State of the Climate in Africa

2020

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

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Contents

Foreword

State of the Climate in Africa 2020 is the second in the series on the continent, following the first report in 2019. The 2020 report, like its predecessor, is a collaborative effort involving the World Meteorological Organization (WMO), experts from Africa, other United Nations agencies and the African Union, as well as experts from partner international scientific and technical institutions.

During 2020, the climate indicators in Africa were characterized by continued warming temperatures, accelerating sea-level rise, extreme weather and climate events, such as floods and droughts, and associated devastating impacts. The rapid shrinking of the last remaining glaciers in eastern Africa, which are expected to melt entirely in the near future, signals the threat of imminent and irreversible change to the Earth system.

Along with COVID-19 recovery, enhancing climate resilience is an urgent and continuing need. Investments are particularly needed in capacity development and technology transfer, as well as in enhancing countries' early warning systems, including weather, water and climate observing systems.

I take this opportunity to thank regional and international organizations and individual experts for collaborating on this issue of the State of the Climate in Africa for the second consecutive year. WMO remains committed to enhancing this collaboration and to issuing annual State of the Climate reports for the six WMO Regions..

Prof. Petteri Taalas
Secretary General
World Meteorological Organization

Preface

Climate change is a global threat with severe, cross-sectoral, long-term and, in some cases, irreversible impacts. Africa is witnessing increased weather and climate variability, which leads to disasters and disruption of economic, ecological and social systems.[1] By 2030, it is estimated that up to 118 million extremely poor people (i.e. living on less than US$ 1.90/day) will be exposed to drought, floods and extreme heat in Africa,[2] if adequate response measures are not put in place. This will place additional burdens on poverty alleviation efforts and significantly hamper growth in prosperity.[3] In sub-Saharan Africa, climate change could further lower gross domestic product (GDP) by up to 3% by 2050.[4] This presents a serious challenge for climate adaptation and resilience actions because not only are physical conditions getting worse, but also the number of people being affected is increasing.

Agenda 2063 of the African Union – "The Africa We Want" – is a shared strategic framework for inclusive growth and sustainable development in Africa. It recognizes climate variability and climate change as one of the main challenges threatening the continent's realization of the goals of Agenda 2063. In line with the Agenda, which is aligned with the United Nations Sustainable Development Goals, the Integrated African Strategy on Meteorology (Weather and Climate Services), adopted at the African Ministerial Conference on Meteorology, provides strategic guidance on the development and application of weather, water and climate services, which are critical for climate-resilient development in Africa.

The State of the Climate in Africa reports inform the African Union and its member States on a regular basis, providing critical science-based information for climate policy and decision-making about the status of the climate and its associated annual variability. The African Union Commission will continue to play a leadership role in coordinating the implementation of weather- and climate-related strategic frameworks in Africa, including disaster risk reduction, to ensure effective and coherent development and delivery of adequate, science-based and sector-specific weather, water and climate services for the continent's socioeconomic development.

H.E. Josefa Leonel Correia Sacko
Commissioner for Rural Economy
and Agriculture
African Union Commission

1 Niang, I. et al., 2014: Africa. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (V.R. Barros et al., eds.). Cambridge and New York, Cambridge University Press, https://www.ipcc.ch/report/ar5/wg2/.

2 Shepherd, A. et al., 2013: *The Geography of Poverty, Disasters and Climate Extremes in 2030*, https://cdn.odi.org/media/documents/8633.pdf.

3 Jafino, B.A. et al., 2020: *Revised Estimates of the Impact of Climate Change on Extreme Poverty by 2030.* Policy Research Working Paper, No. 9417. Washington, DC, https://openknowledge.worldbank.org/handle/10986/34555.

4 Global Center on Adaptation, 2021: A global call from African leaders on the Covid-19-climate emergency and the Africa Adaptation Acceleration Program, https://gca.org/news/a-global-call-from-african-leaders-on-the-covid-19-climate-emergency-and-the-africa-adaptation-acceleration-program/.

Key messages

The warming trend for 1991–2020 was higher than for the 1961–1990 period in all African subregions and significantly higher than the trend for 1931–1960.

Annual average temperatures in 2020 across the continent were above the 1981–2010 average in most areas. The largest temperature anomalies were recorded in the north-west of the continent, in western equatorial areas and in parts of the Greater Horn of Africa.

The rates of sea-level rise along the tropical and South Atlantic coasts and Indian Ocean coast are higher than the global mean rate, at approximately 3.6 mm/yr and 4.1 mm/yr, respectively. Sea levels along the Mediterranean coasts are rising at a rate that is approximately 2.9 mm/yr lower than the global mean.

The current retreat rates of the African mountain glaciers are higher than the global mean and if this continues will lead to total deglaciation by the 2040s. Mount Kenya is expected to be deglaciated a decade sooner, which will make it one of the first entire mountain ranges to lose glaciers due to anthropogenic climate change.

Higher-than-normal precipitation predominated in the Sahel, the Rift Valley, the central Nile catchment and north-eastern Africa, the Kalahari basin and the lower course of the Congo River. Dry conditions prevailed along the south-eastern part of the continent, in Madagascar, in the northern coast of the Gulf of Guinea and in north-western Africa.

The compounded effects of protracted conflicts, political instability, climate variability, pest outbreaks and economic crises, exacerbated by the impacts of the coronavirus disease (COVID-19) pandemic, were the key drivers of a significant increase in food insecurity.

Food insecurity increases by 5–20 percentage points with each flood or drought in sub-Saharan Africa. Associated deterioration in health and in children's school attendance can worsen longer-term income and gender inequalities. In 2020, there was an almost 40% increase in population affected by food insecurity compared with the previous year.

An estimated 12% of all new population displacements worldwide occurred in the East and Horn of Africa region, with over 1.2 million new disaster-related displacements and almost 500 000 new conflict-related displacements. Floods and storms contributed the most to internal disaster-related displacement, followed by droughts.

In sub-Saharan Africa, adaptation costs are estimated at US$ 30–50 billion (2–3% of regional gross domestic product (GDP)) each year over the next decade, to avoid even higher costs of additional disaster relief. Climate-resilient development in Africa requires investments in hydrometeorological infrastructure and early warning systems to prepare for escalating high-impact hazardous events.

Household surveys by the International Monetary Fund (IMF) in Ethiopia, Malawi, Mali, the Niger and the United Republic of Tanzania found, among other factors, that broadening access to early warning systems and to information on food prices and weather (even with simple text or voice messages to inform farmers on when to plant, irrigate or fertilize, enabling climate-smart agriculture) has the potential to reduce the chance of food insecurity by 30 percentage points.

Rapid implementation of African adaptation strategies will spur economic development and generate more jobs in support of economic recovery from the COVID-19 pandemic. Pursuing the common priorities identified by the African Union Green Recovery Action Plan would facilitate the achievement of the continent's sustainable and green recovery from the pandemic while also enabling effective climate action.

Global climate context in 2020

Concentrations of the major greenhouse gases (GHGs) – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) – continued to increase in 2019 and 2020.[5] Despite the La Niña conditions in the latter part of the year, the global mean temperature in 2020 was one of the three warmest on record (Figure 1), at about 1.2 °C above pre-industrial levels. The past six years, including 2020, have been the six warmest years on record. Global mean sea level has risen throughout the altimeter record, but recently it has been rising at a faster rate partly due to increased melting of the Greenland and Antarctic ice sheets.

The goal of the Paris Agreement[6] is to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels. Progress towards this global goal is measured relative to pre-industrial conditions (1850–1900). There are no separate limits for temperatures at a regional scale. In fact, it is impossible to calculate a reliable pre-industrial baseline for many regional time series owing to a lack of data for much of the Earth from the late nineteenth century. Consequently, 1981–2010 is used as a temperature baseline in this report.

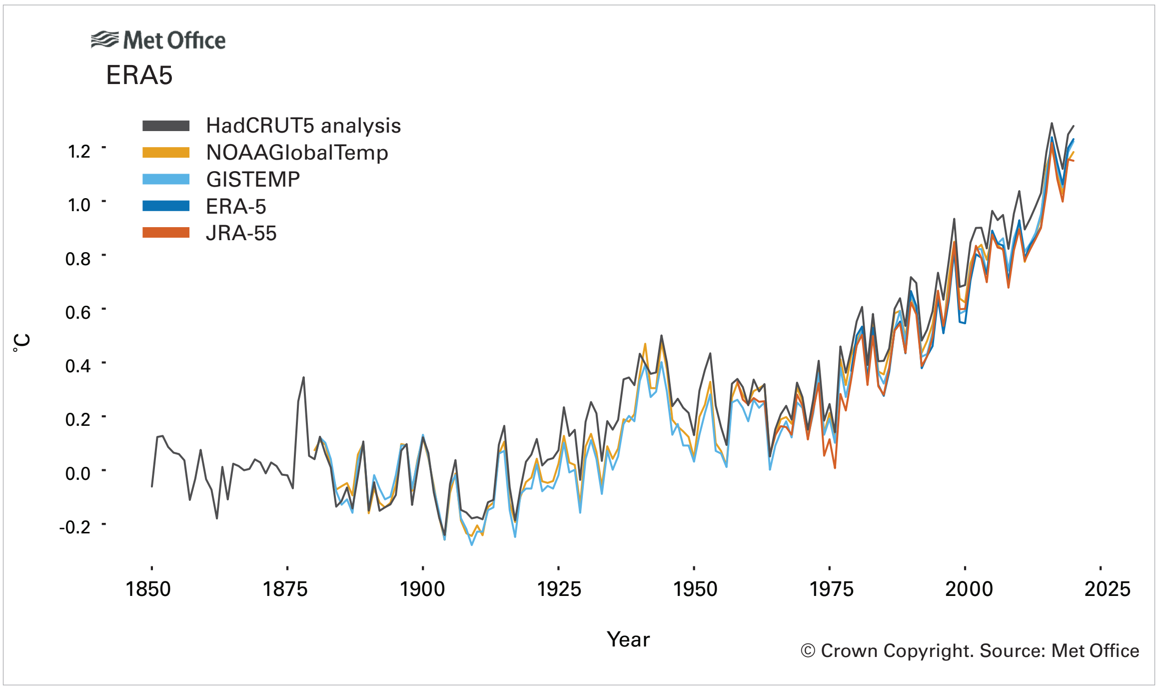


Figure 1. Global annual mean temperature difference from pre-industrial conditions (1850–1900) for five global temperature data sets. *Source:* Met Office, United Kingdom

5 Friedlingstein, P. et al., 2020: Global Carbon Budget 2020. *Earth System Science Data*, 12(4): 3269–3340, https://doi.org/10.5194/essd-12-3269-2020.

6 https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

Temperature in Africa in 2020

Near-surface (2 m) air temperature averaged across Africa in 2020 was between 0.45 °C and 0.86 °C above the 1981–2010 average (Figure 2), depending on the data set used, ranking 2020 between the third and eighth warmest year on record. Africa warmed faster than the global average temperature over land and ocean combined. This is consistent with the Intergovernmental Panel on Climate Change (IPCC) special report on climate change and land,[7] which showed that land areas have consistently warmed faster than the global average. Predominantly tropical areas have warmed more slowly than higher latitudes such as Europe and Asia. This analysis is based on six data sets – HadCRUT5, NOAAGlobalTemp, GISTEMP, Berkeley Earth, JRA-55 and ERA5 – validated in some cases with in situ observations.[8]

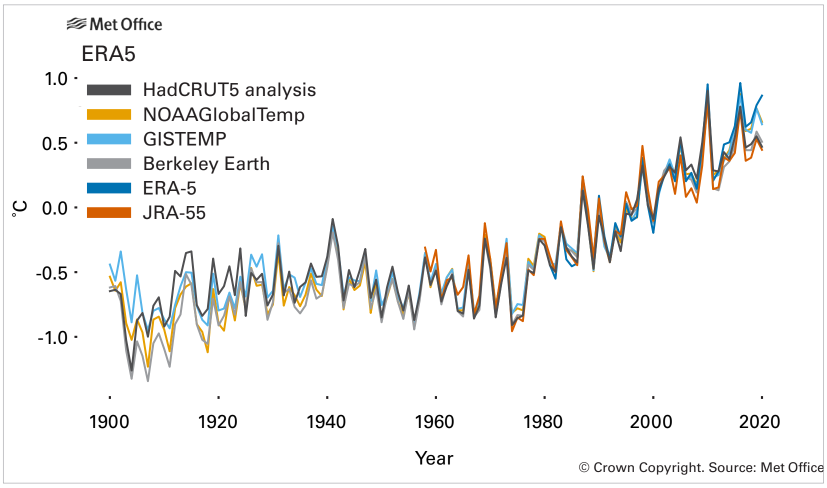


Figure 2. Area average land air temperature anomalies in °C relative to the 1981–2010 long-term average for Africa (WMO Regional Association I) based on six temperature data sets. *Source:* Met Office, United Kingdom

At subregional scales, the temperature analysis using the six data sets shows that the warming trend in the 1991–2020 period was higher than in the 1961–1990 period in all African subregions and significantly higher than in the 1931–1960 period (Figure 3). Uncertainty in the trends of the earlier two periods is larger than for the latter two periods, which is not necessarily well described by the spread of the available data sets.

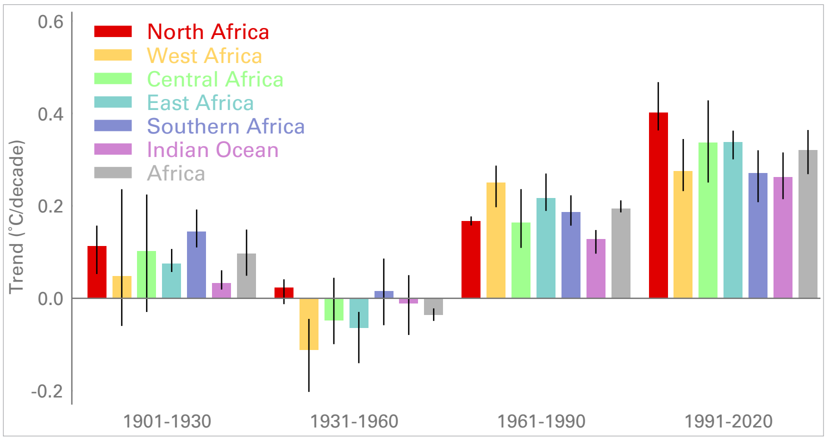


Figure 3. Trends in the area average temperature anomaly time series for the subregions of Africa and for the whole region over four sub-periods. The black lines at the top of each bar indicate the range of the trends calculated from the six data sets.

Annual average temperatures in 2020 across the continent were above the 1981–2010 average in most areas (Figure 4). The largest temperature anomalies were recorded in the north-west of the continent, in western equatorial areas and in parts of the Greater Horn of Africa. However, near-average or slightly below-average temperatures were recorded in Southern Africa, the north of Lake Victoria and the Sahel region.

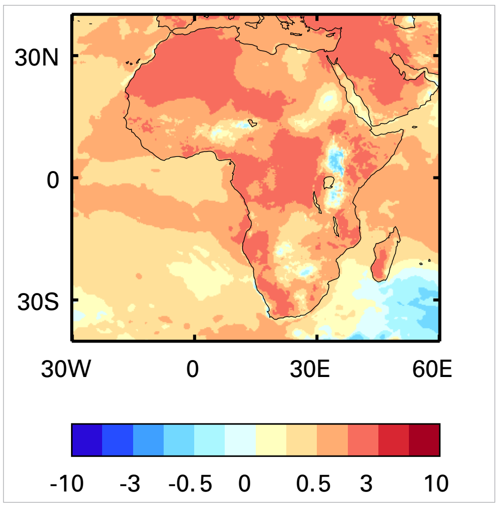


Figure 4. Map of near-surface annual air temperature anomalies relative to the 1981–2010 average. *Source:* European Centre for Medium-Range Weather Forecasts (ECMWF) ERA5 data set

7 IPCC, 2019: *Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (P.R. Shukla et al., eds.), https://www.ipcc.ch/srccl/.

8 Further information about these data sets is provided at the end of this report.

Sea level

Since the early 1990s, sea level has been routinely measured by high-precision altimeter satellites at global and regional scales. Satellite-derived data indicate that the rise in global mean sea level has accelerated due to ocean warming and land ice melt. They also show that the sea-level rise is not geographically uniform, primarily due to non-uniform ocean thermal expansion and regional salinity variations. Other important factors that influence regional sea level include the ice mass loss from West Antarctica and Greenland, ocean thermal expansion, gravitational, deformational and rotational effects, changes in ocean circulation, steric (freshwater/salinity) effects, groundwater extraction, reservoir construction, as well as changes in atmospheric wind and pressure.

Analysis based on the Copernicus Climate Change Service (C3S) gridded sea-level data set[9] shows that the sea-level change rates on the Atlantic side of Africa were rather uniform and close to the global mean, while the rates were slightly higher on the Indian Ocean side (Figure 5).

The Mediterranean coasts display the lowest sea-level rise, at approximately 2.9 mm/yr lower than the global mean. Sea-level rise along the tropical and South Atlantic coasts is higher than the global mean, at approximately 3.6 mm/yr.

The sea-level time series along the Indian Ocean coast show the highest trend (4.1 mm/yr) and significant interannual variability, likely driven by the Indian Ocean Dipole (IOD), a mode of internal climate variability of the Indian Ocean. Positive phases of the IOD are often (but not always) triggered by El Niño–Southern Oscillation (ENSO) (e.g. in 1998 and 2015/2016), but can occur under neutral ENSO conditions (as in 2019).

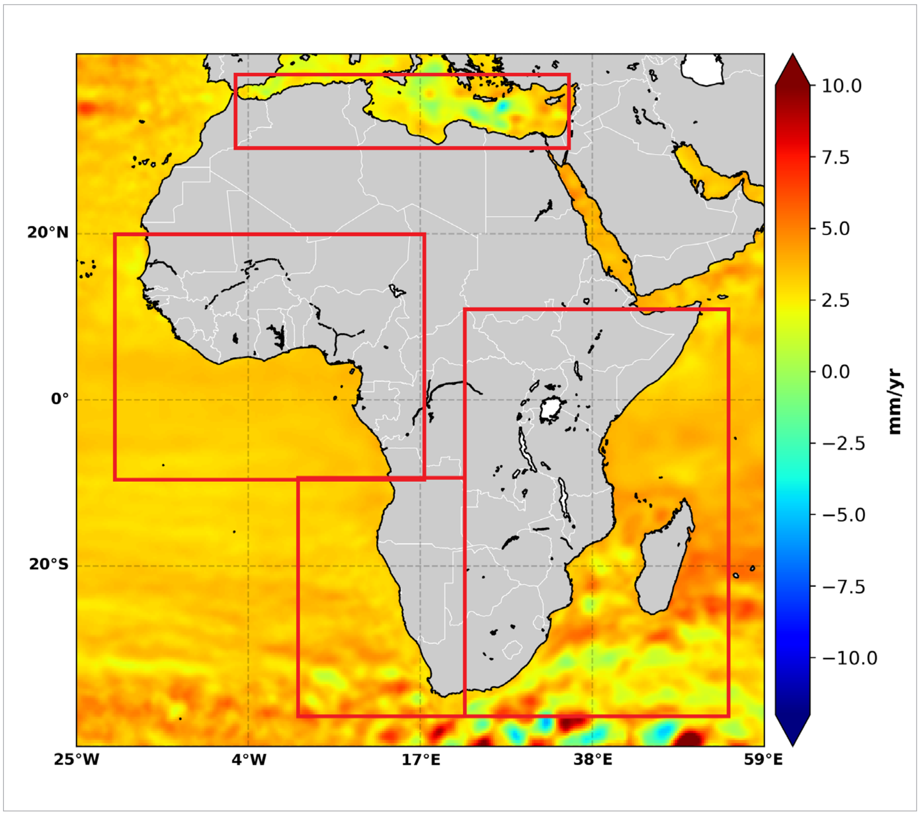


Figure 5. Sea-level trends from January 1993 to June 2020 (mm/yr). The red boxes indicate the areas for the analysis of coastal sea-level trends: the Mediterranean Sea, the tropical Atlantic, the South Atlantic and the Indian Ocean. *Source:* C3S

9 C3S, https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-sea-level-global

Mountain glaciers

Presently, only three mountains in Africa are covered by glaciers – the Mount Kenya massif (Kenya), the Rwenzori Mountains (Uganda) and Mount Kilimanjaro (United Republic of Tanzania). Although these glaciers are too small to act as significant water reservoirs, they are of eminent touristic and scientific importance. Like glaciers in other mountain ranges, the African glaciers reached a late Holocene maximum extent around 1880. Since then, they have been shrinking and are now at less than 20% of their early twentieth century extent (Figure 6). Retreat rates are higher than the global mean.[10] If current retreat rates prevail, the African mountains will be deglaciated by the 2040s. Mount Kenya is likely to be deglaciated a decade sooner, which will make it one of the first entire mountain ranges to lose glaciers due to anthropogenic climate change.[11,12]

Reduced snowfall amounts and frequency on the East African summits are related to the altered sea-surface temperature (SST) patterns across the Indian Ocean, that is, a change of the IOD. The impinging air masses increase thermodynamic stability, which impedes the formation of deep clouds and precipitation at the summit levels.[13,14] Establishing such teleconnections requires long-term in situ observations at the summits, which scientists – from the University of Innsbruck (Austria), University of Otago (New Zealand), University of Erlangen-Nuremberg (Germany) and University of Massachusetts Amherst (United States of America) – have maintained during the last two decades through considerable physical and financial efforts. The work is currently at risk of being abandoned as a result of increasing administrative barriers. The African glaciers' imminent loss demands more vigorous endeavours to keep in situ monitoring programmes alive; the large-scale atmosphere-ocean dynamics of the African glaciers are also relevant for global climate change monitoring.

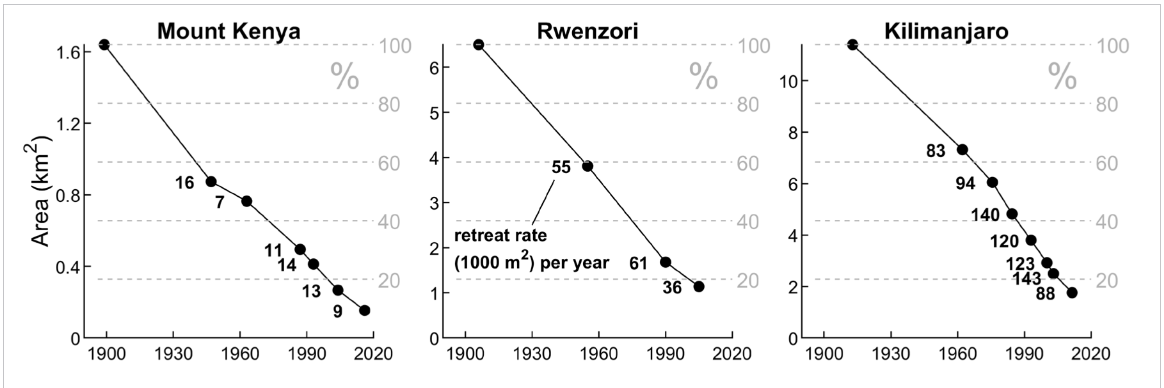


Figure 6. Changes of the glacier area on Mount Kenya, Rwenzori and Kilimanjaro. The total glacier area is indicated on the y-axes (note the different scales) and the timeline on the x-axes. Bold numbers depict the mean annual area change during the marked and the previous survey year. *Sources*: Mölg et al, 2013; Collier, E. et al., 2018: Recent atmospheric variability at Kibo summit, Kilimanjaro, and its relation to climate mode activity. *Journal of Climate*, 31: 3875–3891; Mölg, T. et al., 2020: Mesoscale atmospheric circulation controls of local meteorological elevation gradients on Kersten Glacier near Kilimanjaro summit. *Earth System Dynamics*, 11: 653–672.

10 Zemp, M. et al., 2019: Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. *Nature*, 568: 382–386, https://www.nature.com/articles/s41586-019-1071-0.

11 Prinz, R. et al., 2016: Climatic controls and climate proxy potential of Lewis Glacier, Mt. Kenya. The Cryosphere, 10: 133–148.

12 Prinz, R. et al., 2018: Mapping the loss of Mt. Kenya's glaciers: an example of the challenges of satellite monitoring of very small glaciers. *Geosciences*, 8(5): 174, https://www.mdpi.com/2076-3263/8/5/174/htm.

13 Mölg, T. et al., 2009: Temporal precipitation variability versus altitude on a tropical high mountain: observations and mesoscale atmospheric modelling. *Quarterly Journal of the Royal Meteorological Society*, 135(643): 1439–1455, https://doi.org/10.1002/qj.461.

14 Mölg, T. et al., 2013: East African glacier loss and climate change: corrections to the UNEP article "Africa without ice and snow". *Environmental Development*, 6: 1–6.

Precipitation

Precipitation in Africa is highly variable in space owing to diverse and complex topographical or orographical features and circulation regimes, but also on a temporal scale owing to various large-scale climate drivers, such as the Atlantic dipole, IOD and ENSO, as well as the usual internal variability that characterizes precipitation in general.

In 2020, prominent features included a large and contrasting geographical distribution of precipitation excess and deficit compared with the long-term 1981–2010 average (Figure 7). On the one hand, above-normal precipitation totals were recorded in the northern Sahel region, associated with a stronger and northern extension of the West African summer monsoon, the Nile and most parts of the Congo basin, the northern Kalahari basin and the lower course of the Congo River. On the other hand, the largest precipitation deficits were recorded around southern, central and eastern Angola, the southern Democratic Republic of the Congo, Zambia, northern Zimbabwe, west of the Mozambique Channel, the Congo basin, central and southern Madagascar, the south-eastern coastal region, the northern coast of the Gulf of Guinea and north-west of the Atlas Mountains. Below-normal precipitation amounts were also recorded in the Somali peninsula and south-western Africa.

With regard to specific subregions, in West Africa precipitation totals in 2020 were generally higher than the long-term 1981–2010 average, continuing the above-average

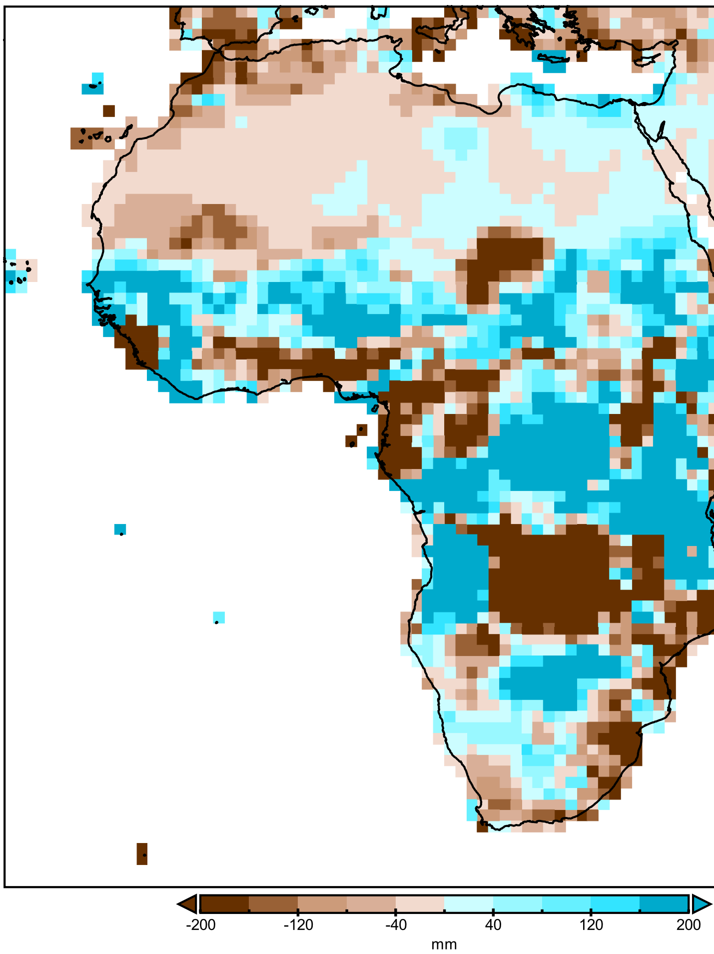


Figure 7. Absolute precipitation anomalies for 2020 in relation to the 1981–2010 reference period. Blue areas indicate above-average precipitation while brown areas indicate below-average precipitation. *Source:* Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany[15]

15 Schneider, U. et al., 2020: *GPCC Monitoring Product: Near Real-Time Monthly Land-Surface Precipitation from Rain-Gauges Based on SYNOP and CLIMAT Data.* DOI: 10.5676/DWD_GPCC/MP_M_V2020_250, http://dx.doi.org/10.5676/DWD_GPCC/MP_M_V2020_250.

conditions experienced in 2019. The western Sahel recorded the highest rainfall total in the last 20 years. The positive phase of the Atlantic SST dipole favoured an active West African summer monsoon season in 2020, leading to above-normal rainfall in the Sahel (see Drivers of observed climate variations in 2020).

In 2020, East Africa recorded precipitation above the long-term 1981–2010 average, except in north-eastern Somalia, southern parts of Kenya and Lake Victoria, indicating a high spatial variability in that subregion. Southern Africa recorded precipitation below the long-term 1981–2010 average, especially in western parts. While north-eastern Africa received precipitation amounts above the long-term average, following two dry years, north-western Africa experienced the second year in a row of below-average precipitation.

In 2020, precipitation totals compared with the 1951–2010 reference period (Figure 8) indicate high precipitation amounts (within the upper 10% of values) in the northern Sahel region, the Rift Valley, the central Nile catchment and north-eastern Africa, the Kalahari basin and the lower course of the Congo River. On the other hand, abnormally low precipitation amounts (within the lowest 10% of values in the rainfall distribution) were recorded around the mountain range between the Kalahari and Congo basin, central and southern Madagascar, west of the Mozambique Channel, the northern coast of the Gulf of Guinea and north-western Africa.

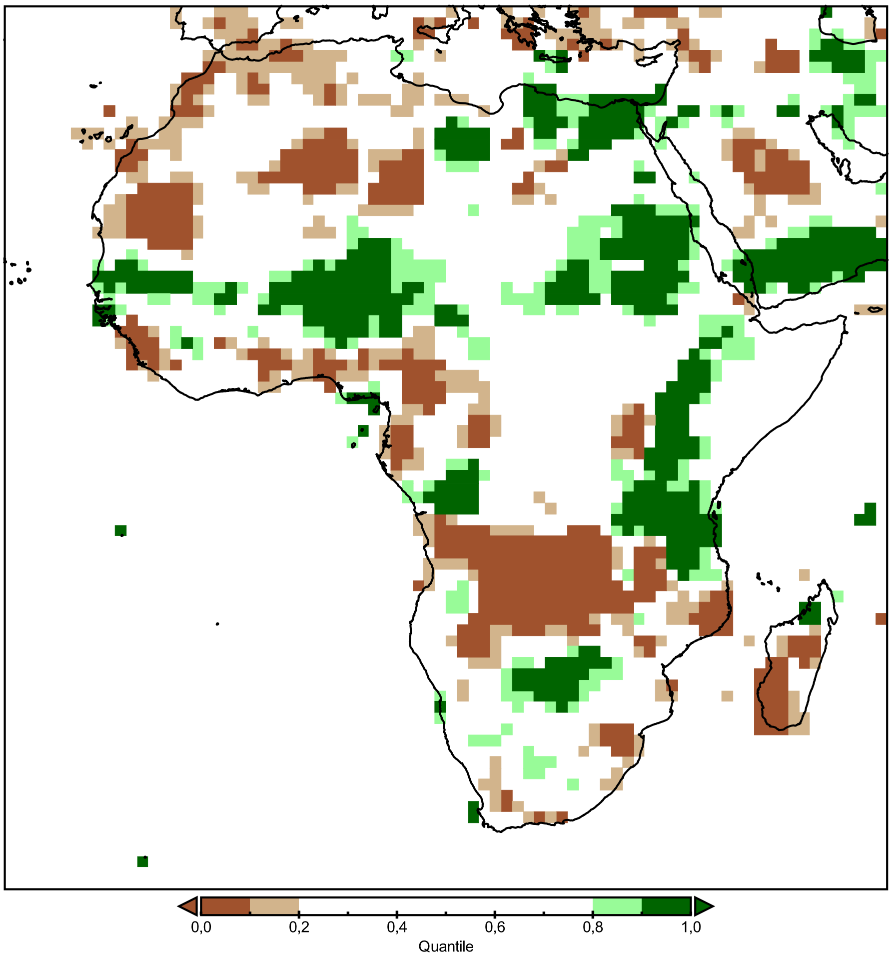


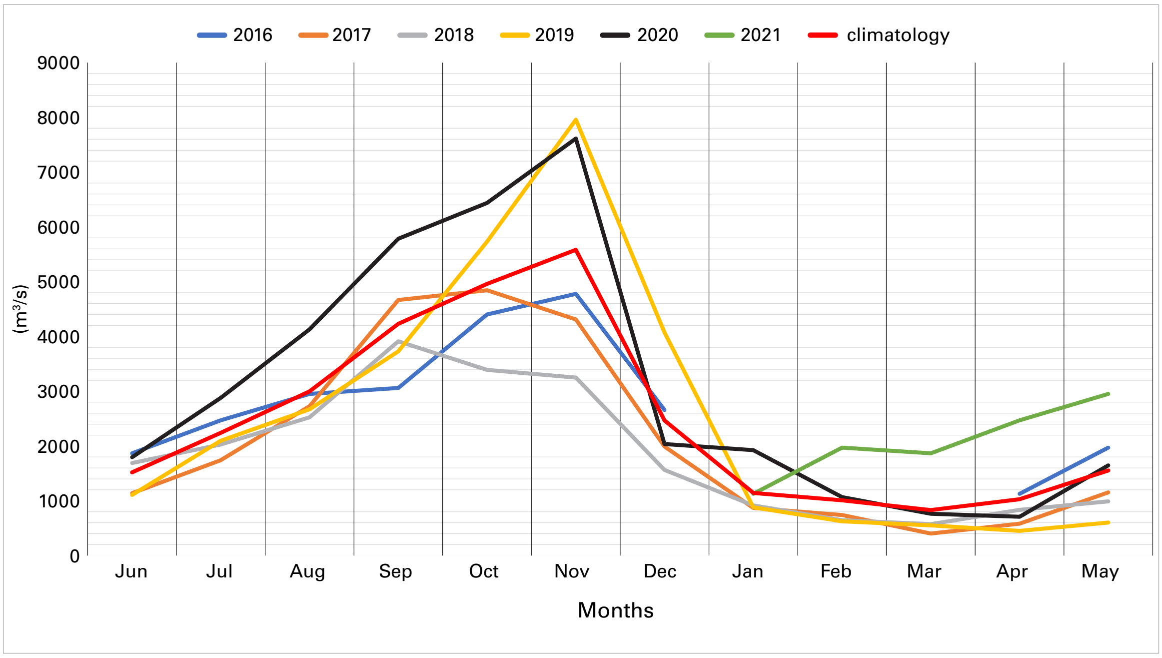
Figure 8. Precipitation quantiles for 2020. Brown areas indicate abnormally low precipitation totals (light brown indicates the lowest 20% and dark brown indicates the lowest 10% of the observed totals). Green areas indicate unusually high precipitation totals (light green indicates the highest 20% and dark green indicates the highest 10% of the observed totals). The reference period is 1951–2010. *Source:* GPCC, Deutscher Wetterdienst, Germany

Key hydrological features in 2020

Consistent with higher-than-normal rainfall recorded in the Sahel and Congo basin (see Precipitation), the monthly flow of the two main rivers, Congo-Oubangui (Figure 9) and Niger (Figure 10), significantly exceeded the average values, especially during the peak months of October and November. The high water level in the Congo River led to the collapse of part of La Corniche in Brazzaville (Figure 11).

The flow of the Niger River in Niamey, as shown in Figure 10, illustrates the exceptional character of the hydrological year 2020/2021 in Niamey. A comparison of the hydrographs for 1997/1998, 2019/2020 and 2020/2021 shows the effect of climate variability on the flow pattern in Niamey. In 1997/1998, the first peak recorded in August as a response to the effect of local rainfall deficit was lower than the second peak value recorded in late 1997 and early 1998, which was due to the water flow propagating downstream from the upper basin in Guinea to Niamey. In 2019/2020, however, the opposite was true. The active monsoon season from June to September and the associated high amount of rainfall led to a pronounced streamflow peak in August with values exceeding the second peak values in January. In 2020/2021, the hydrological pattern was similar to that of 2019/2020, but with peak values more pronounced and extended in time. Owing to the high amount of rainfall during the monsoon season, the hydrological red alert threshold of 620 cm of river level was exceeded in the hydrological gauge of Niamey on 12 August 2020. This led to river flood in the city of Niamey and the break of the city's protective dykes.

Figure 9. Monthly flow (m^3/s) of the Congo-Oubangui River for each year 2016–2021. The average monthly flow (climatology) over the same period is shown in red. *Source:* Hydroweb, http://hydroweb.theia-land.fr/hydroweb/



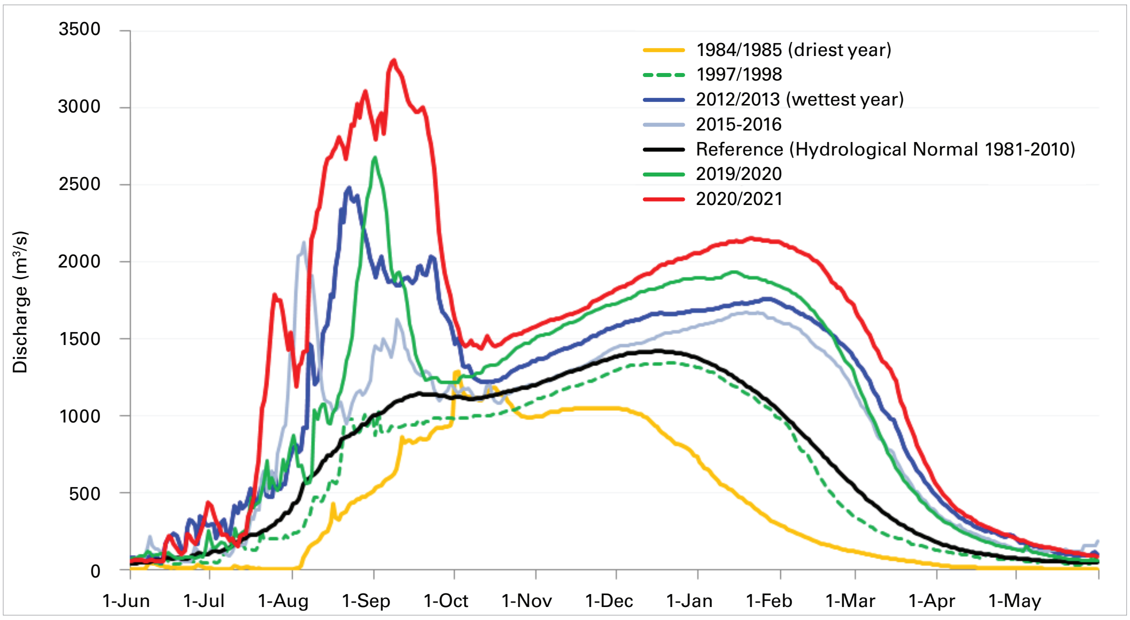


Figure 10. Hydrographs of the Niger River at Niamey station, comparing daily flows for selected hydrological years and with the 1981–2010 hydrological long-term average. The long-term average is shown in black. *Source:* Regional Training Centre for Agrometeorology and Operational Hydrology and their Applications (AGRHYMET)

Figure 11. Collapse of part of La Corniche overlooking the Congo River in Brazzaville, 9 January 2020. *Source:* RFI/ Loïcia Martial, https://www.rfi.fr/fr/afrique/20200110-congo-b-eboulements-touchent-centre-ville-brazzaville

Drivers of observed climate variations in 2020

In January 2020, SSTs over the equatorial central Pacific region were close to El Niño thresholds, then evolved into a reverse situation during the following months and reached moderate La Niña conditions in October 2020 (Figure 12). La Niña conditions are typically associated with above-average summer precipitation over the Sahel.[16]

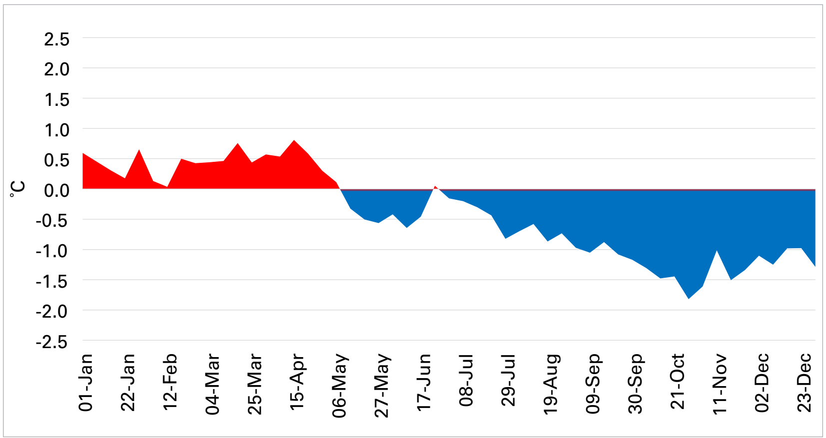


Figure 12. The Niño 3.4 SST anomaly index for 2020 calculated with SSTs in the box 170°W–120°W, 5°S–5°N. *Source:* African Centre of Meteorological Applications for Development (ACMAD), based on data from the State of the Ocean Climate, https://stateoftheocean.osmc.noaa.gov/sur/pac/nino34.php.

TROPICAL ATLANTIC SEA-SURFACE TEMPERATURE

The tropical Atlantic (TASI[17]) SST index (Figure 13) is the difference between the tropical North Atlantic SST and tropical South Atlantic SST indices. The index started in January under a cold phase and evolved to reach a significant positive phase in August–September 2020. This latter pattern, which features anomalously warm water off the western coast of the Sahel region, is usually favourable for above-average summer precipitation in the Sahel, by contributing to the northward extension and persistence of the West African monsoon. Conversely, the TASI index showed a significant negative value during the first quarter of 2020, related to above-average SSTs over the tropical South Atlantic. This pattern drove the well above-average precipitation experienced over Central Africa, particularly in Angola from January to March 2020.

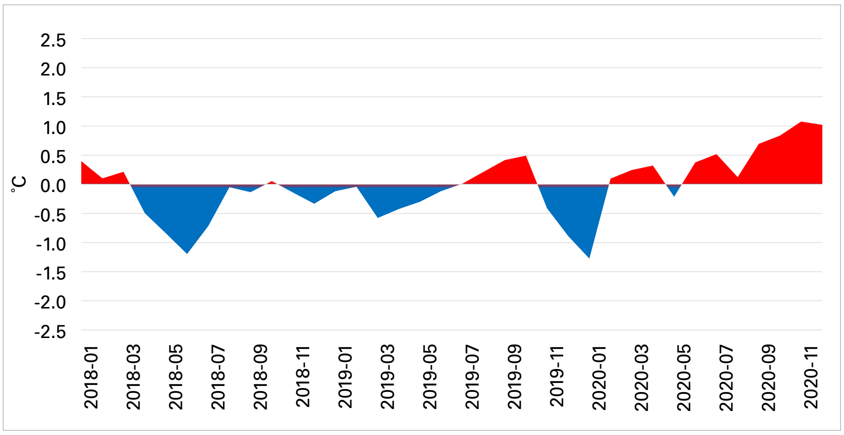


Figure 13. Tropical Atlantic SST index. *Source:* ACMAD, based on data from NOAA National Centers for Environmental Prediction (Reynolds, R.W. et al., 2002: An improved in situ and satellite SST analysis for climate. Journal of Climate, 15(13): 1609–1625).

16 Famine Early Warning Systems Network, 2020: La Niña and precipitation. *Agroclimatology Fact Sheet Series*, 2: 1–2, https://fews.net/la-ni%C3%B1a-and-precipitation.

17 National Oceanic and Atmospheric Administration (NOAA), the State of the Ocean Climate, https://stateoftheocean.osmc.noaa.gov/sur/atl/

DIPOLE MODE INDEX

The IOD is commonly measured by an index (the Dipole Mode Index, or DMI), which is the difference in SST anomalies between the western and eastern equatorial Indian Ocean.[18] When the SST in the western Indian Ocean is higher than on the eastern side, a positive IOD is recorded, promoting the formation of a massive low-pressure system accompanied by extreme wind and precipitation anomalies across large areas of eastern Africa.[19] The fraction of precipitation variance, in September–November, explained by the IOD mode of variability is about 32% for north-eastern Africa and 59% for south-eastern Africa, calculated for the 1958–2019 period using the GPCC precipitation data set, thus reflecting the strength of this teleconnection in these regions.[20]

Following significant positive values in 2018 and 2019, the DMI returned to near neutral conditions in 2020 (Figure 14), except a slight positive excursion that occurred from late April to early July. During neutral conditions, rainfall patterns become less predictable and can lead to rainfall outcomes due to other drivers such as ENSO or natural variability.

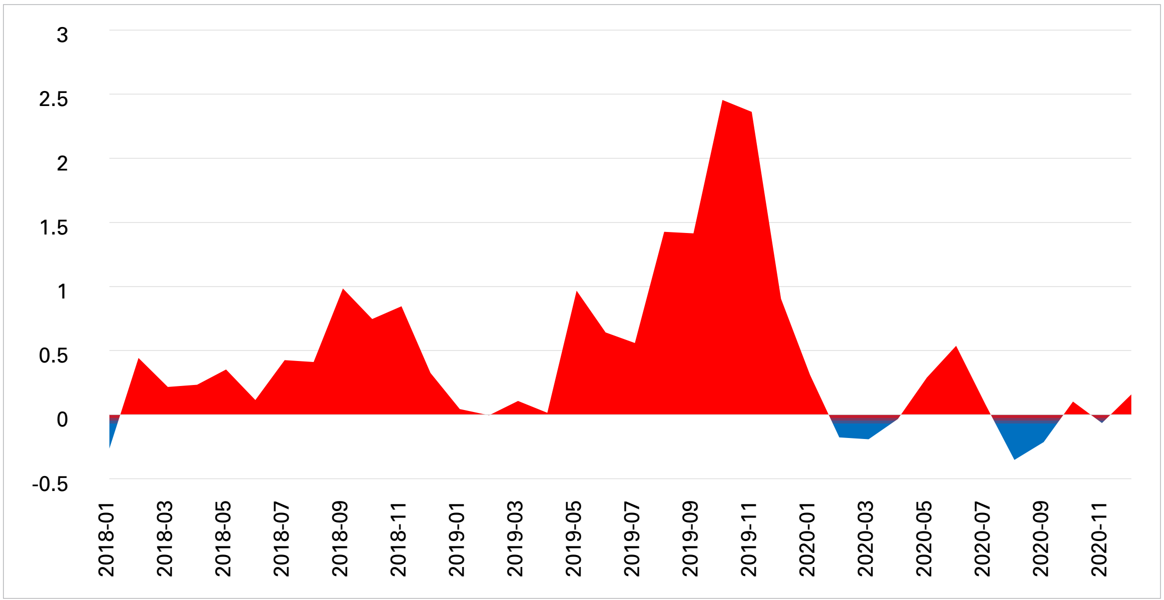


Figure 14. Indian Ocean DMI time series from January 2018 to December 2020. *Source:* ACMAD, based on data from NOAA National Centers for Environmental Prediction (Reynolds et al., 2002).

18 Australian Government, Bureau of Meteorology, 2021: About ENSO and IOD indices, http://www.bom.gov.au/climate/enso/indices/about.shtml.

19 Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC), 2019: October to December 2019 extreme floods in eastern Africa, climate variability or change? https://icpac.medium.com/october-to-december-2019-extreme-floods-in-eastern-africa-climate-variability-or-change-e48a0be7a610.

20 IPCC, 2021: Summary for policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (V. Masson-Delmotte et al., eds.). Cambridge University Press, https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/.

BOX 1. ANTICIPATORY ACTION TO MITIGATE POTENTIAL IMPACTS OF EL NIÑO–SOUTHERN OSCILLATION ON AGRICULTURE IN AFRICA

Overview

During La Niña, the easterly trade winds blowing across the equatorial Pacific are reinforced, resulting in the accumulation of warm water in the western Pacific. No two La Niña events are alike, and analysis of previous occurrences shows that impacts over Africa are varied. Eastern Africa tends to experience drier-than-normal conditions, affecting the second agricultural season of the region from November to March. Southern Africa usually records above-average rainfall between November and April, due to the suppression of the Indian Ocean monsoon over south-eastern Africa, resulting in a high risk of flooding which affects agricultural livelihoods (e.g. through seed loss, crop damage, livestock morbidity and mortality).

Approach

In the immediate aftermath of the strong 2015/2016 El Niño, the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), together with other partners, developed the Inter-Agency Standard Operating Procedures for Early Action to El Niño/La Niña Episodes (IA-SOPs). Endorsed by the United Nations Inter-Agency Standing Committee in 2018, the IA-SOPs seek to facilitate a common understanding of El Niño/La Niña-related extreme weather events and risk thresholds and to provide guidance for coordinated anticipatory action at the global, regional and country level in order to prevent and mitigate negative impacts of such events on the most vulnerable.

When La Niña warnings became more accurate in mid-2020, and in line with the IA-SOPs, the Global ENSO Analysis Cell of the Inter-Agency Standing Committee – which includes FAO, the International Federation of Red Cross and Red Crescent Societies (IFRC), the International Research Institute for Climate and Society (IRI), OCHA, the United Nations Children's Fund, WMO, the World Health Organization, the World Food Programme and others – was activated and collaboration among partners was initiated months before the official La Niña declaration by WMO in October. The Global ENSO Analysis Cell convened as early as August to assess the situation and determine the countries with the highest risk of potential impacts from the event in the last quarter of 2020 and the first quarter of 2021. Consequently, an advisory note summarizing the level of risk was communicated to the respective United Nations Resident Coordinators/Humanitarian Coordinators recommending further country-level monitoring, analysis and preparedness for anticipatory action.

In December 2020, FAO built on the inter-agency efforts and developed an in-depth La Niña advisory, which provides an outlook of the potential effects on the agricultural sector and outlines context-specific anticipatory action recommendations to protect agricultural livelihoods and food security in high-risk countries. Anticipatory action to address the risks of localized dry spells and torrential rains in the Horn of Africa included the combination of cash transfers and drought-tolerant agricultural inputs ahead of the planting Belg/Gu seasons, as well as animal disease surveillance, vaccinations and treatment of core breeding stock to prevent drought-induced animal disease. For areas at high risk of flooding in Southern Africa, recommended anticipatory action included the establishment of food storage sites and provision of storage equipment to reduce post-harvest losses caused by above-normal rainfall conditions, as well as increased surveillance of pest and diseases, including locust and fall armyworm.

Results

The IA-SOPs established after the strong El Niño event in 2015/2016 proved highly valuable to convene multiple partners, at the global, regional and national levels, to produce common early warning messages and recommendations to act before the 2020/2021 La Niña impacts materialized. Thanks to this and to sector- and region-specific advisories, many governments and partners are now more attentive to potential La Niña effects on regional climate and actions to be taken to protect livelihoods.

For example, the Ethiopia inter-agency anticipatory action framework was activated in December 2020 as the pre-agreed triggers for forecast La Niña-induced drought and projected food security deterioration were met. The Central Emergency Response Fund released pre-arranged funds to allow implementing agencies to protect the most vulnerable households, whose livelihoods were already depleted owing to multiple concurrent shocks in 2020. Finally, FAO focused on providing short cycle drought-tolerant seeds, animal treatment, animal vaccination, animal feed and unconditional cash to the most vulnerable households in Afar, Somali and the Southern Nations, Nationalities, and Peoples' Region.

Next steps: forward-looking solutions

- Country-level risk monitoring systems and sector-specific standard operating procedures should be strengthened, to be activated upon ENSO event early warnings to facilitate timely action to protect lives and livelihoods ahead of expected shocks.

- Climate services and community early warning coverage should be enhanced, providing timely and well-communicated appropriate advisory information to all socioeconomic sectors, including agricultural advice for farmers to take up appropriate actions ahead of ENSO event impacts on their livelihoods.

- In countries expected to be severely affected by ENSO events, flexible finance will be critical to allow for anticipatory action based on concrete warning signals, tailored to livelihoods and the evolving risks.

High-impact events in 2020

Flooding that occurred over Africa in 2020 was extensive across many parts of East Africa, with the Sudan and Kenya the worst affected: 285 deaths reported in Kenya,[21] and 155 deaths and over 800 000 people affected in the Sudan.[22] Moreover, there were further indirect impacts from diseases. Countries reporting loss of life or significant displacement of populations included the Sudan, South Sudan, Ethiopia, Somalia, Kenya, Uganda, Chad, Nigeria (which also experienced drought in the southern part), the Niger, Benin, Togo, Senegal, Côte d'Ivoire, Cameroon and Burkina Faso. Many lakes and rivers reached record high levels, including Lake Victoria (in May) and the Niger River at Niamey and the Blue Nile at Khartoum (in September).

Long-term drought continued to persist in parts of Southern Africa, particularly the Northern and Eastern Cape Provinces of South Africa. However, heavy winter rains saw water storages reach full capacity in Cape Town, aiding the recovery from the extreme drought situation which peaked in 2018. Rainfall during the 2019/2020 summer rainy season in the interior of Southern Africa was locally heavy, and many areas had above-average rainfall in November and December, though long-term drought persisted in some areas.

On 22 November 2020, Tropical Cyclone *Gati*, originating from the Bay of Bengal, became the strongest storm ever to hit Somalia (the first cyclone making landfall in Somalia as a category 2 storm on the Saffir–Simpson scale).[23] The storm brought heavy rain to the region, and local authorities reported at least nine people killed, tens of thousands displaced and a few thousand properties belonging to nomadic communities in the affected areas destroyed.[24]

CENTRAL AFRICA

The Central African region recorded a high number of extreme events in 2020, including floods, windstorms and landslides (Figure 15). For example, in August 2020, a mesoscale convective system, triggered by a deep monsoon penetration at the Atlantic coast, resulted in heavy rainfall over Douala (Cameroon). Later, in Maroua, far north of Cameroon and over Chad, another mesoscale convective system generated heavy downpours and strong microbursts causing an aircraft to leave the runway at Maroua-Salak Airport but without damage to the aircraft.[25]

Heavy rainfall in the region caused the bursting of the Congo River and the Mayo Palar. Adverse impacts included the collapse of the Corniche Monument in the Congo (Brazzaville) and of Palar Bridge in Cameroon (Maroua) in January and August 2020, respectively, as well as the economic losses in transboundary exchanges between Cameroon and Chad (the Palar case).

During 2020, parts of the Gulf of Guinea received an annual count of up to 85 days with daily precipitation ≥20 mm resulting in floods and landslides in Douala (Cameroon) and Gabon. In the far region of Cameroon, the high number of cases of flood events was due to the monsoon intensity in 2020 and accentuated by the topography of the area (flat land with inadequate drainage system). As mentioned above, teleconnection played a crucial role with the active climate drivers in the region.

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21 Centre for Research on the Epidemiology of Disasters (CRED), International Disaster Database (EM-DAT), www.emdat.be

22 OCHA, ReliefWeb, 2020: Sudan situation report, 13 November 2020, https://reliefweb.int/report/sudan/sudan-situation-report-13-nov-2020-enar.

23 National Aeronautics and Space Administration (NASA), Earth Observatory, 2020: Gati makes historic landfall in Somalia, https://earthobservatory.nasa.gov/images/147576/gati-makes-historic-landfall-in-somalia.

24 OCHA, ReliefWeb, 2020: Tropical Cyclone Gati - Nov 2020, https://reliefweb.int/disaster/tc-2020-000232-som.

25 Noëth, B., 2020: Cameroon Air Force C-130 Hercules overruns runway at Maroua-Salak Airport, Cameroon. Aviation24.be, 4 August, https://www.aviation24.be/military-aircraft/cameroon-air-force/c-130-hercules-overruns-runway-at-maroua-salak-airport-cameroon/.

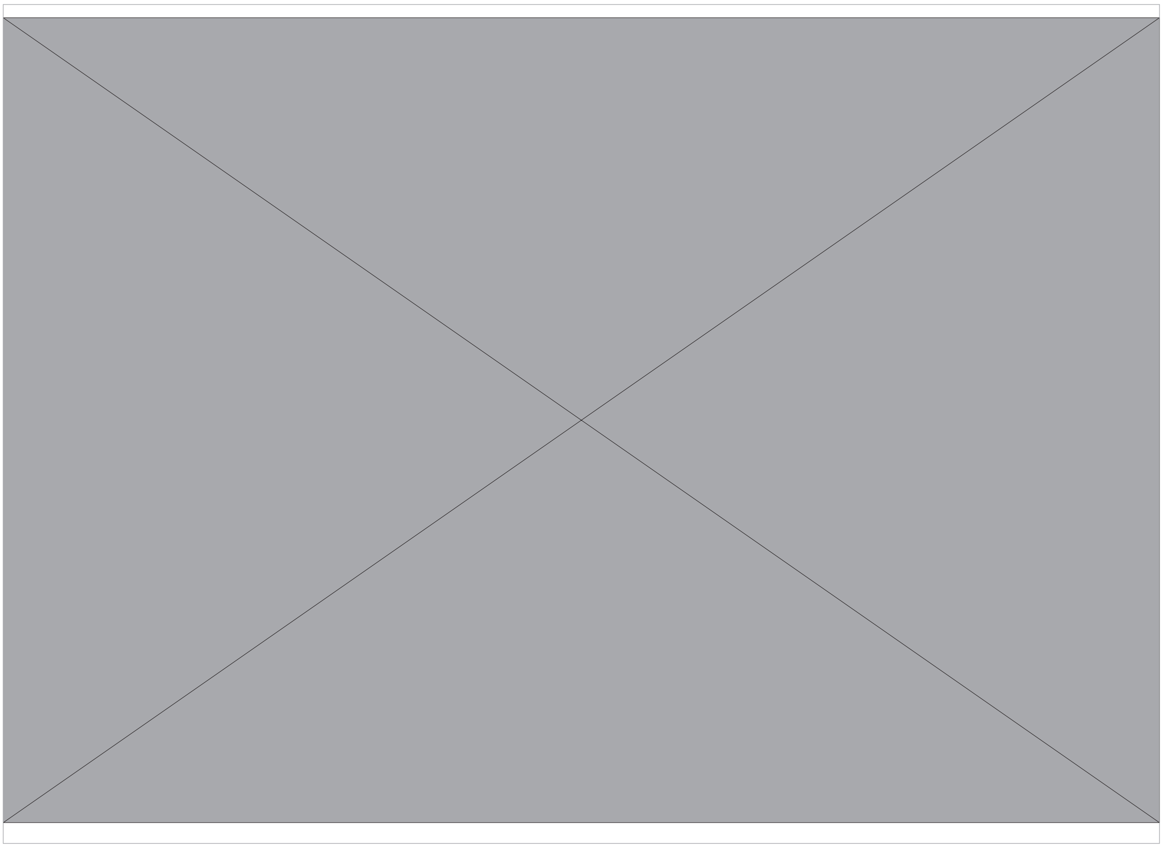

Figure 15. Summary of extreme events that occurred in 2020 in Central Africa, including flood events, windstorms and landslides. *Source:* Climate Application and Prediction Centre for Central Africa (CAPC-AC), based on media reports and feedback from National Meteorological and Hydrological Services (NMHSs) of the countries of the Economic Community of Central African States (ECCAS).

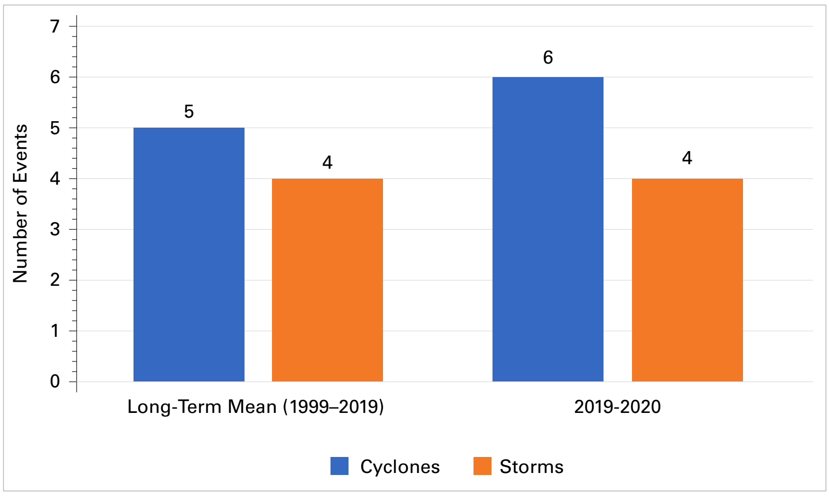

Figure 16. Number of tropical cyclones and storms in the 2019–2020 season in the SWIO (west of 90°E) compared with the long-term mean (1999–2019). In this figure, tropical cyclones are systems which reach a maximum 10-minute wind speed of more than 118 km/h, and tropical storms are systems with a maximum 10-minute wind speed of 63–118 km/h. *Source:* ACMAD, based on data provided by the La Réunion Regional Specialized Meteorological Centre/ Tropical Cyclone Centre, Météo-France, http://www.meteofrance.re/cyclone/saisons-passees/2019-2020/dirre/01-20192020.

Figure 17. (left) Maize crops submerged in water, Namwala District, Southern Province, Zambia. *Source:* Disaster Management and Mitigation Unit, Southern Province Regional Office

Figure 18. (right) Damaged bridge along the Choma Namwala road, Namwala District, Southern Province, Zambia. *Source:* Disaster Management and Mitigation Unit, Southern Province Regional Office

SOUTHERN AFRICA

The South-western Indian Ocean (SWIO) cyclone season starts in November and ends on 15 May the following year, though storm formation outside the normal season does occur occasionally particularly in the month of October. The number of cyclones in the SWIO in the 2019–2020 season (six) exceeded the long-term average (five), whereas the number of recorded storms (four) remained the same as the long-term average (Figure 16).

Zambia recorded above-average rainfall due to the passage of tropical cyclones over the southern Indian Ocean traversing towards Southern Africa, which triggered extensive flooding across many parts of the country. An estimated 2 720 hectares of cultivated crops in Namwala District, Southern Province, were under water (Figure 17). Additionally, the bursting rivers and overflowing of the Kabulamwanda Dam damaged one of the bridges that connects the district to the rest of the country (Figure 18). In one district, where the communities are mainly pastoralist farmers, animals had limited grazing area owing to flooding in the plains. A total of 16 primary schools were affected by floods and pupils experienced difficulties accessing the schools, which increased school absenteeism.

In South Africa, dry conditions persisted over large areas in the west of the country. In some parts, the dry conditions have continued for approximately seven years, but it should be noted that some regions received good rains at the beginning of the 2020/2021 summer rainfall season. The Northern Cape was declared a disaster area after a drought that had crippled the province for the past couple of years. R 200 million was set aside to help address the crisis. KwaZulu-Natal province was also hit hard by a shorter-term drought, accompanied by very high temperatures, which affected 256 towns and surrounding communities. The identified hotspot areas include the districts of uThukela, uMzinyathi, Amajuba, Zululand, King Cetshwayo and uMgungundlovu. However, the early summer, starting in October, experienced well above-normal rainfall in the North West province extending south-eastwards over the central and eastern interior into southern KwaZulu-Natal. This was accompanied by heavy storms resulting in losses of life and extensive damage, including to hundreds of residential dwellings.

WEST AFRICA

The exceptional flooding in 2020 of the Niger River led to deaths and extensive damage. As of 31 December 2020, the Niger recorded 557 800 people affected, or 69 407 households, with 66 deaths from house collapses, 14 deaths from drowning and 100 injuries.[26] In addition, 51 560 houses and huts were destroyed and 9 741 hectares of crops were submerged by water. The most affected regions were Maradi, Tillabéri, Dosso, Niamey, Tahoua and Zinder.

26 Direction Générale de la Protection Civile (DGPC), the Niger

Figure 19. (left) Landspout tornadoes in Oued Zem, Morocco, on 15 March 2020. *Source:* severe-weather.eu, https://twitter.com/severeweathereu/status/1239763413666070528

Figure 20. (right) Giant hailstones in Tripoli, Libya. The diameter of the hailstones seems to be from 15 cm to 20 cm. *Source:* Korosec, M., 2020.

NORTH AFRICA

Concerning extreme precipitation events, 146 mm of rain was recorded in 24 hours in Jijel, Algeria, on 21 December 2020, which contributed to a lot of damage to infrastructure. In Morocco, dry conditions persisted from September 2019 to May/June 2020, and the rainy season was one of the four driest years since 1981. Anomalies of monthly mean temperature reached +3.5 °C in Algeria and +4.0 °C in Morocco. In July, it was very hot in Morocco and Algeria, with temperatures reaching or even exceeding 48 °C in the majority of the southern regions of Algeria (the Sahara); 47.8 °C in Hassi Messaoud and Ouargla; and 48.5 °C in Adrar.

In Tunisia, 2020 was the third hottest year since 1950, after 2016 and 2014, with an average temperature of 20.2 °C and a positive anomaly of 0.9 °C.

In Morocco, tornadoes, which have been observed in recent years, continued to be reported, although with no known damage (Figure 19).

Tripoli, Libya, was affected by severe weather conditions on 27 October 2020.[27] The winds ahead of the trough, which strengthened with height, favoured organized convective storms including rotating and supercell storms which produced exceptionally large giant hailstones of about 20 cm in diameter (Figure 20).

SOUTH-WESTERN INDIAN OCEAN

Island States located in the SWIO basin are prone to disastrous impacts of hydrometeorological events, notably from the winds and rainfall, though minimal impacts from the associated storm surges are experienced. Historically, the worst storm Mauritius has experienced in terms of casualties was Tropical Cyclone *Carol* in February 1960, which led to damages amounting to about MUR 150 million (about US$ 2 million at the time).

In January 2020, Tropical Cyclone *Calvinia*, Severe Tropical Storm *Diane* and Moderate Tropical Storm *Esami* influenced the weather over Mauritius. *Diane* also crossed Madagascar after forming in the Mozambique Channel. In December, Severe Tropical Storm *Chalane*, which originated in the central Indian Ocean, went all the way into the South Atlantic, off Namibia, after crossing Madagascar, Mozambique, Zimbabwe, Botswana and Namibia.

27 Korosec, M., 2020: World's largest hail record may be challenged by exceptionally large 20+ cm (8 inches) hailstones hit the capital of Libya on Tuesday, Oct 27th. *Severe Weather Europe*, 28 October, https://www.severe-weather.eu/global-weather/large-giant-hail-libya-mk/.

Climate-related risks and socioeconomic impacts

FOOD SECURITY

According to the Global Report on Food Crises of the World Food Programme, in 2020 approximately **98 million** people suffered from acute food insecurity and needed humanitarian assistance in Africa, which is an almost **40%** increase from 2019. The compounded effects of protracted conflicts, political instability, climate variability, pest outbreaks and economic crises, exacerbated by the impacts of the COVID-19 pandemic, were the key drivers. Restrictions put in place to contain the spread of COVID-19 contributed to a significant loss of income and jobs, impairing domestic and cross-border trade of food commodities. As a result, market availability decreased and food prices increased, further constraining food access for vulnerable households. In several countries, poor rains curbed crop production, while in other regions heavy rains triggered floods leading to damage and loss across agrifood systems, and rural and market infrastructures, as well as to disrupted trade flows.

Climate change effects in Africa have increased the frequency and intensity of droughts in some regions, lowered animal growth rates and productivity in pastoral systems and produced negative effects in food security in drylands, among other impacts. West Africa has a high number of people vulnerable to increased desertification and yield decline, and the situation is likely to worsen, with Africa projected to be one of the regions with the highest number of people vulnerable to increased desertification.[28]

In 2020, the number of severely food-insecure people in the Democratic Republic of the Congo continued to increase, with up to 21.8 million (Acute Food Insecurity Integrated Phase Classification (IPC) Phase 3 or above). In Nigeria, food insecurity levels reached the highest on record, with approximately 9.2 million in IPC Phase 3 or above. The upsurge was mainly driven by the effects of the COVID-19 pandemic on the local economies and the impacts of large-scale floods and long-term conflicts that displaced populations and disrupted livelihoods. The food security situation also worsened in Burkina Faso, Mali and the Niger owing to the impacts of floods and conflicts. The Sudan, Ethiopia, South Sudan and Somalia were hit by the combined force of the COVID-19 pandemic, extensive floods and desert locust outbreaks. Moreover, the food security situation deteriorated in Zimbabwe, Mozambique and southern parts of Madagascar where poor rains curbed crop production in 2020, resulting in low household supplies and high food prices.

Building household resilience and improving coping mechanisms can significantly reduce the risk of food insecurity. Household surveys by the IMF in Ethiopia, Malawi, Mali, the Niger and the United Republic of Tanzania found, among other factors, that broadening access to early warning systems and to information on food prices and weather (even with simple text or voice messages to inform farmers on when to plant, irrigate or fertilize, enabling climate-smart agriculture) has the potential to reduce the chance of food insecurity by 30 percentage points.[29]

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28 IPCC, 2019: Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems (P.R. Shukla et al., eds.), https://www.ipcc.ch/srccl/.

29 IMF, 2020: Adapting to climate change in sub-Saharan Africa. In: *Regional Economic Outlook*. Washington, DC, https://www.elibrary.imf.org/view/books/086/28915-9781513536835-en/28915-9781513536835-en-book.xml.

EAST AFRICA

High precipitation and abnormal vegetation growth provided unusually favourable conditions for the feeding and breeding of desert locusts. The locust invasion continued through 2020 with swarms migrating from one country of East Africa to another according to the ecological and climatic conditions suitable for development and reproduction, as well as the prevailing wind direction which was enabling migration (Figure 21). Ethiopia and Somalia were the countries most affected by desert locusts and which experienced the highest associated crop and pasture losses. In 2020, Ethiopia lost an estimated 356 286 tons of cereal, affecting about 806 400 farming households, 197 163 hectares of cropland and 1.35 million hectares of pasture and browse.[30]

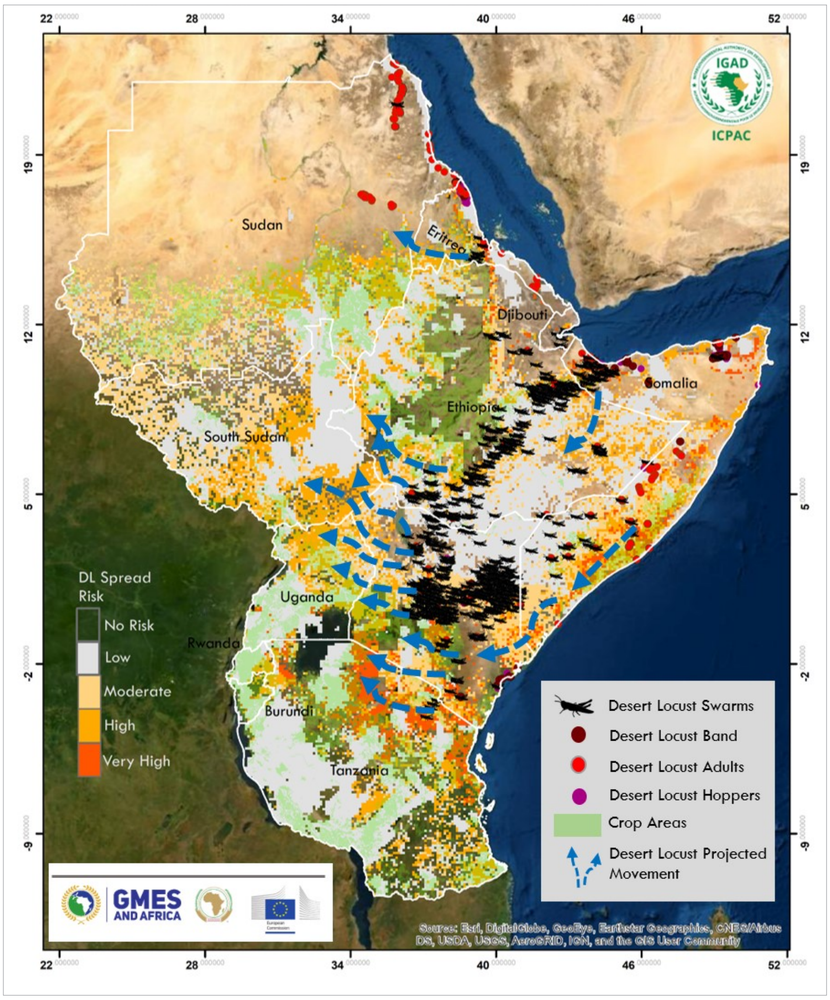


Figure 21. Desert locust movement over East Africa in 2020 and prediction for February 2021. *Source:* ICPAC

30 Impact of desert locust infestation on household livelihoods and food security in Ethiopia, https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/assessments/desert_locust_impact_assessment_report_for_ethiopia.pdf

BOX 2. DESERT LOCUST UPSURGE: EARLY WARNING FOR ANTICIPATORY ACTION

Overview

The atypical weather conditions in 2018–2020 due to a positive IOD (Figure 14), which caused the weakening of the westerlies and allowed warm water and precipitation to shift towards East Africa and the Arabian Peninsula, generated strong cyclones and heavy rains (Cyclones *Luban* and *Mekunu* in 2018, *Pawan* in 2019 and *Gati* in 2020). High precipitation and abnormal vegetation growth throughout this period resulted in favourable conditions for the feeding and breeding of desert locusts that lasted more than two years and continued in 2020 (Figure 21).

Approach

Early warning and rapid response: Using the latest technologies including Earth observations, models and real-time data, FAO's Desert Locust Information Service provided real-time assessments, forecasts and alerts so that affected countries could respond rapidly and international partners could ensure the continuation of these efforts.

Surveillance: FAO rapidly expanded the digital tools used to enter survey and control data in the field, to include a mobile version (eLocust3m) as a crowdsourcing approach and a GPS version (eLocust3g) developed for extra seconded field teams. Information gathered through these apps is transmitted in real time for organizing control operations, sent daily to national locust control centres across the region and shared with the Desert Locust Information Service at FAO headquarters.

Ground and air control operations: FAO provided assets and equipment to support the detection of locust populations, including the procurement and hiring of seven planes, seven helicopters, 94 vehicles and 110 motorcycles, distributed across Somalia, Ethiopia, Kenya and Uganda. Aircraft were managed by a new geospatial system (EarthRanger).

Strengthened regional and national capacities and enhanced preparedness: FAO supported the revision of regional and national preparedness and capacities to rapidly learn from ongoing efforts, identify shortcomings and apply course correctors.

Enhanced regional advocacy and national level coordination: The FAO Resilience Team for Eastern Africa, together with OCHA, co-organized monthly coordination and briefing meetings to raise awareness among stakeholders and guide the planning of livelihoods interventions to ensure maximum coverage and harmonized approaches.

Awareness campaigns: Through the Sensitization Taskforce for Eastern Africa, 29 partners maintained bimonthly meetings to increase awareness using various communication tools, including key messages – translated into local languages – for dissemination by radio, SMS and flyers, as well as guidance and media (e.g. photos, videos) for use by partners.

Promotion of regional partnerships and collaboration: The regional Food Security and Nutrition Working Group, co-led by FAO and IGAD, provided the framework and technical means for developing harmonized impact assessments. Additionally, the regional desert locust Community Sensitization Taskforce for Eastern Africa, co-chaired by FAO and OCHA, played a critical role in raising awareness and harmonizing desert locust messaging across the region.

Results

Control operations prevented the loss of **3.1 million tons** of cereals (equivalent to the food consumption of **18 million** people for an entire year) worth about **US$ 800 million**. The livelihoods of **28 million** people were saved, and food security was protected in 2020. Moreover, **1.56 million** hectares of land were treated in the Greater Horn of Africa and Yemen in 2020.

FAO and partners mobilized **US$ 195 million** for rapid response and anticipatory action in 2020. The economic benefits of the interventions in 2020 were estimated at **US$ 1.2 billion**.

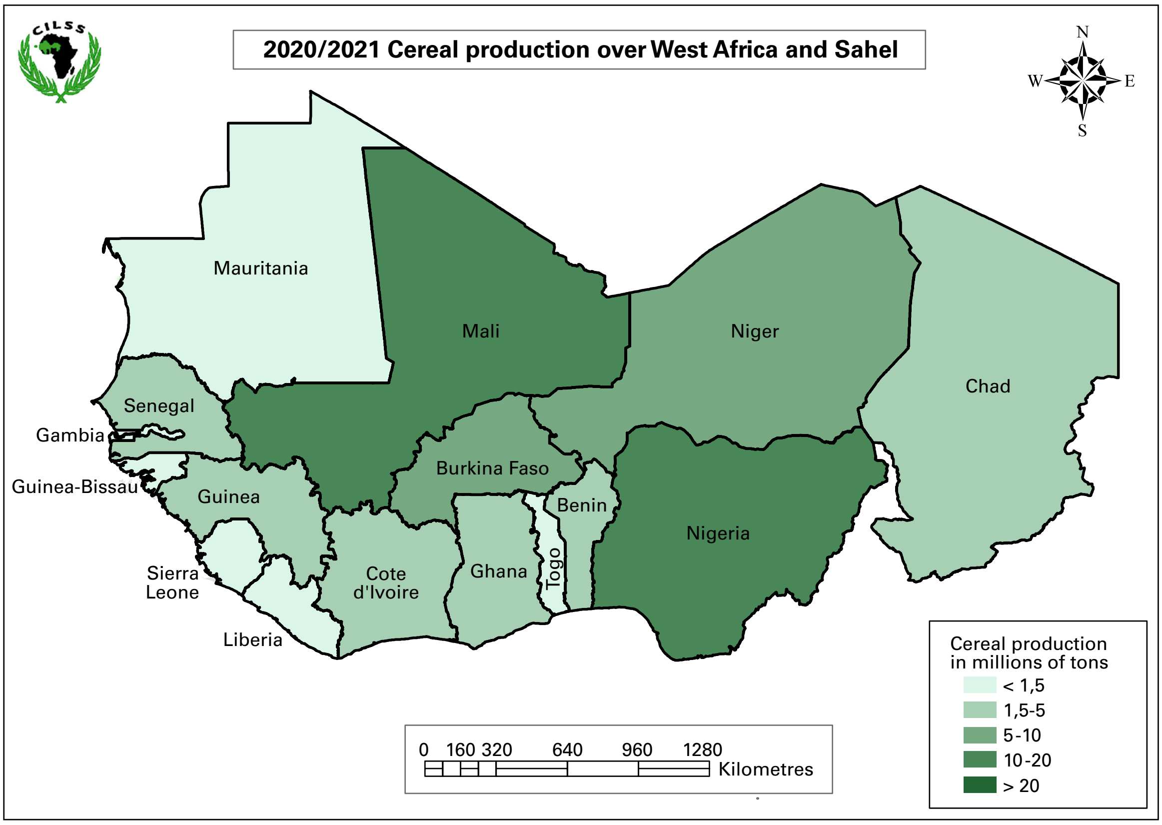
Next steps: forward-looking solutions

- The use of biopesticides should be promoted, with an estimated 75–80% effectiveness, similar to conventional pesticides. They were hardly used during the 2020 desert locust upsurge (7% came from biopesticides).

- The expansion of innovative digital tools should be continued, to improve field data for real-time decision-making.

- A five-year programme in East Africa should be established, to sustain and improve the acquired capacities beyond the current emergency for a longer-term monitoring and response mechanism.

Figure 22. 2020/2021 cereal production over West Africa and the Sahel. *Source:* Permanent Inter-State Committee on Drought Control in the Sahel (CILSS), quarterly bulletin 01/2021



WEST AFRICA

The results for the 2020/2021 agricultural and agropastoral season in the Sahel and West African region show good production across the region, compared with last year and the average for the past five years (Figure 22). Cereal production was estimated at 74.8 million tons, an increase of 1.3% from the previous season. In the Sahelian countries, it was estimated at 28.5 million tons (an increase of 4.8% from the previous season), and in the coastal countries at 46.33 million tons (a decrease of 0.7% from the previous season).

Owing to favourable weather conditions, especially with regard to the spatial and temporal distribution of rainfall, there was a projected gross surplus of local cereals of 4.3 million tons, but a deficit of 4.3 million tons of wheat and 0.655 million tons of rice. For a population estimated at 427 million people, the amount needed is about 61.7 million tons. By the end of 2020, cereal availability was expected to be 60.5 million tons, 76% of which consists of millet, sorghum and maize, 23% rice and 1% wheat.

Population displacement

In the first six months of 2020, the Internal Displacement Monitoring Centre recorded 14.6 million new displacements across 127 countries and territories; conflict and violence accounted for approximately 4.8 million and disasters 9.8 million.[31] Approximately 12% of all new displacements worldwide occurred in the East and Horn of Africa region, with over 1.2 million new disaster-related displacements and almost 500 000 new conflict-related displacements (Figure 23).

Floods and storms contributed the most to internal disaster-related displacement, followed by droughts. The Sudan and Kenya were the worst affected by the devastating floods, with more than 440 deaths reported. Over 800 000 people were affected in the Sudan, and over 900 000 in Somalia, among further indirect impacts from diseases. Instances of conflict between farmers and pastoralists were recorded in several countries, arising from the stressors that natural hazards had placed on these vulnerable communities and the adverse impacts.[32]

Despite generally favourable rainfall and associated yields of cereal crops, flooding along the Niger River notwithstanding, the International Organization for Migration (IOM) assessments estimated a total of 1.25 million displaced people in Burkina Faso, Mali and the Niger, contexts already characterized by conflict and food insecurity, as well as forced internal and cross-border population movements. This interannual displacement adds to the long-term exacerbating factors that concern the wider Sahel, which is experiencing population growth, unregulated irrigation, deforestation, desertification and drought.

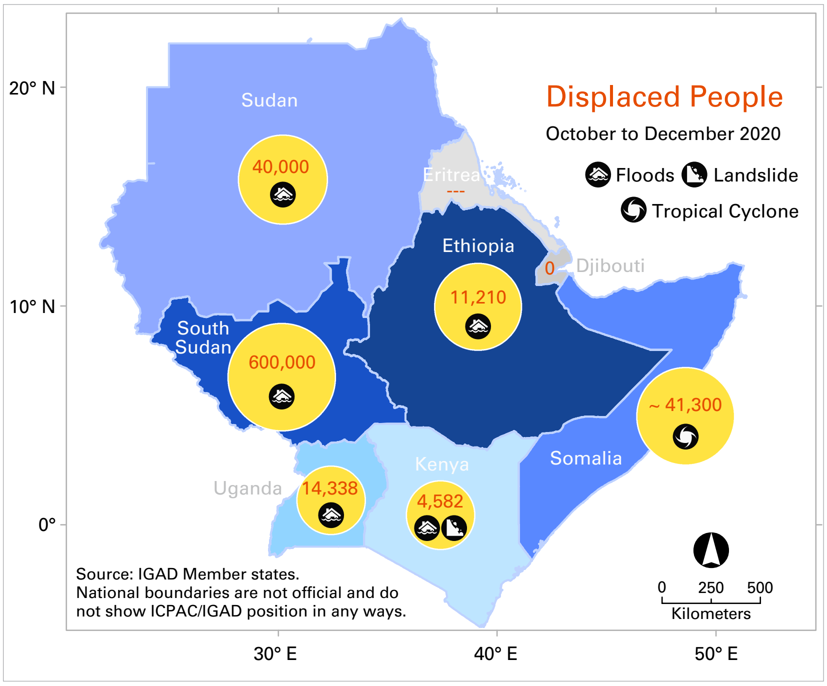


Figure 23. Total number of people affected due to various hazards and climate-induced disasters in the IGAD region in 2020. *Source:* IGAD member States

31 Internal Displacement Monitoring Centre, 2020: *Mid-Year Update 2020*, https://www.internal-displacement.org/sites/default/files/publications/documents/2020%20Mid-year%20update.pdf.

32 United Nations Climate Security Mechanism Toolbox – Overview, https://dppa.un.org/en/climate-security-mechanism-toolbox-overview

Long-term impact on socioeconomic development

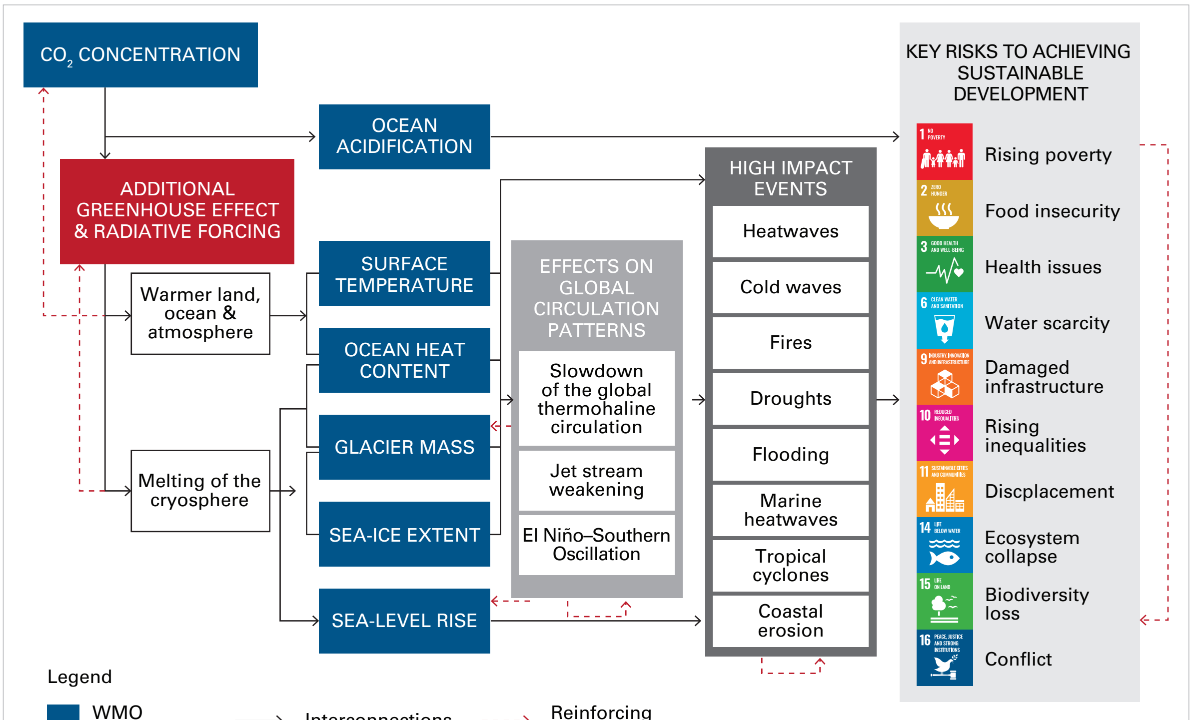
OVERALL CHALLENGES

The 2030 Agenda for Sustainable Development provides a shared blueprint for peace and prosperity at present and into the future. It includes a set of Sustainable Development Goals (SDGs). However, the achievement of many SDGs is put at risk by climate change (Figure 24). For example, rising temperatures lead to the loss of species and ecosystems, which can reduce agricultural and fishing yields, and contribute to food insecurity and affect livelihoods (SDGs 1, 2, 14 and 15). Extreme weather and climate events can also exacerbate health risks, damage infrastructure and lead to water scarcity (SDGs 1, 3, 6, 9 and 11). These threats, together with others, are interrelated with conflict and stability (SDG 16). Such risks and impacts do not affect all populations or regions equally and can reinforce or worsen existing inequalities (SDG 10).

EXPOSURE AND VULNERABILITY

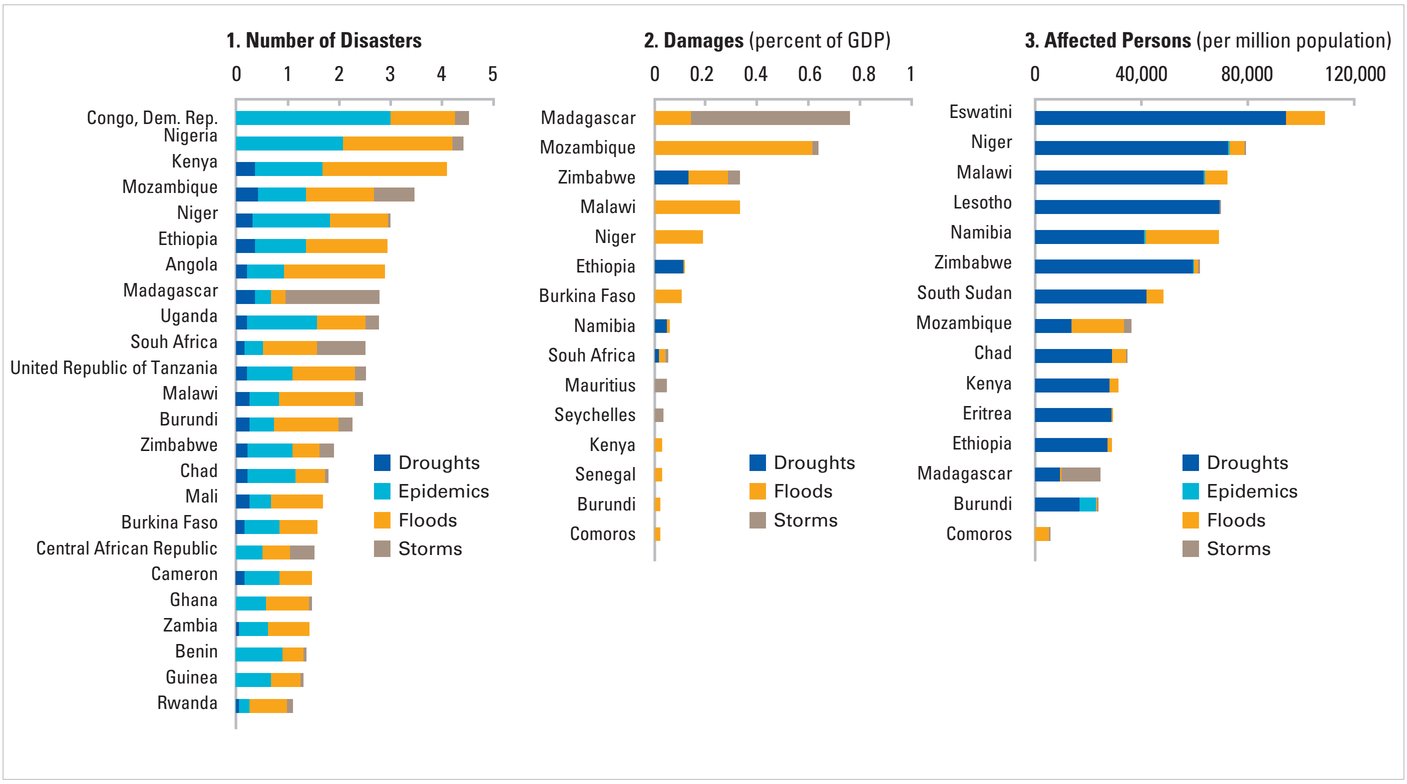
Droughts, floods and storms are the most common natural hazards affecting Africa (Figures 25 and 26). The SWIO countries and those in the east of Southern Africa, such as the Comoros, Madagascar, Malawi and Mozambique, are particularly susceptible to tropical cyclones from the Indian Ocean. Similarly, Guinea-Bissau and Sierra Leone are exposed to storms from the Atlantic Ocean. Large coastal cities (Abidjan, Accra, Dakar, Dar es Salaam and Lagos) are exposed to floods associated with rising sea levels. Floods can spread diseases because they create breeding grounds for mosquitoes and contaminate drinking water,[33] creating challenges for safeguarding the achievements of recent years in reducing incidences of malaria and improving access to drinking water.

Figure 24. Selected climate change-related risks to the achievement of the SDGs. *Source:* WMO, 2021: Climate Indicators and Sustainable Development: Demonstrating the Interconnections (WMO-No. 1271).



Sources: IPCC, WMO

33 IMF, 2016: Enhancing resilience to natural disasters in sub-Saharan Africa. In: Regional Economic Outlook. Washington, DC, https://www.imf.org/external/pubs/ft/reo/2016/afr/eng/sreo1016.htm?cmpid=FB.



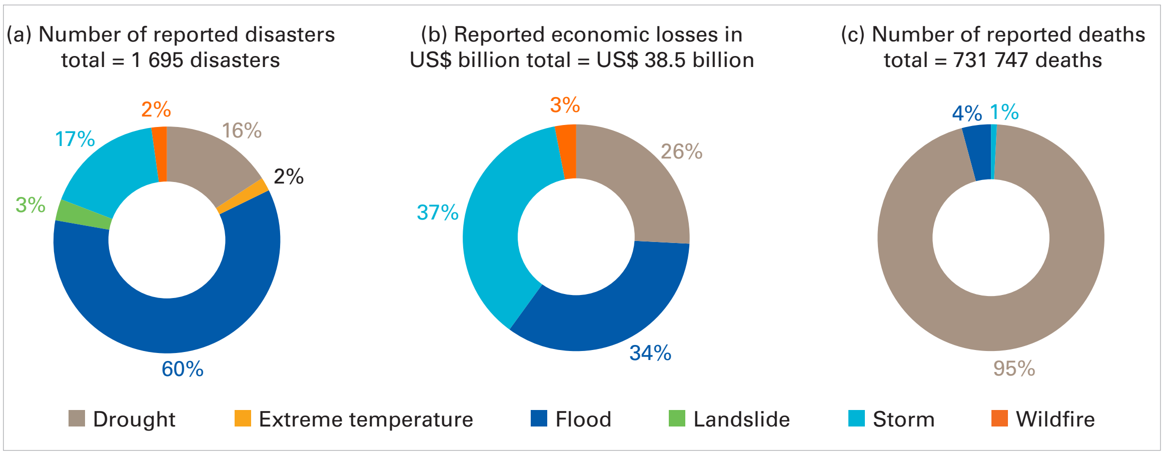


Figure 25. Exposure and vulnerability to climate-related hazards by category.
Top: Natural disasters statistics by country, 2000–2018. Epidemics are also included as they can be highly correlated with climate in Africa. Note: Actual damages are likely to be higher as some recorded disasters are missing impact data. *Sources*: CRED, EM-DAT; IMF calculation.
Bottom: Overview of (a) weather-, climate- and water-related disasters; (b) economic losses; and (c) deaths reported in Africa (1970–2019). *Source:* WMO, 2021: *WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019)* (WMO-No. 1267). Geneva.

Africa is exceptionally vulnerable to climate variability and change compared with many other regions. Almost half of the population in sub-Saharan Africa live below the poverty line[34] and depend on weather-sensitive activities, such as rain-fed agriculture, herding and fishing, for their livelihoods (Figure 27). Limited financial buffers and low levels of education and health care impede their ability to adapt to the increased vulnerabilities to food insecurity, income losses and unemployment. Weather and climate exacerbate already significant inequalities in sub-Saharan Africa. Analyses by the IMF[35] show that in Ethiopia, Malawi, Mali, the Niger and the United Republic of Tanzania, food insecurity

34 The poverty line is measured as the poverty head count at US$ 1.90 a day in terms of 2011 purchasing power parity.

35 IMF, 2020: Adapting to climate change in sub-Saharan Africa. In: Regional Economic Outlook. Washington, DC, https://www.elibrary.imf.org/view/books/086/28915-9781513536835-en/28915-9781513536835-en-book.xml.

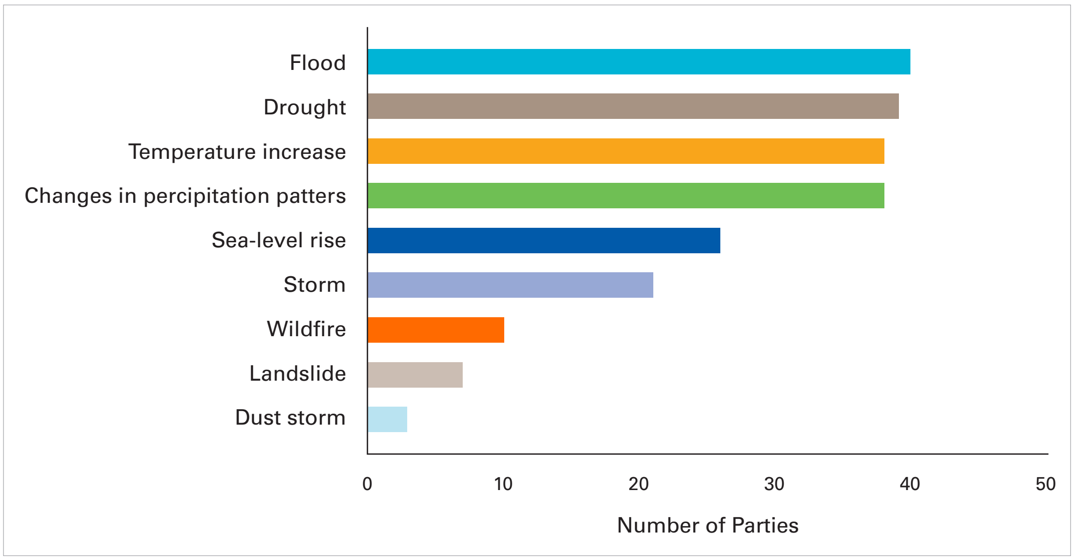


Figure 26. Hazards of greatest concern for the African Region. *Source:* WMO analysis of the nationally determined contributions (NDCs) of 53 countries in Africa

increases by 5–20 percentage points with each flood or drought.[36] Additionally, associated deterioration in health and in children's school attendance can worsen longer-term income and gender inequalities.

In Africa, water bodies (seas, rivers and lakes) are endowed with abundant flora and fauna and marine ecosystems – including diverse fish, other aquatic life and coral reefs. They are essential for many Africans' livelihood, water resources, food, power generation and transportation activities, as well as critical for the continent's blue economy development. However, rising ocean temperatures and ocean acidification aggravate the loss of fishery resources.

Climate variability and change, and the exposure and vulnerability of millions of people in Africa, trigger migration, displacement and related protection needs. Refugees and internally displaced people in Africa often reside in climate hotspots, where they are particularly exposed to, and affected by, slow- and sudden-onset hazards, thus increasing their risk of secondary displacement and/or preventing their opportunity for return. Although most disaster- and climate-related displacement in Africa is internal, displacement across borders, which may be interrelated with situations of conflict or violence, also occurs, with climate change acting as a threat multiplier. Invariably, among the worst affected are refugees, internally displaced and stateless people and migrants, as well as the poor, women, children, the elderly and people with disabilities.

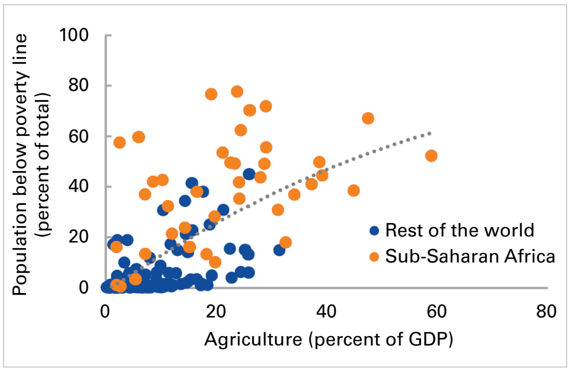


Figure 27. Population living below the poverty line and percent of GDP from agriculture, in sub-Saharan Africa. *Source:* World Development Indicators, World Bank

36 These results are based on an analysis of household surveys for Ethiopia (2015–2016), Malawi (2016–2017), Mali (2017–2018), the Niger (2014) and the United Republic of Tanzania (2014–2015).

State of climate change policies in Africa

NATIONALLY DETERMINED CONTRIBUTIONS

The global climate response is framed by the Paris Agreement.[37] The Paris Agreement is implemented through NDCs.[38] NDCs are voluntary and guide the development of national climate change responses. They define both mitigation and adaptation pathways, as well as indications of the sources of financing such as actions between domestic (unconditional) and external (conditional) finance.

Adaptation to climate change is the primary concern of African countries, as reflected in the predominance of adaptation in their NDCs. Priorities identified in the NDCs of African countries reflect the agrarian nature of many African economies (Figure 28).

In Africa, most countries (38) mentioned in their NDCs the need for early warning systems to help them to respond to weather-, water- and climate-related hazards, which are becoming more frequent and more intense.

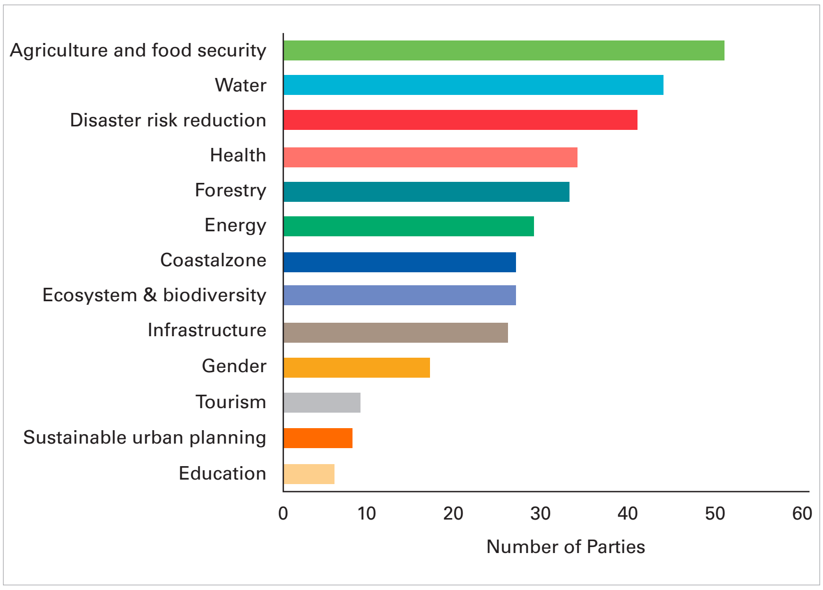


Figure 28. Priority areas for adaptation for the African Region. *Source:* WMO analysis of the NDCs of 53 countries in Africa

In particular, the vast majority of the parties identified disaster preparedness and response as the top priority for disaster risk reduction, followed by detection, monitoring, analysis and forecasting (Figure 29).

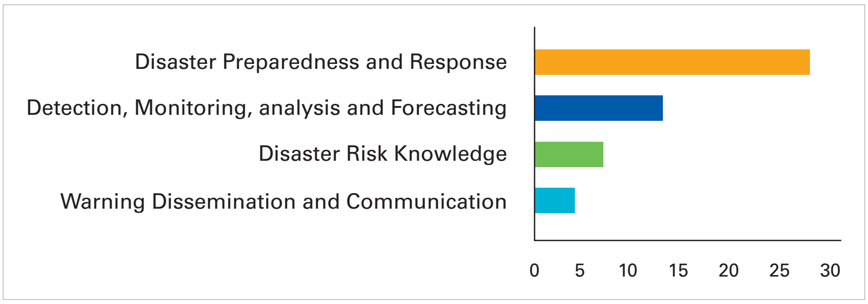


Figure 29. Overview of disaster risk reduction in the NDCs. *Source:* WMO analysis of NDCs [39]

37 Paris Agreement, https://unfccc.int/sites/default/files/english_paris_agreement.pdf

38 United Nations Framework Convention on Climate Change (UNFCCC), Nationally determined contributions (NDCs), https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs

39 Grasso V.F. et al., 2021: Climate shocks – Africa. In: *State and Trends in Adaptation in Africa*. Global Center on Adaptation, forthcoming.

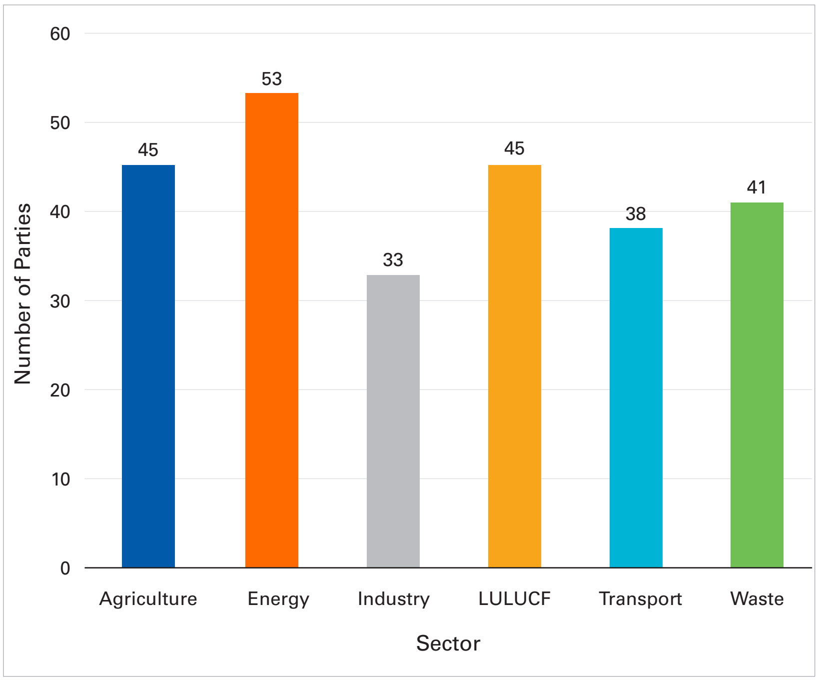


Figure 30. Mitigation sectors covered by African countries. Abbreviation: LULUCF, Land Use, Land-Use Change and Forestry. *Source:* WMO analysis of the NDCs of 53 countries in Africa

In the NDCs, mitigation contributions are stated in terms of targets (GHG and non-GHG), actions (policies, plans and projects), or a combination of targets and actions. Only one African country (Democratic Republic of the Congo) has GHG targets, while two countries (Burundi and Gabon) have GHG and non-GHG targets. Moreover, 18 countries have GHG targets and actions, 6 have non-GHG targets and actions, and 20 have GHG and non-GHG targets and actions. Mitigation contributions identified in African NDCs cover various sectors (Figure 30), taking guidance from the IPCC Guidelines.[40]

COST OF NATIONALLY DETERMINED CONTRIBUTIONS

The UNFCCC notes that the many forms of climate finance include local, national or transnational financing, which may be drawn from public, private and alternative sources of financing to mitigate and adapt to climate change.[41]

The NDCs of sub-Saharan African countries also specify technology transfer and capacity-building needs, with only nine countries not including a technology transfer and capacity-building component. The types of capacity-building and technology transfer needs expressed in these NDCs include technical capacities, institutional capacities (policies and frameworks) and skills development (Figure 31).

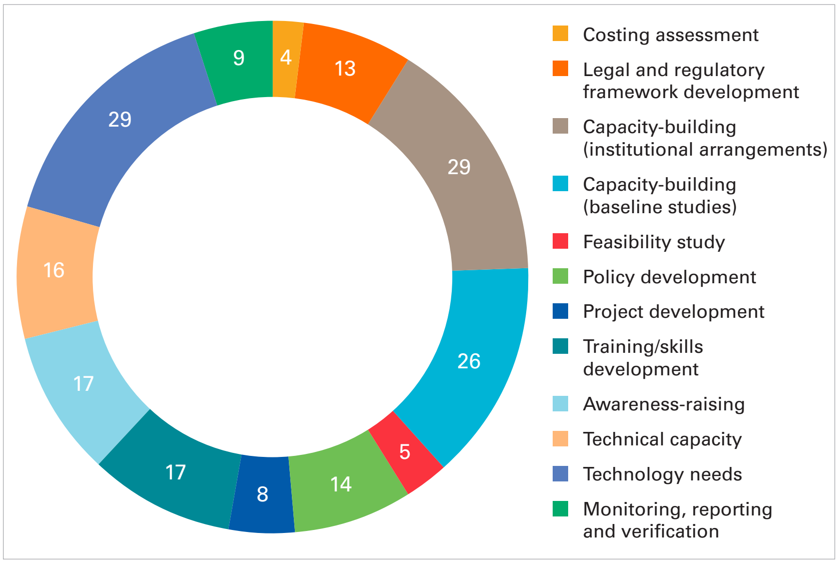


Figure 31. Types of capacity-building and technology transfer needs expressed by the sub-Saharan countries. *Source:* Adapted from Global Climate Change Alliance Plus (GCCA+), 2020

40 IPCC, 2019: *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*, https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/.

41 UNFCCC, Introduction to climate finance, https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance

For 53 African countries, the African Climate Policy Centre calculates the cost at US$ 7.4 billion a year, which is the same order of magnitude as the projection made by the Adaptation Gap Report of the United Nations Environment Programme (UNEP) (US$ 7–15 billion). This sum represents a very low percentage of the GDP of the continent (about 4.8% based on IMF figures).[42]

IMPLEMENTATION OF NATIONALLY DETERMINED CONTRIBUTIONS

Many of the NDCs of African countries are conditional upon receiving adequate financial, technical and capacity-building support. Overall, Africa will need investments of over **US$ 3 trillion** in mitigation and adaptation by 2030 to implement its NDCs,[43] requiring significant, accessible and predictable inflows of conditional finance.

Africa continues to spend a significant proportion of its income on adaptation to climate change. It is estimated that countries spend between 2–9% of their GDP on adaptation to climate change.[44] The cost of adapting to climate change in Africa will rise to US$ 50 billion per year by 2050, even assuming the international efforts to keep global warming below 2 °C.[45]

OPPORTUNITIES FOR REVISED NATIONALLY DETERMINED CONTRIBUTIONS AS DEVELOPMENT INSTRUMENTS

The outbreak of the COVID-19 pandemic in 2020 was an unprecedented public health crisis which immediately translated into a socioeconomic crisis. However, many countries seized the opportunity to develop their revised NDCs into tools to support green recovery from the pandemic.[46] Furthermore, as emphasized by UNEP, a low-carbon pandemic recovery could cut 25% off the GHG emissions expected in 2030, compared with the policies in place before the pandemic. Such a recovery could far outstrip savings foreseen by the implementation of unconditional NDC targets under the Paris Agreement and put the world close to the 2 °C pathway.[47]

42 African Development Bank (AfDB), 2019: *Analysis of Adaptation Components of Africa's Nationally Determined Contributions (NDCs)*, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Analysis_of_Adaptation_Components_in_African_NDCs_2019.pdf.

43 AfDB, Climate change in Africa, https://www.afdb.org/en/cop25/climate-change-africa

44 United Nations Economic and Social Council, 2021: Background paper on Sustainable Development Goal 13 (Climate action), and the corresponding goals of Agenda 2063: The Africa We Want, of the African Union (ECA/RFSD/2021/11).

45 United Nations Development Programme (UNDP), 2021: Raising adaptation action through aligning NAPs and NDCs in African LDCs, https://www.adaptation-undp.org/raising-adaptation-action-through-aligning-NAPs-NDCs-in-African.

46 UNDP, 2020: *20 Insights on NDCs in 2020*, https://reliefweb.int/sites/reliefweb.int/files/resources/Climate%20Promise-2020%20Insights_FINAL-spreads-compressed.pdf.

47 UNEP, 2020: *Emissions Gap Report 2020*, https://www.unep.org/emissions-gap-report-2020.

Strategic perspectives

AGENDA 2063 OF THE AFRICAN UNION

Agenda 2063: The Africa We Want is a shared strategic framework for inclusive growth and sustainable development in Africa. It recognizes climate variability and climate change as one of the main challenges threatening the continent's realization of the goals of Agenda 2063. In line with the Agenda, which is aligned with the United Nations SDGs, several sectoral frameworks for which climate has implications and which address climate-related issues have been put in place. The Integrated African Strategy on Meteorology (Weather and Climate Services) provides strategic guidance on the development and application of weather, water and climate services, which are critical for Africa's climate-resilient development, adaptation planning, early warning, and climate-informed policy and decision-making. The Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods commits to "enhancing resilience of livelihoods and production systems to climate variability and other related risks".

The African Union Commission leads the continent in the implementation of the disaster risk reduction agenda. The Africa Regional Strategy for Disaster Risk Reduction, the Sendai Framework for Disaster Risk Reduction 2015-2030, and the programmes of action for the implementation of the Africa Regional Strategy and of the Sendai Framework are the key disaster risk reduction frameworks. The African Union has developed and launched the 2050 Africa's Integrated Maritime Strategy to help tackle the problems in a strategic, coordinated and sustainable manner. Moreover, it has developed the Africa Blue Economy Strategy, a framework that defines Africa's blue economy and helps to coordinate activities at the continental level and provide support to member States, in particular small island States, on strategies for the beneficiation of sectors that have immediate potential for growth and job creation, such as aquaculture in marine and fresh waters. Other opportunities include enhanced science, technology and innovations for sustainable management, and collaborative management of shared water resources and conservation. The mainstreaming of climate into these frameworks provides a broad basis for addressing climate-related risks and opportunities.

COVID-19 RECOVERY PATHWAYS

The containment of the adverse humanitarian, social and economic costs of climate change and its role in amplifying pandemics will depend on both adaptation and mitigation strategies.[48] The countries of the region can step up mitigation and achieve a green economic recovery from the COVID-19 pandemic through transitioning to green energy sources, promoting carbon capture through reforestation,[49,50] and limiting investment in polluting capital with financial regulations.

Adaptation strategies, however, play a greater role in Africa, in particular sub-Saharan Africa, where economies are particularly dependent on climate-sensitive sectors and have limited carbon emissions compared with advanced and large emerging market economies. Rapid implementation of adaptation strategies will spur economic development and generate more jobs in support of economic recovery from the COVID-19 pandemic.

Financing adaptation to climate change will be more cost-effective than frequent disaster relief. For example, for sub-Saharan Africa, adaptation will be expensive – estimated at US$ 30–50 billion (2–3% of regional GDP) each year over the next decade – but savings from reduced post-disaster spending could

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48 The Paris Agreement considers adaptation as a parallel component to mitigation. Most sub-Saharan African countries have submitted some adaptation goals and measures as part of their climate strategies for the agreement. They will revisit these strategies at the twenty-sixth session of the Conference of the Parties to the UNFCCC in November 2021.

49 IMF, 2019: Fiscal Monitor: How to Mitigate Climate Change, https://www.imf.org/en/Publications/FM/Issues/2019/09/12/fiscal-monitor-october-2019.

50 Nyiwul, L., 2019: Climate change mitigation and adaptation in Africa: strategies, synergies, and constraints. In: *Climate Change and Global Development* (T. Sequeira and L. Reis, eds.). Cham, Switzerland, Springer.

be three to twelve times the cost of upfront investment in resilience and coping mechanisms. Adaptation to climate change would also benefit other development areas, such as resilience to pandemics, and ultimately boost growth, reduce inequalities and sustain macroeconomic stability.

African countries need to enhance their capacities (institutional, human, infrastructural) for climate-resilient development and adaptation planning. A key component of the required capacities is an investment in hydrometeorological systems and services to improve monitoring, predictions and early warning against high-impact hazardous events and tailor information for decision-making in climate-affected sectors such as those prioritized in African NDCs.

ENSURING RESILIENCE FOR VULNERABLE PEOPLE

Increased investment is essential for ensuring resilient societies, as the number of vulnerable people in the continent continues to increase as a result of pandemics, conflicts and multiplying factors associated with climate change and related disasters. Investment needs to be boosted in the areas of prevention, preparedness, disaster risk reduction, policy engagement, legal guidance, data collection and analysis, as well as to reduce the environmental impact of refugee settlements. This includes supporting the implementation of the Agenda for the Protection of Cross-Border Displaced Persons in the Context of Disasters and Climate Change, the free movement protocols, the Paris Agreement, the Sendai Framework for Disaster Risk Reduction, as well as the Global Compact on Refugees and the Global Compact for Safe, Orderly and Regular Migration. Policies on environmental migration and disaster displacement in Africa need to be not only centred on protection, and evidence-based, but also solution-oriented, so that they can be tailored to the actual needs and realities of the communities.

Documenting the resilience of communities is as important as documenting their vulnerabilities. Successful adaptation strategies developed by migrants, refugees and displaced communities to cope with climate impacts and prevent displacement from occurring should be further analysed to provide policymakers with solutions linked to green recovery and nature-based solutions.

When displacement occurs, existing protection frameworks must apply wherever relevant, to ensure the protection of displaced people in need. Moreover, the participation of affected people, including displaced persons, refugees, migrants and hosting communities, especially women, is vital.

FILLING GAPS IN HYDROMETEOROLOGICAL SYSTEMS AND SERVICES

NMHSs in Africa clearly recognize the importance of hydrometeorological systems and services for adaptation in climate-sensitive sectors, as 92% of the countries in Africa mention climate services in their NDCs. NMHSs, as recognized by the Convention of the World Meteorological Organization, are fundamental components of the national infrastructure and play an important role in supporting vital socioeconomic functions such as disaster reduction, agriculture and food security, water resources, health, energy and transportation. This role necessitates the NMHSs to provide better early warning services to reduce disaster risks, as well as support national development and life-supporting activities that are sensitive to weather, climate and water outcomes. It requires conducting systematic observations and data gathering that form the foundation for the monitoring and prediction of weather, climate, water and related environmental conditions, as well as the issuance of warnings, alerts and advisories. Moreover, the effective and efficient delivery of weather, climate and water services is critical, as well as collaboration with the media to deliver forecasts and warnings to the "last mile" communities and foster international cooperation through exchange of meteorological data and products that enable real-time and non-real-time forecasting activities. To perform these functions, NMHSs must overcome a number of challenges, including:

- Limited human expertise that reduces their capacities to take advantage of advances in science and technology to improve services;
- Inadequate observation networks in countries, which contributes to poor representation of weather systems, climate patterns and status of water resources affecting countries (the sparse observation networks ultimately affect the quality and range of services that the NMHSs can provide);
- Inadequate telecommunication facilities and networks for the exchange of data and products, which enable them to fulfil their national mandates (most telecommunication networks used by NMHSs in Africa are obsolete, and this hampers the efficient flow of observations and products, including multi-hazard early warnings);
- Inadequate mechanisms for engagement between NMHSs and users (customers), which result in low demand and uptake of necessary decision-making information and services;
- Inadequate characterization of current and future weather, climate and water outcomes and impacts, which may lead to the absence of mainstreaming weather, climate and water considerations in the various socioeconomic sectors;
- COVID-19 impacts on national economies, which have further reduced investments in NMHSs from national budgets and development partners.

WMO Members assess their capacity for providing climate services and documenting associated socioeconomic outcomes and benefits through a survey that addresses functional capacities across the climate services value chain. Functional capacities assessed by the survey are organized into six groups: governance, basic systems, user interface, capacity development, provision and application of climate services, and monitoring and evaluation. Many of these functional capacities are listed under "basic", "essential", "full" or "advanced" levels. The percentage of functions satisfied in each group for each capacity level provides a basis for assessing country capacities and needs in each area, as well as for categorizing the overall level of service provided by the Member according to WMO criteria.[51] Data are currently available for 84 of the 193 WMO Members, of which 27 are from Africa.

Data show that there is a need to reinforce the service delivery aspects, especially monitoring and evaluation of socioeconomic benefits (Figure 32). It is important to note that service delivery is critical to meeting the decision-support needs in the climate-affected sectors identified in the NDCs as shown in Figure 28.

Recognizing the need for financial and technical assistance to address the challenges of sustaining observing infrastructure in Africa, WMO and the members of the Alliance for Hydromet Development are establishing the Systematic Observations Financing Facility (SOFF). The SOFF will provide long-term support for the collection and sharing of meteorological observations in compliance with the WMO Global Basic Observing Network.

51 WMO, *2019: 2019 State of Climate Services. Agriculture and Food Security* (WMO-No. 1242). Geneva.

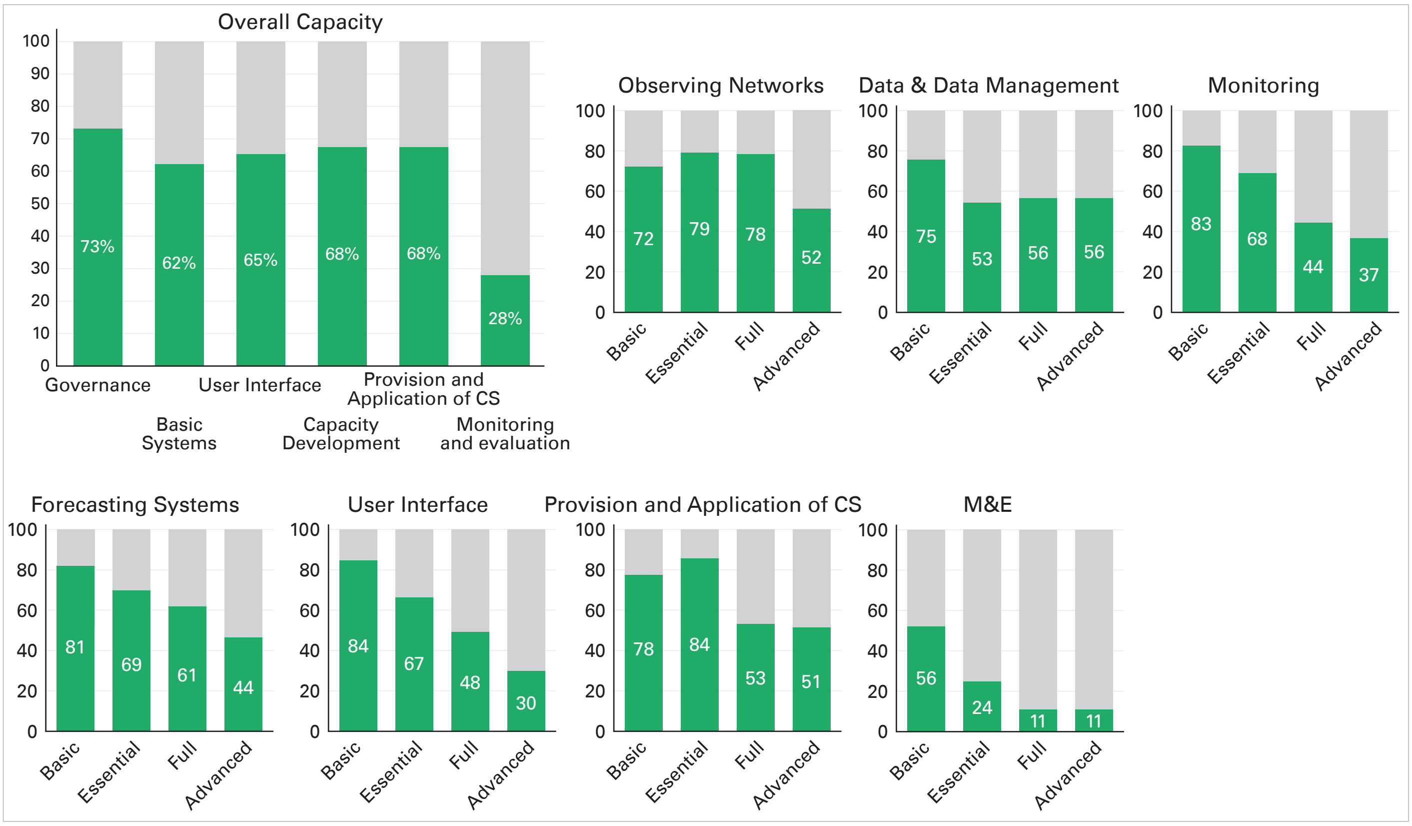

Figure 32. Capacities across the climate services value chain in Africa by component for 27 WMO Members, calculated as a percentage of functions satisfied in each component area for each functional capacity level. Abbreviations: CS, climate services; M&E, monitoring and evaluation.

DATASET DETAILS

HadCRUT.5.0.1.0: Morice, C.P., J.J. Kennedy, N.A. Rayner, J.P. Winn, E. Hogan, R.E. Killick, R.J.H. Dunn, T.J. Osborn, P.D. Jones and I.R. Simpson (in press) An updated assessment of near-surface temperature change from 1850: the HadCRUT5 dataset. Journal of Geophysical Research (Atmospheres) doi:10.1029/2019JD032361. HadCRUT.5.0.1.0 data were obtained from http://www.metoffice.gov.uk/hadobs/hadcrut5 on 14 February 2021 and are © British Crown Copyright, Met Office 2021, provided under an Open Government License, http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

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