial resources is crucial so that adaptation actions are well designed and do not create new vulnerabilities (see below).[144]

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 are ignored (high confidence).[145] These include infrastructure and institutions that are inflexible and costly, and increase risk and impacts (high confidence).[146]

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 bioenergy displaces subsistence farming and food crops, and so threatens food security; or displaces biodiversity-rich areas that provide valuable ecosystem services, such as freshwater flows. Overuse of fertilisers leading to environmental degradation is another form of maladaptation that undermines resilience.[147]

KEY INVESTMENT AREAS FOR A CLIMATE-RESILIENT SOUTHERN AFRICA

The IPCC's *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 climate change adaptation measures to support sustainable development for all[148]**

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.[149]

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).[150] 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.[151]

Many African countries, especially 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 the self-financing of 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.[152]

Aligning sovereign debt relief with climate goals could increase finance by redirecting debt-servicing payments to climate resilience.[153]

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.[154] 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').[155, 156] However, this is hindered by low national-level climate literacy rates, ranging from 25% in Mozambique to 60% in Malawi (average 35%),[157] 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.[158]

> **There is high confidence that together with improved institutional capacity building and strategic financial investment, climate services can help African stakeholders adapt to projected climate risks**[159]

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, research on Africa received just 3.8% of climate-related research funding globally.[160] Of this amount, only 14.5% went to African institutions, while 78% went to EU and North American institutions to do research on Africa.

> **From 1990–2019, research on Africa received just 3.8% of climate-related research funding globally**[161]

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).[162] 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.[163]

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).[164]

Robust legislative frameworks that develop or amend laws are an important basis for mainstreaming climate change across government and society. Stand-alone climate change legislation is largely absent in southern African countries, with the exception of a framework Bill drafted in South Africa and one under discussion in Zimbabwe. However, a number of countries have integrated climate change considerations into existing law, including Malawi, Mozambique and Zambia.[165]

Working across sectors and at transboundary levels can ensure that adaptation and mitigation actions in one sector do not exacerbate risks in other sectors, and cause maladaptation.[166, 167] Cross-sectoral approaches provide significant opportunities for large co-benefits and/or avoided damages. Examples of co-benefits include climate change adaptation supporting Covid-19 pandemic preparedness and 'One Health' approaches benefiting human and ecosystem health.[168] 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.[169]

> **Cross-sectoral 'nexus' approaches provide significant opportunities for large co-benefits and/or avoided damages (very high confidence)**[170]

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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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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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