FACTSHEET

NORTH AFRICA

CDKN Climate & Development Knowledge Network
ACDI African Climate & Development Initiative

THE IPCC'S SIXTH ASSESSMENT REPORT

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

Harvesting olives in Tunisia. By 1.5°C global warming, yields are projected to decline for olives in North Africa © Flickr/Citizen59

*Disputed border

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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.

North 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. North 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 North African economies and ecosystems[2]**

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

HOW NORTH 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, North Africa's climate has warmed even more than the global average in the past few decades:

Temperature: Average and seasonal surface temperatures have increased at twice the global rate over most regions in North Africa as a result of climate change (high confidence). Since the 1970s, temperatures have increased between 0.2°C and 0.4°C per decade, especially in the summer. Similar warming has occurred since the mid-1960s over the Sahara and the Sahel.[5]

Extreme heat and heat waves: Average maximum and minimum temperatures have increased by between +2°C and +3°C per century over North Africa, and hot days and tropical nights (minimum temperature above 20°C), as well as warm days and nights, have also become more frequent. The length of warm spells has increased in many North African countries and heat waves have become more intense and impacted a wider area across North Africa since 1980. Since 2000, the increase in heat wave events can be attributed to climate change.[6]

Marine heat waves: The number of heat waves in the ocean doubled in North Africa from 1982–2016, with 90–100% probability this was the result of human-induced climate change.[7]

Rainfall: Since 1960, average annual rainfall has decreased over most of North Africa. Since 2000, in western North Africa, average annual rainfall has recovered or become wetter with accompanying increases in heavy rainfall and flooding. However, in eastern North Africa, rain days of over 10mm per day have decreased and the number of consecutive dry days has increased.[8]

Extreme rainfall: Heavy rainfall and flooding have increased in the western parts of North Africa.[9]

Drought: North Africa is becoming more arid due to significant decreases in precipitation.[10]

NORTH 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, average annual surface temperatures in North Africa are projected to be higher than the global average.[16]

Heat waves: Heat waves are projected to become more frequent and intense even at 1.5°C of global warming. Children born in North Africa in 2020 will, under 1.5°C global warming, be exposed to 4–6 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: Average annual rainfall is projected to decrease in North Africa at warming levels of 2°C and higher (high confidence), with the most pronounced decrease in the northwestern parts.

Extreme rainfall: Extreme rainfall in North Africa is projected to decrease, notwithstanding observations of extreme rainfall in the west of North Africa in recent decades.[19]

Drought: Above 4°C global warming, meteorological drought frequency will increase and drought length will double from 2 to 4 months over North Africa from 2050–2100 (medium confidence).[20] [A meteorological drought is when there is an abnormal lack of rainfall.]

CLIMATE CHANGE IMPACTS WE HAVE ALREADY SEEN IN NORTH 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.[21]

Human life and health

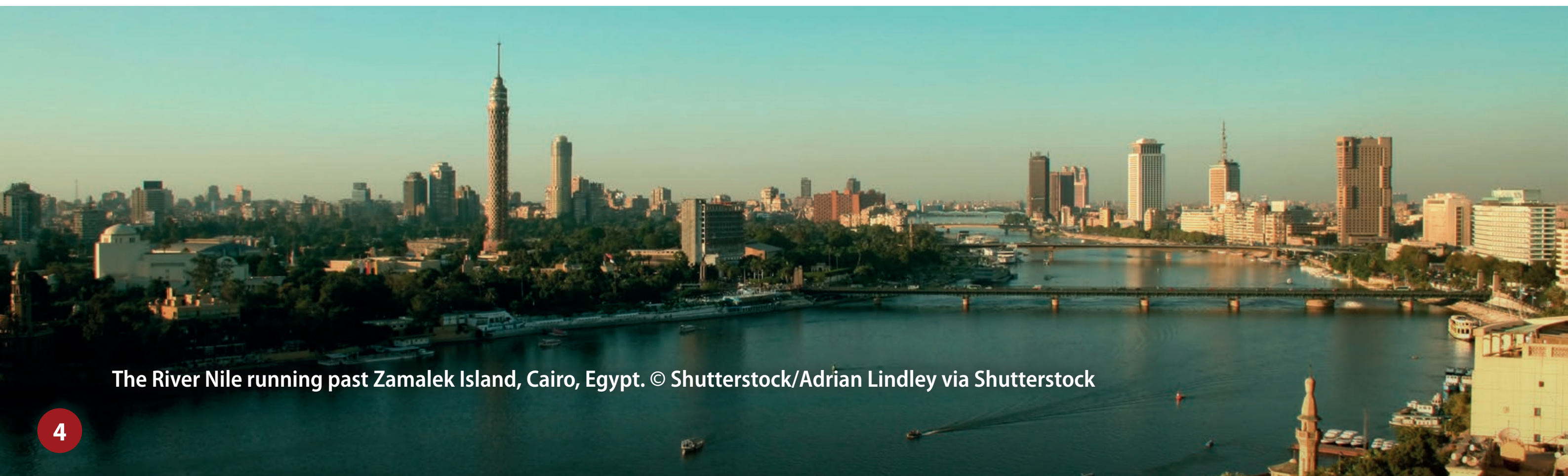
- Climate variability and change already affect the health of tens of millions of people in North Africa and across the continent, by exposing them to high temperatures and extreme weather, and increasing the range and transmission of infectious diseases (high confidence).[22]
- Recorded death rates have been above normal on days with raised temperatures in Tunisia – most commonly because of cardiovascular disease. Respiratory, stroke and non-communicable diseases have also been linked with heat.[23]
- 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.[24]
- 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).[25]

Ecosystems and biodiversity

- 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 savannas. This is a new area of scientific understanding and consensus since the IPCC's *Fifth Assessment Report* in 2014.[26]
- Human land-use 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.[27, 28]

- Vegetation changes affect animal species. For instance, bird, reptile and mammal species that depend on grassland habitats become rarer, as woody plants spread.[29]

- Small changes in the climate have had a large impact on freshwater ecosystems. Temperatures across North African freshwater bodies rose by 0.1–0.4°C in a decade; and by 0.4–0.6°C per decade in Lake Nassar in Egypt.[30] Increases in temperature, changes in rainfall, and reduced wind speed have altered the physical and chemical properties of inland water bodies, affecting water quality and the productivity of algae, invertebrates and fish (high confidence).[31]



The River Nile running past Zamalek Island, Cairo, Egypt. © Shutterstock/Adrian Lindley via Shutterstock

Food systems

- Climate change is reducing crop productivity in North Africa. Climate change has slowed the growth of agricultural productivity in Africa overall by 34% since the 1960s, the highest impact of any world region. Two-thirds of people in Africa perceive that climate conditions for agricultural production have worsened over the past ten years.[32]

- Encroachment by woody plants (shrubs and trees) on important grazing lands has reduced the availability of fodder for livestock.[33] The combination of high temperatures and high relative humidity can be especially dangerous for livestock and has already decreased dairy production in Tunisia.[34] Increased livestock mortality and livestock price shocks have been associated with droughts in Africa, as well as being a potential factor in localised conflicts.[35]

- 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.[36]

Water for people

- Rainfall and river discharge have been extremely variable in North 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.[37]

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.[38]
- In North Africa, livelihoods and economies are strongly dependent on agriculture. Pressure on water demand due to climate change and variability is threatening income, development processes and food security in the region (high confidence).[39]
- 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).[40]

Young girls collecting water in Sudan. Bad weather may lead households to keep children home from school. © Shutterstock/Riccardo Mayer

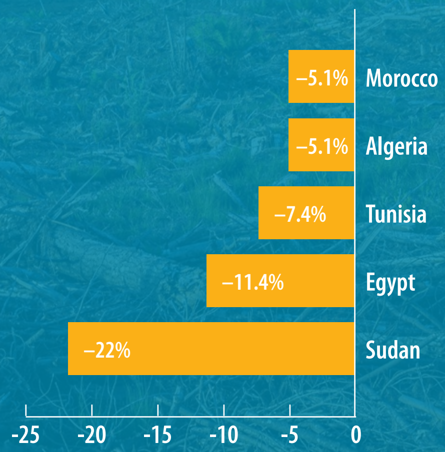


Figure 1 Percentage change in GDP per capita in North African countries due to observed climate change (1991–2010)[41]

Human settlements and infrastructure

- Sea level rise and storm surge have impacted the Nile Delta coast: In 2010, 2011 and 2015, the Nile Delta coast experienced storm surges of 1.2 metres above mean sea level (0.4–0.5 metres is more typical of this area). There was coastal flooding and damage to some coastal structures and moderate flooding of the Nile Delta lowlands. Potable water supplies were affected by saltwater intrusion. There was coastal erosion and property damage. Meanwhile, Alexandria city experienced flooding as a result of heavy rainfall in 2015. Increased turbidity of water sources affected efficiency of water treatment plants leading to reduction of water supplies, affecting public health systems.[42]
- High water demand due to high rates of urbanisation and population growth, coupled with drought, has reduced groundwater levels in cities such as Tripoli. This has increased saltwater intrusion into groundwater in coastal areas, reducing water availability and water security. Such changes especially impact people who are not connected to municipal water networks.[43]
- There is an urban heat island effect in North Africa. The present-day number of high heat-stress nights is around 10 times larger in urban areas than in rural areas.[44]

> **Globally, the highest rates of population growth and urbanisation are taking place in Africa's coastal zones (high confidence). Coastal urban populations account for 25–29% of the total population in West, North and southern Africa[45]**

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.[46]

Migration

- Climate-related displacement is widespread in Africa.[47] Migrants often move to informal settlements in urban areas located in low-lying coastal areas or alongside rivers, exacerbating existing vulnerabilities.[48]
- In Africa, most climate-related migration is currently within countries or between neighbouring countries, rather than to distant high-income countries (high confidence).[49]

Conflict

- There is growing evidence linking increased temperatures and drought to conflict risk in Africa (high confidence).[50] 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.[51]

Compound risks

- In Africa, including North 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.[52]
- 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.[53]

> **Climate change is already challenging the health and wellbeing of African communities, compounding the effects of underlying inequalities (high confidence)[54]**

PREPARING FOR FUTURE CLIMATE RISKS

Human life and health

- Above 1.5°C, the risk of heat-related deaths rises sharply (high confidence), with at least 15 additional deaths per 100,000 annually across large parts of Africa.[55]
- At 1.5°C global warming, the risk of vector-borne diseases becomes high, with millions more North Africans exposed to dengue fever and zika virus.[56]
- Very high risk for human health is projected to occur from 2°C global warming (high confidence).[57] Climate change-related illness will strain healthcare systems and economies in North Africa.[58]
- Above 2.5°C, heat-related deaths are expected to 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.[59]
- The difference between an intermediate global warming scenario of 2.5°C and a very high global warming scenario of over 4°C could be tens of thousands of African lives saved from heat-related illness – especially in North, West, Central and parts of East Africa.[60]


A young farmer harvests his wheat crop near Luxor, Egypt. © Flickr/Mina Guli

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[61]

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 Sahara and Sahel
>2°C	Plants, insects, vertebrates	>50%	18%	Widespread
>4°C	Plants, insects, vertebrates	>50%	45–73%	Widespread

Figure 2 Severe heat stress duration for cattle in Africa with increased global warming[75]

KEY: (A) Number of days per year over the heat stress threshold in the historical climate (1985–2014). **(B and C)** Increase in the number of days per year over the heat stress threshold for global warming 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).[76]

- At 2°C global warming, 36% of African freshwater fish species are vulnerable to local population collapse, 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.[62]
- At 2°C global warming, 20% of North African mammals may lose all suitable climates; and at 2.5°C global warming, more than half of the habitat of coastal lobster species in North Africa are projected to disappear.[63]
- 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 ecosystems reaching irreversible tipping points.[64]

> **Tipping point: A level of change in system properties beyond which a system reorganises, often abruptly, and does not return to the initial state[65]**

Food systems

- Future warming will negatively affect food systems in Africa by shortening growing seasons and increasing water stress (high confidence).[66] Dryland agricultural areas are especially sensitive to changes in rainfall. Without adaptation, substantial yield declines are projected for staple crops in North Africa.[67] However, there is uncertainty in the actual yield changes for wheat in North Africa, on the basis of how wheat will respond to adaptation actions and increased carbon dioxide concentrations in the atmosphere.[68]
- By 1.5°C global warming, yields are projected to decline for olives in North Africa.[69]
- 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.[70]
- Compared to 1995–2005, economic welfare in the agriculture sector in North Africa is projected to decline 5% for 2°C global warming and 20% for 3°C global warming. This is more pessimistic than previous economic estimates.[71]

- Climate change threatens livestock production in North Africa (high agreement, low evidence)[72] 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.[73] The primary productivity of rangelands is projected to decline by 32% for North Africa over the 2000–2050 period, under a high-warming scenario.[74]

- Ocean warming, acidification and de-oxygenation are projected to affect the early life of several marine food species, including fish and crustaceans.[77] The greater the warming, the more the Maximum Catch Potential of Africa's marine fisheries will decrease.[78]
- 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.[79]
- In Morocco especially, people depend heavily on fish for nutrition and fisheries are at high climate risk, even under a low-warming scenario.[80]
- 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.[81]
- For freshwater fisheries, areas where fish are caught mostly in lakes are less likely to experience reductions in fish catch than areas reliant on rivers and floodplains.[82]

- 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.[83]

Water for people

- There is increasing demand for water for agricultural and energy production in the eastern part of North Africa.[84] Climate change introduces significant risks to governments' 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 each river basin.[85]
- One study found that 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 scenario, compared to a scenario without climate change.[86]
- In the upper White Nile basin, increased rainfall (originating in the Lake Victoria Basin) under a mid-range warming scenario could lead to variability in future river discharge of 5 to 26%.[87]
- In the upper Blue Nile basin, models indicate an increase in runoff of up to 15% during the wet season, with an accompanying higher risk of flash floods, from 2021–2040, under the highest global warming scenario. Meanwhile, models show a decrease in runoff of up to −24% in the dry season under the same scenario and timeframe, which could lead to less water for irrigation, and household and business use.[88]
- The Middle Draa valley in Morocco is expected to experience more severe droughts and a lack of water supply in the future.[89]

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. For Africa, damages to GDP are projected across most future-warming scenarios.[90]
- 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.[91] 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.[92]

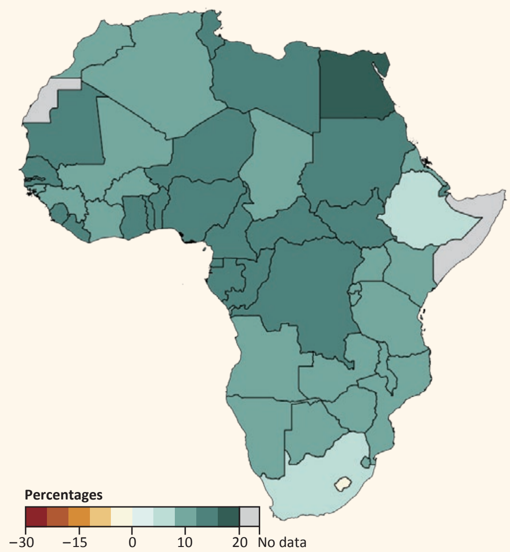


Figure 3 Differences in GDP per capita for African countries for the period 2081–2100, if global warming is limited to 1.5°C versus 2°C above pre-industrial temperatures[93]

For example, the map shows that Egypt's GDP per capita would be around 20% higher at 1.5°C global warming, than it would be at 2°C global warming.

High population growth and urbanisation in low-elevation coastal zones will be a major driver of exposure to sea level rise in the next 50 years (high confidence)[97]

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.[94] Approximately 59% of urban dwellers live in informal settlements and this number is expected to increase.[95] 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.[96] High population growth and urbanisation in low-elevation coastal zones will be a major driver of exposure to sea level rise in the next 50 years (high confidence).[97] (See below, Alexandria and Cairo)

- Egypt and Sudan are in the top 20 countries globally for projected future damages from flooding.[98]

Egyptian cities' exposure to climate hazards

Selected African cities exposed to sea level rise include Cairo and Alexandria in Egypt. Orange shows built-up area in 2014. Shades of blue show permanent flooding due to sea level rise by 2050 and 2100 under low, medium and high greenhouse gas emissions scenarios.[100] Darker colours for higher-emissions scenarios show areas projected to be flooded in addition to those for lower-emissions scenarios. The figure assumes failure of coastal defences in 2050 and 2100. Some areas are already below current sea level rise and coastal defences need to be upgraded as the sea level rises in Egypt.

In the absence of any adaptation, Egypt is one of the countries (along with Mozambique, and Nigeria) projected to be most affected by sea level rise in terms of the number of people at risk of flooding annually in a 4°C or high-end warming scenario. Recent estimates have explored the potential damages due to sea level rise and coastal extreme events in 12 major African cities. City characteristics and exposure play a larger role in expected damages and risk than changes in sea level *per se*. The city of Alexandria in Egypt leads the ranking, with aggregate expected damage ranging from US$ 36 billion to US$ 79.4 billion for the medium- to highest-warming scenarios.[101]

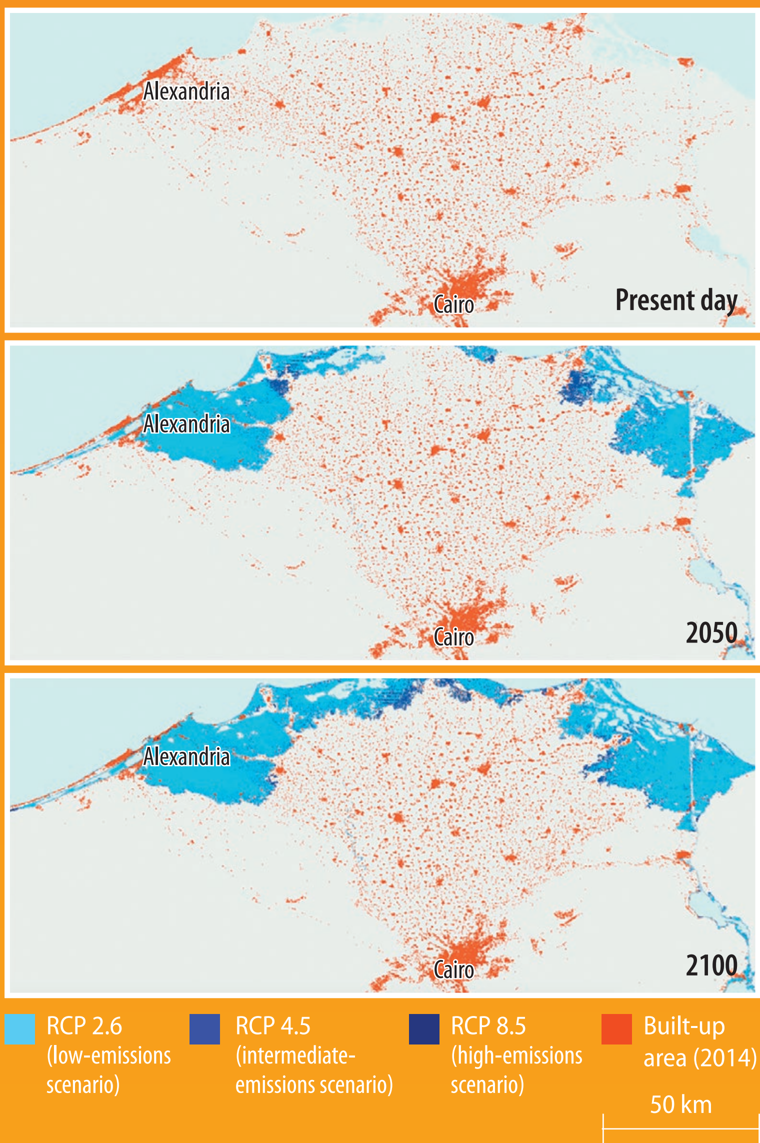
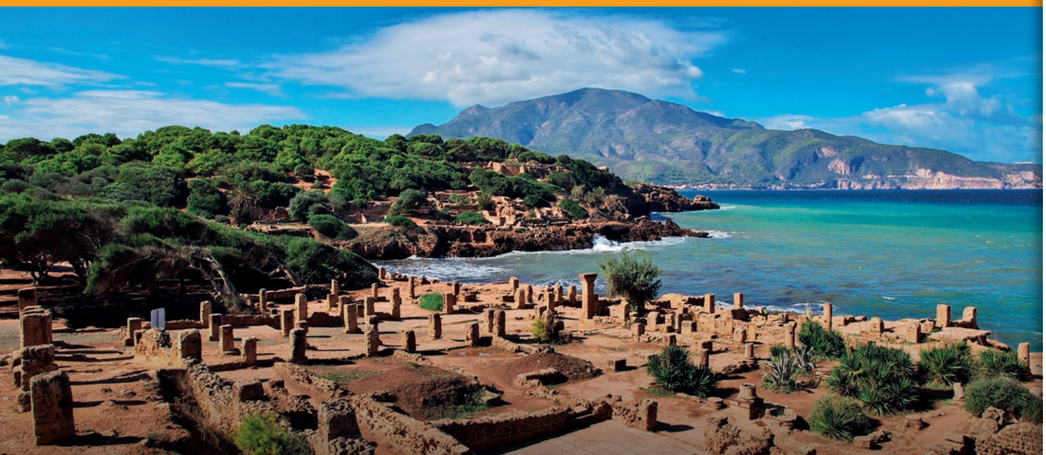


Figure 4 Exposure to flooding from sea level rise in Cairo and Alexandria[99]

North Africa's heritage at risk

African heritage is already at risk from climate hazards, including sea level rise and coastal erosion (high confidence).[104] This includes loss of traditional cultures and ways of life, loss of language and knowledge systems and damage to heritage sites.[105] Most of these heritage sites are neither prepared for, nor adapted to, future climate change (high confidence).[106]

Climate risk to African heritage has not been systematically 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.[107, 108, 109] North Africa has seven of the 10 cultural sites facing sea level rise, but also medium and high risk of erosion under both current and future conditions (2050 and 2100). These are: Tipasa and Kasbah of Algiers in Algeria; the Archaeological Site of Sabratha and Archaeological Site of Leptis Magna in Libya; the Archaeological Site of Carthage, the Punic town of Kerkuane and its Necropolis, and Medina of Sousse in Tunisia.[110]



Tipasa, a UNESCO World Heritage Site in Algeria, is at risk from coastal flooding and erosion due to sea level rise. © Shutterstock/Sergey-73

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.[102]

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.[103]

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).[111]
- 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.[112]

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

NORTH AFRICA'S POTENTIAL TO ADAPT

Climate change is already affecting all walks of life and aspects of the natural and built environment in North 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.[113] North 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. 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.[114]

- **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.[115] 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).[116] For example, 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.[117]

  Beyond 1.5°C of global warming, certain ecosystems – such as mangroves and marshes – will be irreversibly damaged and thus will contribute less to nature-based adaptation solutions.[118]

- In agriculture, there is considerable 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.[119]

- **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.[120]

> **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)**[121]

- 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.[122]

- 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.[123]

- **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.[124] 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.[125]

> 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)[126]

- **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).[127]
- The ability of North African communities and sectors to pursue effective adaptation options to the full is **constrained by lack of finance.**[128]

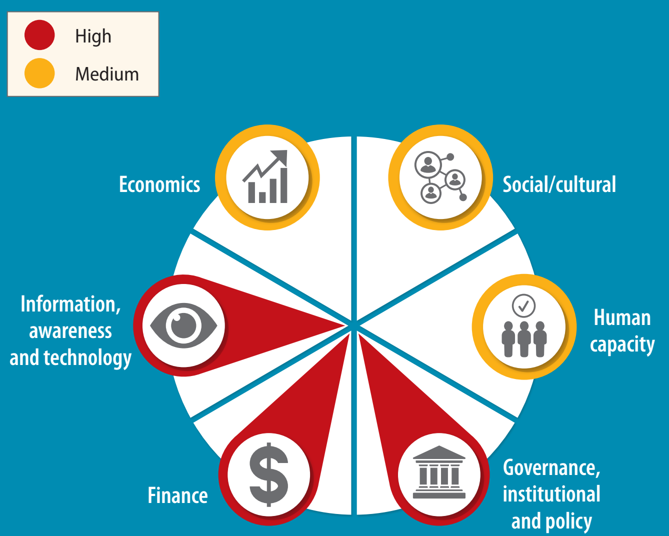


Figure 5 Constraints for the African continent that make it more difficult to plan and implement adaptation

Women farmers growing vegetables in Sudan. © Flickr/Nicole Jawerth, IAEA

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.[129] Access to adequate financial resources is crucial.[130]

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).[131] These include infrastructure and institutions that are inflexible and costly, and increase risk and impacts (high confidence).[132]

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.[133]

KEY INVESTMENT AREAS FOR A CLIMATE-RESILIENT NORTH 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 adaptation measures to support sustainable development for all[134]**

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.[135]

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).[136] 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.[137]

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.[138]

> **Only 15% of adaptation finance commitments for North Africa were disbursed in the period 2014–2018[139]**

Aligning sovereign debt relief with climate goals could increase finance by redirecting debt-servicing payments to climate resilience.[140]

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.[141] 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').[142, 143] However, this is hindered by low climate literacy rates (as low as 23% for Tunisia),[144] and limited weather and climate data.

> Research on the impacts of human-induced climate change on society is still scarce in many regions, especially North and Central Africa[145]

Increased funding for African partners, and direct control of research design and resources can provide more actionable insights on adaptation in Africa.[146]

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.[147] Of this, 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[148]

Flooding in Alexandria, Egypt. © Shutterstock/Justina Atlasito

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).[149] 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.[150]

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).[151]

Robust legislative frameworks that develop or amend laws are an important basis for mainstreaming climate change across government and society. No country in North Africa has enacted a climate change law, although Algeria and Morocco have integrated climate change considerations into existing law.[152]

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.[153] Cross-sectoral approaches provide significant opportunities for large co-benefits and/or avoided damages (very high confidence).[154] Examples of co-benefits include climate change adaptation supporting Covid-19 pandemic preparedness and 'One Health' approaches benefiting human and ecosystem health.[155] 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.[156]

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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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ACDI is an inter- and transdisciplinary research and training institute that brings academics and researchers from the University of Cape Town (UCT) and other higher education and research institutions together with business, civil society and government actors to co-produce and test new insights, evidence and innovations with the specific context of addressing the climate and development challenges of Africa from an African perspective.

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