Present and Projected Climate Risks in Africa

KEY MESSAGES

- **Africa is particularly vulnerable to climate extremes, or even shifts in weather norms such as the start of the monsoon, as so much food production is dependent on rain-fed agriculture and pastoralism.** Infrastructure that supports the wider economy is also highly exposed to extreme events.
- **Surface temperatures are increasing across all African regions.** Africa is warming faster than the global average over both land and oceans. The latest IPCC report (AR6) now predicts that globally, critical warming levels are likely to be reached earlier in the century than previously projected. Both the need and the urgency to adapt are stronger than ever.
- **Adaptation is even more essential than generally acknowledged because, although there is now wide awareness of the scale and scope of climate change, small changes in weather patterns arising from climate change can also gradually erode the productivity of food systems and cause losses of assets through events too small to attract global or even national attention.** These changes affect people's well-being and can counter efforts to rise out of, or can push people back into, poverty, leading to millions of people never being able to escape poverty.
- **The collection of weather and climate observations in Africa is weak and deteriorating in recent years.** The Global Framework for Climate Services (GFCS) State of Climate Services reports


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prepared by WMO and partner organizations have identified needs for significant additional investment to improve systematic weather and climate observations; operational exchange of data and products between the national, regional and global levels; interaction with stakeholders in climate sensitive sectors to co-design, develop and deliver tailored hydromet products and services; "last mile" service delivery; use of the best available science for climate action and associated investments; data on country capacities and on financial allocations for hydro-met systems and services, to enable tracking of financing in relation to assessed gaps and needs; and documentation of socio-economic and environmental benefits of adaptation action.

"(we need to)…revisit our climate ambitions and accelerate the implementation of our actions planned under our national priorities. To do this we will need to focus on actions to adapt to the impacts of climate change, these include nature-based solutions, energy transition, enhanced transparency framework, technology transfer and climate finance."

H.E. President Félix-Antoine Tshisekedi Tshilombo of the Democratic Republic of Congo, and African Union Chairperson
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Introduction: A picture of intensifying climate change in Africa

"In Somalia they called the drought Sima, meaning equal, because it hammered everyone equally hard."[1]

Sima is one of the most recent and largest droughts to strike Africa, but it is just one of a series of droughts, floods, and heat waves that even in the current climate have devastated the livelihoods of so many Africans in the past few years. Such events are associated with major suffering when they occur, and such impacts will likely be exacerbated by further warming.

The east coast of Africa has faced a period of droughts that began in 2008 and have extended, without much relief, except for occasional floods, until recently. In 2019 strong cyclones and heavy rains along the Arabian Peninsula, resulted in higher-than-normal vegetation growth, which provided ideal conditions for desert locusts. The result was the largest desert locust outbreak in 25 years in the Greater Horn of Africa and Yemen, which exacerbated existing conditions of undernourishment. In Ethiopia alone, 200,000 hectares of cropland were damaged, and over 356,000 tons of cereals were lost, leaving almost one million people food insecure.[2] By September 2020, the number of Somalis facing acute malnutrition and marginally able to meet minimum food needs tripled to 3.5 million compared to early 2020.

Droughts in southern Africa brought Cape Town face to face with its Day Zero on 22 April 2018, which was the day the city was projected to run out of water. Only the most stringent water restrictions and cooperation from citizens saw the city through the crisis until it was relieved by winter rains.

But drought is common across much of Africa. The Sahel, that strip of land between the Sahara to the north and tropical rain forests to the south, faced a drought extending through much of the 1970s. It was so extreme that the idea of establishing a green wall of trees to hold back the advancing Saharan sands was formed (see Great Green Wall insert). Since the 1980s conditions have moderated, but have become even more variable, making the life of smallholder farmers and pastoralists more difficult.

These changes are driven by the West African monsoon, which in turn is affected by cycles of warming and cooling in the Pacific, Indian and surrounding oceans.

During August and early September 2021, Egypt experienced some the hottest weather in the past 50 years. For several weeks temperatures were up to 7°C above average, along with high humidity. Temperatures exceeded 40°C in many areas and sometimes reached 47°C. When combined with humidity of 50 percent or higher, such conditions exceed the limits for safe work outdoors, especially in the sun. In Cairo there were power outages and the metro transport system was closed several times. The deaths of "dozens of people" have been directly attributed to heat stroke, but it is likely the extreme heat has caused many more to succumb to existing illness such as heart disease.[3] This brings home the impact that further global warming will have on people who already live at the limits of human tolerance. The anomalous warm events over Egypt are directly related to an intensification of the Asian monsoon lows which draw warm, dry air from the Arabian Peninsula and the Iranian Plateau across north Africa. Modelling shows that these conditions are expected to increase with climate change.

The east coast of Africa falls within a cyclone zone. In March 2019 Cyclone Idai struck Mozambique near Beira City, to be followed a few weeks later by Cyclone Kenneth, which struck a little to the north. Both were among the strongest cyclones recorded in Africa; they led to havoc from high winds, storm surges and flooding in Mozambique and the rain-induced floods extended inland into Malawi and Zimbabwe. Together they left 1,300 dead and 3.5 million people affected through the loss of livelihoods and of 100,000 homes. The majority of those affected were poor people living in substandard housing in informal settlements that were unable to withstand the high winds, torrential rain and floodwaters. Around 90 percent of Beira's homes were affected.[4] The cyclones coincided with the annual harvest, prolonging the losses through the subsequent food shortages, and then in some areas the recovery was further hampered by a cholera outbreak that affected at least 4,000 people.[5]


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Disasters in Africa

The African continent is often associated with disasters. Its countries have little resilience to hazards, and they are often forced into years of suffering and many of their citizens fall back into poverty following a disaster. The great droughts in Ethiopia and Somalia in 1973 claimed 120,000 lives and damaged the livelihoods of over three million people. A decade later, another drought affecting Ethiopia and Sudan was estimated to claim 450,000 lives and affected 16 million people. Floods usually claim far fewer lives, but they are more numerous, as so many Africans live along the many great African rivers. Nigeria suffered floods in 2010 and 2012 that killed 400 but affected 8.5 million people, and floods in Mozambique in 2000 killed 800 and affected 4.5 million[6].

The EM-DAT database maintained by the Centre for Research on the Epidemiology of Disasters (CRED) is a global, comprehensive and readily accessible record of disasters (Box 1). Their data is often used to make the case that the number and impact of disasters has been increasing rapidly, but these claims must be treated with caution.

The capturing and reporting of events were irregular across the globe for most of the last century, with major droughts and flooding events being captured but many smaller events likely missed. It was in the late 1990s that the number of recorded disasters rose rapidly (Figure 1). This increase is as much due to better reporting and increasing exposure of people and economic assets as it is to climate change. In the past decade the number of recorded disaster events has dropped compared to the previous decade. More time is needed to see if this is a temporary dip or a true trend in a positive direction.

The number of flood events reported has increased about five-fold since the mid-1990s, while the numbers of other types of disaster have changed much less. Some of the increase in floods could be due to a changing climate but changing exposure patterns of populations along rivers and coasts and improved reporting almost certainly contribute as well.

Box 1: The Centre for Research and Epidemiology of Disasters (CRED)

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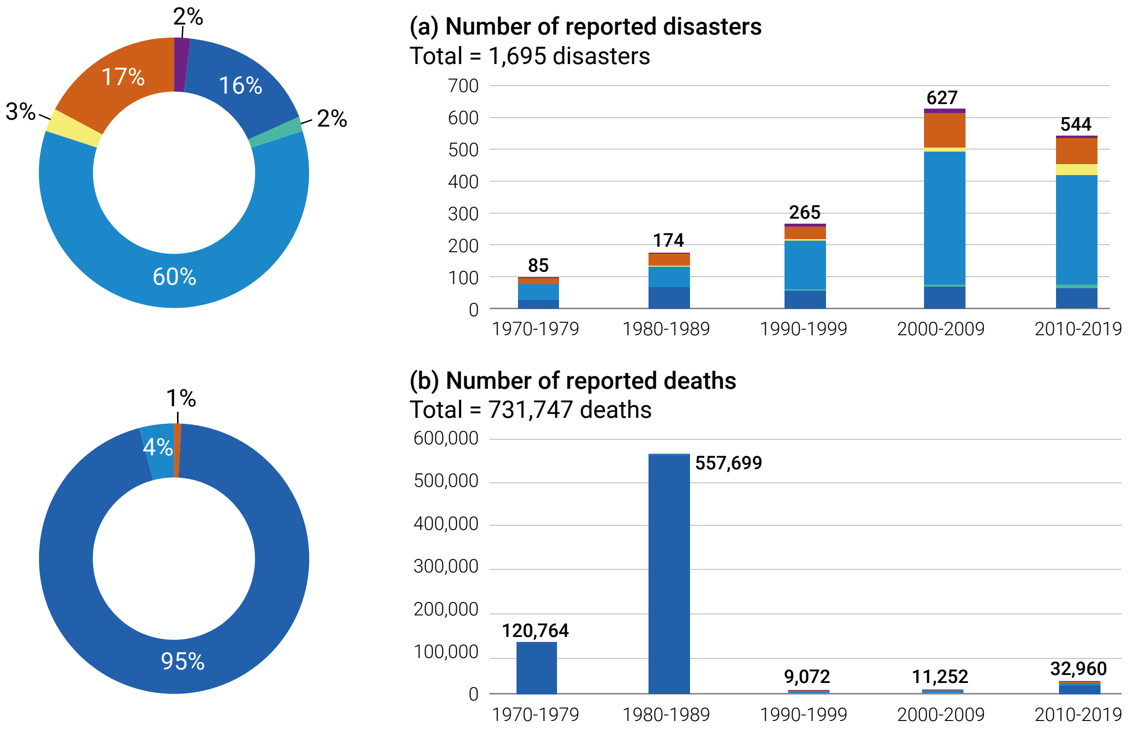
The Centre for Research on the Epidemiology of Disasters (CRED) was established in 1973, and is a World Health Organization Collaborating Centre with links to various UN and NGO humanitarian institutions. It maintains a database on all forms of disaster including climate-related, geophysical (e.g., earthquakes), technological (e.g., industrial and transport accidents), and extra-terrestrial (e.g., geomagnetic storms). Disasters are defined as events that cause at least 10 deaths, or affect, injure or make homeless 100 or more people, or are declared a state of emergency by the affected country. The data base includes estimated loss and damage in monetary terms, but these estimates are available for less than one in six of reported African disasters.

The CRED EM-DAT database is readily accessible at https://www.emdat.be/. This chapter focuses on climate-related disasters which corresponds to their categories of Climatological, Meteorological or Hydrological disasters.

Africa, like most other parts of the world, has shown a marked decline in the number of people reported as being killed in disasters. For example, in the 20 years from 1970 to 1989, 679,000 people were reported as being killed in African climate-related disasters, compared with only 44,000 people killed over the most recent 20-year period. Most of this change represents real improvements stemming from better early warning systems, social safety nets and humanitarian support to alleviate the worst of the impacts. But some of the decline is due to changes in the attribution of the cause of death, especially in relation to drought. During the 20th century four droughts were recorded as leading to over 100,000 deaths, whereas the largest loss of life in the 21st century is a single case of 20,000 deaths attributed to the drought in Somalia in 2010.[7] Deaths associated with recent droughts are likely to be higher than recorded in the EM-DAT database, but now many are attributed more direct causes of death such as infectious and nutrition-related diseases, and not to the drought disaster per se.

Recorded economic losses from 1970-2019 are approximately evenly distributed across drought, floods and storms but, as only 14 percent of disasters in Africa have an estimate of damages recorded, more data is needed on economic damages and losses.

Figure 1: Recorded disasters by event type, 1970–2019



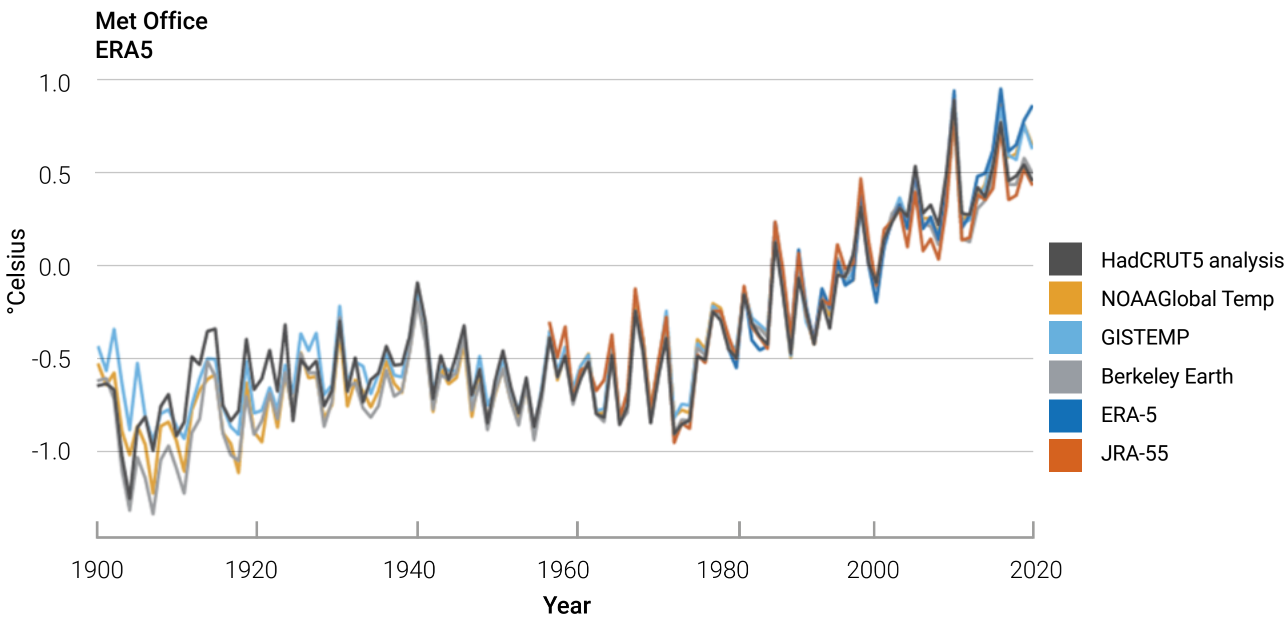
Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019)

Recent trends in African climate

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), based on six data sets.

Depending on the data set used, 2020 was between the third and eighth warmest year on record. Africa has warmed faster than the global average temperature over land and ocean combined.

Figure 2: Area average land air temperature anomalies in °C relative to the 1981-2010 long-term average for Africa



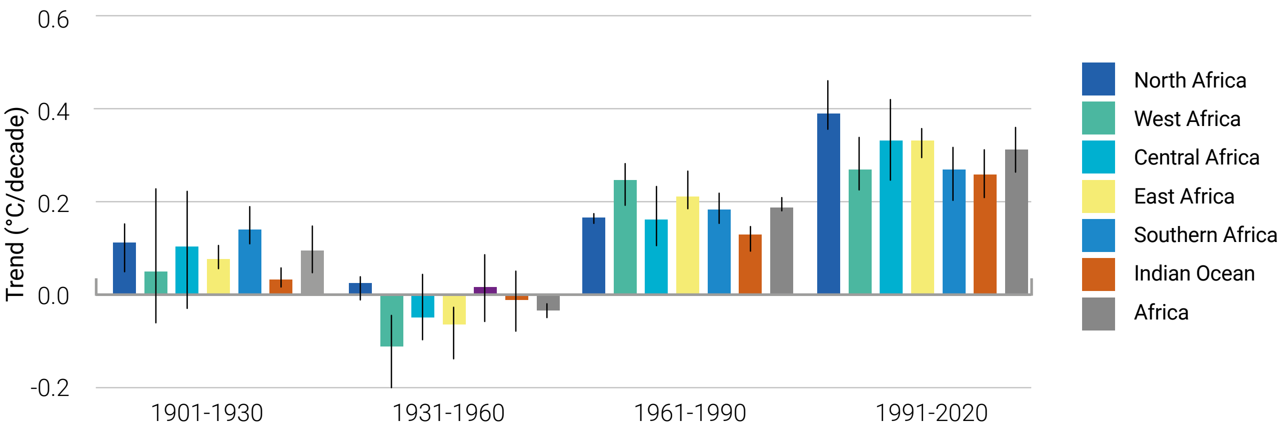
 Source: Met Office, United Kingdom
Note: This is based on six data sets: HadCRUT5, NOAAGlobalTemp, GISTEMP, Berkeley Earth, JRA-55 and ERA5 – validated in some cases with in-situ observations. Africa is the WMO Regional Association I.

At subregional scales, analysis using the six temperature 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.

Sea levels are also rising around the African continent, threatening low-lying coastal areas and small island states, and increasing risks of coastal riverine flooding (Figure 4). Analysis based on the Copernicus Climate Change Service (C3S) gridded sea-level data set 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 4).

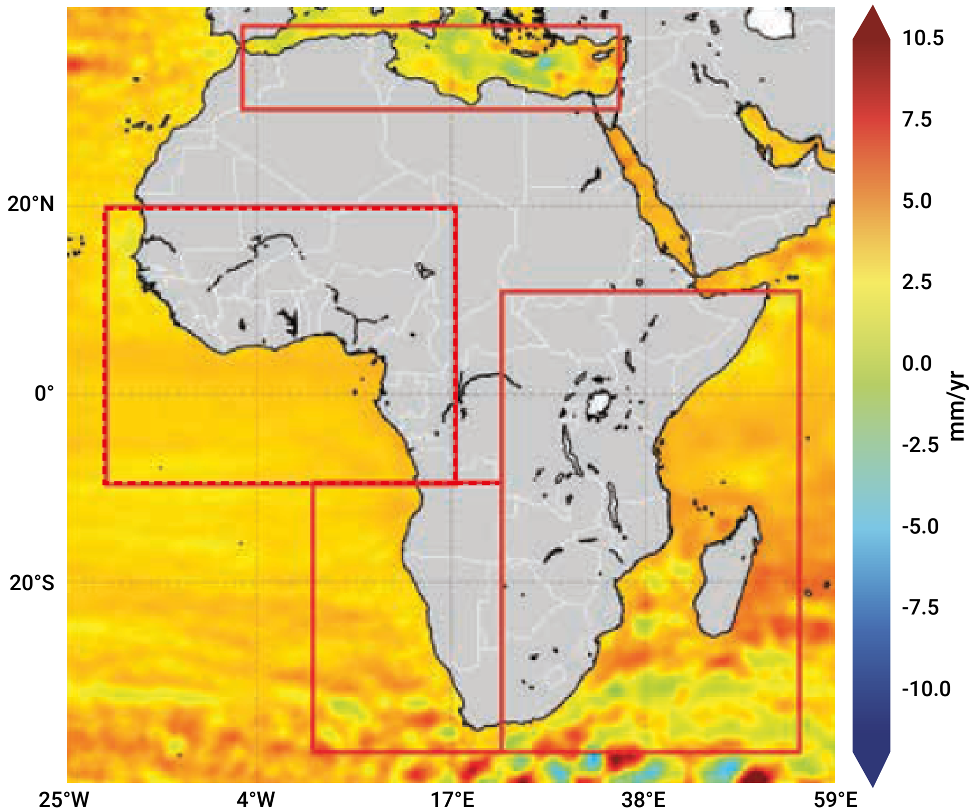
The Mediterranean coasts display the lowest sea-level rise, at approximately 2.9 mm/yr lower than the global mean. Sea-level rise along the tropical and South Atlantic coasts is higher than the global mean, at approximately 3.6 mm/yr.

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



Source: WMO State of Climate in Africa 2020
Note: The black lines at the top of each bar indicate the range of the trends calculated from the six data sets.

Figure 4: Sea-level trends from January 1993 to June 2020 (mm/yr)



Source: WMO State of Climate in Africa 2020
Note: 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

Projections of African climates

This STA21 Report was drafted largely in the first half of 2021 mostly based on climate change insights and modelling derived from the 2013 Fifth IPCC Assessment Report (here abbreviated to AR5). In August 2021 the first volume of the Sixth Assessment Report (AR6) was released with significant new insights and modelling.[8]

This section briefly describes the new findings and tools provided by AR6, with a focus on the interplay between some of the main components of the African climate, climate change, and the people who must seek their livelihoods while negotiating the consequent erratic weather patterns. The first volume of AR6 on the *Physical Science Basis* of climate change will be elaborated by two further volumes due for delivery in February/March 2022. One will deal with *Impacts, Adaptation and Vulnerability* in social and biophysical systems under the different scenarios of climate change, and the other on the *Mitigation of Climate Change*, which will explore many mitigation-adaptation interactions.

Recent IPCC Assessment Reports have been supported by major modelling efforts (Coupled Model Intercomparison Projects or CMIPs). The AR6 report is based on a major new modelling effort (CMIP6), that compares over 30 models of global circulation that include more detail within the models and greater spatial resolution. Since AR5, high-resolution downscaling for regional projections have improved and their results coordinated through international initiatives such as CORDEX. These efforts have advanced the understanding of regional climate variability, adding value to CMIP global models, particularly in areas of complex topography, coastal areas and small islands, and in the representation of extremes.[9] Africa was selected as a focus in developing CORDEX with many African scientists engaged in the initiative.

The AR6 has focused on reporting information relevant to major regions of the globe and for the first time has provided a readily accessible Interactive Atlas for flexible spatial and temporal analyses of much of the observed and projected climate change information.[10]

The technical advances of CMIP6 act to reinforce the messages that were already emerging from previous assessments (Box 2). Confidence in the prediction of changed climate patterns and the attribution to human effects have increased, and it now appears that critical warming levels are likely to be reached earlier in the century than previously projected. **This is the AR6 Report's strongest message for adaptation. Both the need and the urgency to adapt are stronger than ever.**

Box 2: IPCC AR6 headlines statements

- Human influence on climate is now unequivocally established. Humans are the main drivers of climate change.
- Observation and modelling support each other very strongly.
- As global temperatures increase, so too will many other weather extremes.
- Global warming projections are a little higher than previously anticipated. From an adaptation planning point of view these changes are too small to matter much.
- The global temperature projections show that stabilisation or peaking at around 1.5°C can be achieved with a few scenarios, but these scenarios are at odds with the current emissions effort. More likely scenarios show that we must prepare for global warming approaching, or exceeding, 1.5°C by the 2030s, 2°C by 2050 and 3°C to 4°C by 2100 unless decisive global action is taken.[11]

Photo: Istock

Africa in the IPCC AR6 Report

Developing climate models for Africa has been difficult, partly because of its complex set of drivers, but also because past and recent meteorological observations are sparse throughout many parts of the continent.[12] However, since the previous IPCC Report (AR5) research based on and in Africa, the use of remotely sensed meteorological data to back up the sparse observational network has increased, allowing better modelling of Africa in AR6. An example of these new skills is the ability to clarify and attribute the direct human role in the Sahel drought of the 1970s and 1980s and the wetter period that followed. Since the 1950s, increasing aerosols emissions from Europe and North America cooled the North Atlantic, which suppressed Sahel rainfall for decades. The subsequent reduction in aerosol emissions through clean air policies then contributed to North Atlantic warming and recovery of Sahel rainfall.[13]

Africa's changing climate: observed trends and modelled projections

The bulk of the IPCC AR6 WGI report deals with the physical processes that determine changes in the climate system. Chapter 12 of the AR6 report makes the next step towards providing information for evaluating regional impacts and risk assessment. The IPCC AR6 WGII report, *Impacts, Adaptation and Vulnerability* due in February 2022, will take this much further by considering the interactions between the hazards identified in WGI and the wider set of factors, such as exposure, vulnerability, adaptive capacity, etc. Chapter 12 of the AR6 provides a global overview of 33 Climate Impact Drivers (e.g., extreme heat, river floods, aridity, sand & dust storms), and their effects by region.

In keeping with the goal of AR6 to provide a greater regional focus there is a summary of the specific projections for nine regions covering the African continent and surrounding islands. The IPCC regions differ from the African Union's regions that are used throughout most of this report.

In the AR6 report each continent has a two-page fact sheet and concise summary graphic as presented here for Africa in Figure 5. This figure summarises for each Climate Impact Driver and by each subregion whether a change in the driver can be seen against the background variability, and whether it can be seen in observation data or whether it appears in modelling before or after 2050 (dot color). It also shows whether the associated hazard is increasing or decreasing (red or blue background shading) and the confidence in the conclusion (depth of shading). Figure 5 shows high confidence that changes in temperature drivers (grouped as Heat and Cold) are already observed to be consistently warmer across the continent, while moisture (wet and dry) and wind-related drivers are more varied by subregion, with many not yet showing a clear signal above the background variation. Annual precipitation is expected to decrease in North Africa and Southern Africa by 2050 even though such a trend is not yet clear in the observational data. Northern and southern Africa are expected to become more arid throughout this century, but in some parts of southern Africa aridity will be accompanied by an increase in heavy rainfall events possibly leading to floods.

Africa and its subregions are also covered in about eight pages of text (AR6 12.4.1), which is briefly and selectively summarised in Table 1.

Photo: Tonis Valing/Shutterstock

Figure 5: Climatic impact-drivers for different African regions

Summary of the direction of change in selected important Climate Impact Drivers across the IPCC African Regions. The shading shows the confidence in the direction of change and the dots whether the change is already observed in the historical period or whether it is expected to emerge by 2050 in at least the high emission scenarios. Based on Table 12.3 in IPCC AR6 WGI.

	Heat and Cold				Wet and Dry								Wind				Coastal and Oceans				
	Mean air temperature	Extreme Heat	Cold spell	Frost	Mean precipitatiopn	River flood	Heavy precipitation & pluvial flood	Landslide	Aridity	Hydrological drought	Agricultural & ecological drought	Fire weather	Mean wind speed	Severe wind storm	Topical cyclone	Sand & dust storm	Relative sea level	Coastal flood	Coastal erosion	Marine heatwave	Ocean acidity
North Africa (MED)*														3					4		
Sahara (SAH)																			4		
Western Africa (WAF)					1				1	1	1								4		
Central Africa (CAF)																			4		
North Eastern Africa (NEAF)					1,2				1	1	1								4		
South Eastern Africa (SEAF)					1				1	1	1				3				4		
West Southern Africa (WSAF)																			4		
East Southern Africa (ESAF)															3				4,5		
Madagascar (MDG)															3				4,5		

Already emerged in the historical period

Emerging by 2050 at least in Scenarios RCP8.5/SSP5-8.5

Both medium to high confidence

Key

High confidence of decrease

Medium confidence of decrease

Low confidence in direction of change

Medium confidence of increase

High confidence of increase

Not broadly relevant

1. Contrasted signal within region: drying in western portions and wetting in eastern
2. Likely increase over Ethiopian Highlands
3. Medium confidence of decrease in frequency but increase in intensity
4. Along sandy coasts and in the absence of additional sediment sink/sources or any physical barriers to shoreline retreat
5. Substantial parts of ESAF and MDG coasts are projected to prograde if rates of change of present-day ambient shorelines continue

* North Africa assessment is based upon the African portions of the Mediterranean Region
North Africa is not an official region of IPCC AR6, but the assessment here is based upon the African portions of the Mediterranean Region

Source: AR6 WGI (2021), Table 12.3

“

If we are to achieve this ambitious climate adaptation agenda, it is only through partnerships that we can strengthen and accelerate resilience across our continent.”

H.E. President Uhuru Kenyatta of Kenya
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Table 1: Summary of effects of increasing emissions on African climates

Temperature	
	Observed mean annual temperatures are increasing at 0.2°C to 0.5°C per decade.
	Under each of the major emissions scenarios assessed, a global temperature increase of 1.5°C over pre-industrial levels is likely to be exceeded in the next decade or so, and by mid-century all but the lowest emissions scenarios suggest temperature increases of 2°C or more.
	High-emissions scenarios suggest it is very likely that warming will exceed 3°C by 2100 except in Central Africa where the estimate is 2.5°C.
	Extreme heat—observations are limited, so no evidence of a recent increase. Modelling suggests days above 35°C will increase by 20 to 160 days depending on scenario and region.
	Life-threatening temperatures above 41°C are projected to increase by 10 to 140 days depending on scenario and region.
	Cooling degree days will increase and heating degree days will decrease.
Summary: Heat waves and heat stress to increase and drastically so in the worst scenarios	

Precipitation	
	The frequency and intensity of heavy precipitation events are projected to increase almost everywhere in Africa, leading to more flooding events.
	Observations are variable, but in many areas there is evidence of a drying trend especially in parts of North Africa, West Southern Africa and Central Africa. Models project that this trend will continue.
	River floods—observations suggest there has been some increase in recent decades. Model results vary with scenario and region, but they suggest that present 1 in 100-year floods could become as frequent as 1 in 40 years under low warming scenarios and 1 in 20 under higher warming.
	The West African Monsoon appears to shift later in season and rainfalls more intense and erratic.
Drought	Droughts are expected to increase in all regions of Africa except the northern parts of East Africa and the Horn of Africa.
Aridity	Observation and modelling suggest increasing aridity in North Africa, West and East Southern Africa, and in Madagascar.
Summary: Changes in total precipitation are small, but more rain is likely to fall in heavy rainfall events in most regions. But the effect of increased precipitation must also be considered alongside the prospect of increasing temperatures and evaporative demand. Thus, the overall picture is of drier conditions over most of the continent with more droughts but also more flooding.	

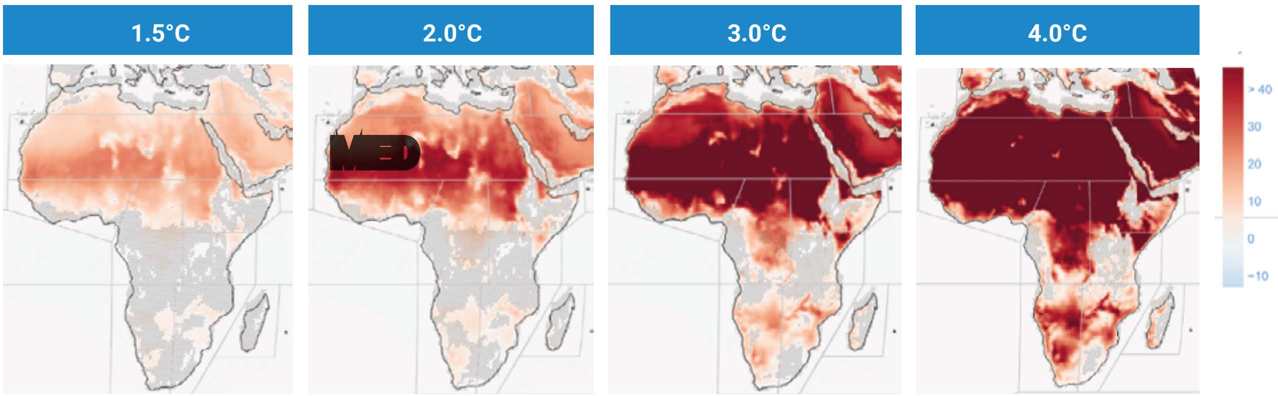
Coastal & Ocean	
	African sea levels are currently rising slightly faster than global average, although a little slower in parts of the Indian Ocean coast. They are virtually certain to continue rising by 0.4m to 0.5m by 2100 under low-warming scenarios and 0.8m to 0.9m under high-warming scenarios.
	Marine heat waves are expected to continue to increase in frequency and intensity, especially around the Horn of Africa.
Cyclones	Cyclones are possibly decreasing in frequency, but high-intensity events will become more common, often associated with very heavy rainfall.
Coastal flooding	Projections suggest that a current 1 in 100 year flooding event will become flooding events with a return period of 10 or 20 years by 2050, and a return period of 5 years to annually by 2100, even under moderate warming.
Fire weather	Likely to increase throughout extratropical Africa.
Dust storms	Evidence is uncertain due to confounding factors, especially changes in land cover and general uncertainty in detailed wind modelling. The whole topic impeded by lack of controlled observations.

Impacts by degrees

The Paris Agreement seeks to limit the global temperature increase in this century to 2°C above pre-industrial levels, while pursuing the means to limit the increase to 1.5°C. This agreement is core to the international mitigation and adaptation negotiations. Summaries such as Figure 5 and Table 1 are useful, but many will seek higher resolution and more nuanced projections of the impacts that may emerge from different global temperature increases. Projections of the impacts on human and natural systems will come mostly from AR6 WGII's report due in February 2022, and subsequent work. However, the WGI report provides a valuable tool to simplify access to the climate projections via its interactive Atlas.

This is demonstrated in Figure 6, which shows the occurrence of extremely hot days (temperatures exceeding 40°C) across Africa for different global warming levels (GWLs). Currently the hottest regions of Africa in the Sahara and north Africa average about 10 to 20 days per year of conditions approaching the safe limits to human activity outdoors. At GWLs of 2°C this will increase by 30 days in some areas. At 3°C parts of western Sahara will endure about 80 additional days per year; at 4°C this rises to 120 days per year in the worst-affected regions. These temperatures will limit the amount and efficiency of work outdoors not just in agriculture but also in construction, transport and tourism.

Figure 6: Increase in the number of days exceeding 4°C under increasing global warming levels



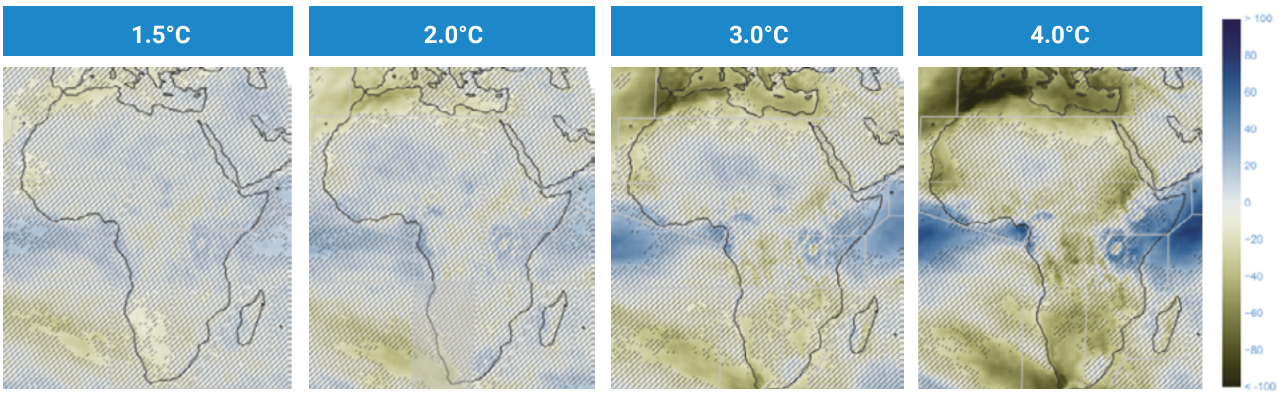
Source: IPCC AR6 WGI Atlas (2021) CORDEX Africa - Days with TX above 40°C (TX40) Change days - Warming 1.5 to 4.0°C RCP 8.5 (rel. to 1995–2014) - Annual (31 models)

Photo: Vadim Petrakov/Shutterstock

Figure 7 shows the long-term trend towards further aridity across much of Africa and the few areas that may become wetter. The Standardized Precipitation Index (SPI) is an index used globally for quantifying and reporting meteorological drought. Essentially it measures the deviation in precipitation from the long-term distribution of rainfall. It is an effective measure of precipitation excess or deficit and thus of meteorological drought. The continental scale projection of the percentage change in SPI can be used as a broad indicator of increasing dryness (brown in Figure 7a) or wetness (blue). Despite some disagreements between the models shown by the shading, as GWL increases areas of increased drought in North Africa, Western Sahara and South-western Africa emerge, as do areas of wetter conditions in northern East Africa and the Horn of Africa. The SPI is most likely an underestimation of increased aridity, as it does not consider the increasing effects of high temperatures on increased evapotranspiration, so agricultural and ecological droughts may be even more pronounced. Figure 7b highlights that even in regions of increasing dryness such as across Madagascar, Central and South-eastern Africa, heavy rainfall events, calculated as the maximum 5-day precipitation events, are also expected to increase, showing that these regions are likely to be subject to both increasing droughts and intermittent floods.

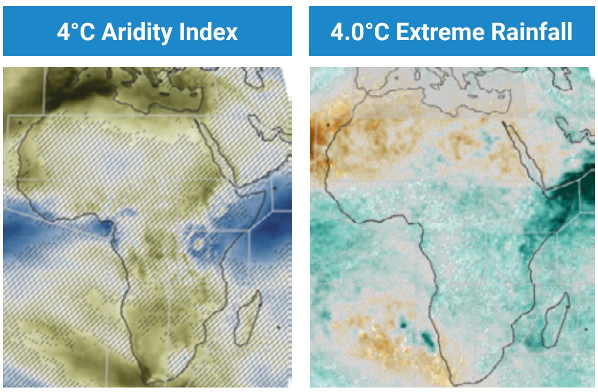
Figure 7a: Percentage change in the Standardized Precipitation Index (SPI-6).

Darker shading shows a shift towards drier conditions and blue to wetter conditions. The hatching shows that over most of the continent there is disagreement between the models.



Source: IPCC AR6 WGI Atlas (2021). CORDEX Africa - Standardized Precipitation Index (SPI-6) Change % - Warming 1.5 to 4.0°C RCP 8.5 (rel. to 1995–2014) - Annual (21 models)

Figure 7b: Some areas with increasing aridity will also be subject to increasing extreme rainfall events.



Source: IPCC AR6 WGI Atlas (2021). CORDEX Africa – Left, Standardized Precipitation Index (SPI-6) Change %; right Maximum 5-day precipitation (Rx5day) Change %. - Warming 4.0°C RCP 8.5 (rel. to 1995-2014) - Annual (20+ models)

Climate change attracts attention when some form of climate shock occurs, and the above figures show the projected trends towards extreme conditions. However, more subtle climate changes also threaten ecosystems and the people whose well-being depends on them. Small changes in weather patterns arising from climate change can gradually erode the productivity of food systems and cause losses of assets through events too small to attract global or even national attention. These changes affect people's well-being and can counter efforts to rise out of, or can push people back into, poverty, leading to millions of people never being able to escape from the threat of poverty.[14]

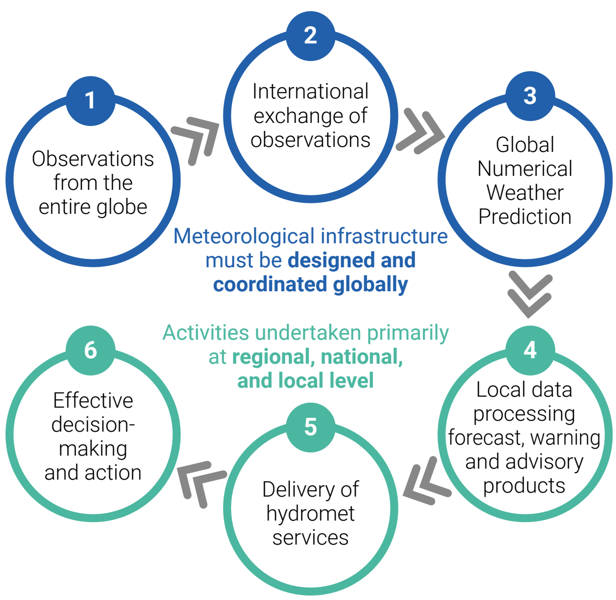
This report makes the case for supporting climate-informed development that increases poor peoples' resilience to a wide range of threats, as climate change so often acts as a magnifier of impacts. Thus, there is a need for social safety nets, risk-spreading mechanisms including subsidized insurance, and resilient infrastructure ranging from cyclone- or flood-resistant housing to resilient road systems. And there is a need for novel financial mechanisms to sustain these interventions (see Finance chapter for more details).

There is also a role for better information about climate. This includes not just changes in the medium (decadal) to long-term climate as is the focus of IPCC, but also risk information and early warning systems of imminent threats that do not just provide an alarm but facilitate risk-reducing behaviours.

Hydromet services

Effective action on climate adaptation and resilience is only possible with high-quality weather, climate, hydrological, and related environmental data ("hydromet" data). This data is collected in each country by national hydromet agencies. Data is, of course, not enough. In the end, what is required is for all stakeholders in society—governments, businesses, and citizens—to take appropriate action based on weather and climate information. For this to happen, the meteorological value chain shown in Figure 8[15] needs to have all components working effectively in a coordinated manner.

Figure 8: The Meteorological Value Chain

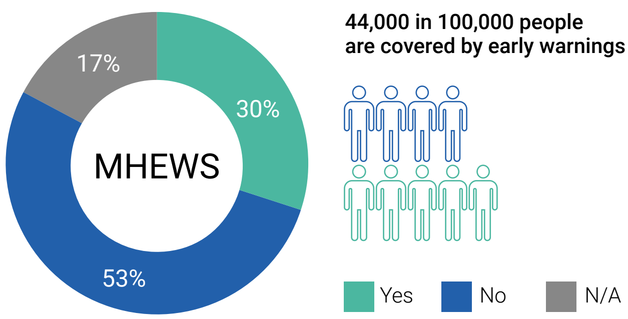


Source: WMO (2021) Hydromet Gap Report

Weather, water and climate observations are collected and exchanged internationally through the WMO Global Data Processing and Forecasting System. This information is used by national meteorological services and the private sector to generate local forecasts, warnings, seasonal outlooks, and other hydromet services. These products can then be used by different stakeholders to act, including on climate adaptation.

One essential product of this value chain is multi-hazard early warning systems. In Africa, the WMO collects data from its Members to evaluate gaps in these systems. Based on data submitted by 46 African countries (87 percent of the region), only 30 percent report having a fully-functioning, end-to-end, Multi-Hazard Early Warning System in place (Figure 9). In addition, only 11 percent of African countries are using the Common Alerting Protocol (CAP) which provides a single system to alert the public of any hazard using all available media. Without strong early warning systems, the ability of communities and societies to be prepared for climate shocks is limited.

Figure 9: Distribution of African countries that reported having a multi-hazard early warning system in place



Source: WMO (2020). 2020 State of Climate Services
Note: as a percentage of the total number of WMO Members in the region (53)

According to an estimate by the World Bank, if early warning systems in low- and middle-income countries were upgraded to European standards, lives lost could be halved and annual losses to assets of between US$ 300 million and US$ 2 billion avoided.[16] The Global Commission on Adaptation reports that a 24-hour advance warning of a coming storm or heatwave can reduce damages by 30 percent.[17] High-quality hydromet data has many other benefits, including economic productivity in key sectors from agriculture to logistics. Better historical hydromet data and projected climate changes are becoming more critical to mobilizing climate finance.

Strengthening the hydromet value chain

Finally, better hydromet data is essential for the insurance and finance sectors, as discussed in the Finance chapter. The Task Force on Climate-Related Financial Disclosures (TFCD) climate risk disclosure standards call for better hydromet data.

The collection of weather and climate observations in Africa is weak and deteriorating in recent years. The WMO estimates that in Small Island Developing States (SIDS) and Least Developed Countries (LDCs), only 300 stations achieve the international standard for data collection and sharing. About 2,000 new and/or rehabilitated stations (surface and upper air) would be needed to have adequate weather data collection.[18] Furthermore, over the last five years (January 2015 to January 2020), the number of upper-air observations dropped by almost half in Africa.[19] This foundational problem poses significant challenges for the rest of the hydromet chain.

The WMO and the Alliance for Hydromet Development have begun working on the above issues through the establishment of a Systematic Observation Financing Facility (SOFF).[20] SOFF aims to support all 67 LDCs and SIDS to achieve sustained compliance with the international standard to collect and share internationally surface weather observations. This target would result in a 28-fold increase of surface data and a 16-fold increase of upper-air data. The World Bank has estimated the benefits of this program to be US$ 5 billion per year, or a US$ 25 return for every dollar invested.[21]

In 2018, the Conference of the Parties called on WMO through its Global Framework for Climate Services (GFCS) to regularly report on the state of climate services with a view to *"facilitating the development and application of methodologies for assessing adaptation needs"*. The GFCS was established by the international community at the World Climate Conference-3 in 2009 to improve climate-related outcomes through the development and incorporation of science-based climate information into planning, policy and practice (see Box 3).

Several reports have been produced by WMO and a consortium of climate finance and United Nations organizations and other partners, focused on the top three adaptation priorities identified by Parties in their Nationally Determined Contributions to the Paris Agreement. [22, 23, 24]

A synthesis of the recommendations areas to be addressed for strengthening these systems and services, and for guiding investments, prepared for a forthcoming WMO contribution by the systematic observation community to the Paris Agreement Global Stocktake, includes the following:

- Systematic observation – The systematic observations that underpin climate services needed to support priority areas identified in Parties' NDCs remain inadequate.
- Systems integration – Operational exchange of data and products between the national, regional and global levels is essential for improving service delivery for country-level adaptation. Fit for purpose-financing is needed to enable data and

products to flow from countries to advanced data processing and forecasting centres and vice versa.

- Co-development of decision-support products and services – Increased interaction with stakeholders in climate sensitive sectors is needed to co-design, develop and deliver the tailored products and services that support improved user decisions leading to improved adaptation outcomes.
- Access to services – Data consistently show that "last mile" service delivery is insufficient to ensure widespread access to climate services, particularly in developing countries.
- Climate science basis – Climate action and associated investments should be based on the best available science. Methods and tools now available for this purpose should be upscaled on a widespread basis to promote adaptation effectiveness.
- Capacity data – Data on adaptive capacities in climate services is incomplete and the data that are available need to be quality assured as a basis for certification of climate services capacities.
- Overall investment levels and associated data – Adaptation finance for climate services remain inadequate, especially for meeting needs in LDCs and SIDS. More detailed data on financial allocations for hydro-met systems and services is needed to enable tracking of financing in relation to assessed gaps and needs.
- Documentation of socio-economic and environmental benefits of adaptation action – Although case studies suggest high returns on investments in climate services for adaptation, more systematic documentation of the benefits of adaptation actions and the resulting improvements in adaptation outcomes is needed to ensure that the measures being financed are cost-effective and that progress towards the global adaptation goal is being achieved.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Box 3: The Global Framework for Climate Services (GFCS)

The GFCS was established by the international community at the World Climate Conference-3 in 2009. The GFCS seeks to accelerate and coordinate the implementation of technically and scientifically sound measures to improve climate-related outcomes through the development and incorporation of science-based climate information into planning, policy and practice. As a framework with broad participation and reach, GFCS enables the development and application of climate services to assist decision-making at all levels in support of addressing climate-related risks. The GFCS has five components, which span the value chain for weather, water and climate: (i) observations and monitoring; (ii) climate services information system; (iii) research, modelling and prediction; (iv) user interface platform; and (v) capacity development.

The GFCS currently focuses on developing and delivering services in five priority areas identified in the NDCs: agriculture and food security, disaster risk reduction, energy, health, and water.

At country level, GFCS implementation is guided by National Frameworks for Climate Services (NFCS)[22]. An NFCS is a multi-stakeholder stakeholder interface platform that enables the development and delivery of climate services at country level. NFCSs focus on improving co-production, tailoring, delivery and use of science-based climate predictions and services, focused on the five GFCS priority areas. NFCSs support NDCs and NAPs by providing climate services that help assess climate vulnerabilities, improve the understanding of climate and its impacts, identify adaptation options, and providing operational products that support decision-making in climate-sensitive sectors. NFCSs also provide a mechanism for the systematic monitoring and documentation of socio-economic benefits associated with the services provided.

The GFCS is now nearing the end of its initial 10-year implementation phase. The next phase of implementation will build on the foundation from the first phase, which has assisted 70 percent of countries for which data are available to provide climate services for adaptation at an essential, full, or advanced level according to WMO criteria. The next phase of the GFCS is expected to emphasize improved articulation of end-use demand, co-development of tailored products, and documentation of the socio-economic benefits of adaptation action, on the one hand, and strengthened operational systems on sub-regional scales to increase country access -- and capacity to add value -- to global and regional data and products needed to provide such services on the other.

Some of the foundational elements in this regard for the next phase include a country-driven focus on identification of national adaptation priorities based on NAPs and NDCs; identification of effective adaptation actions based on scientific evidence of past, present and projected future climate conditions; technical advisory services to ensure that investments in hydro-met systems and services are designed and implemented to international standards; quality management processes to certify specific services and capacity data and improvements; and continuous reporting to the international community on status, gaps and needs in the State of Climate Services reports.

The 'last mile'

All the above efforts will amount to little if the 'last mile' of communication of an early warning system (EWS) fails. Experience has led to the tenet that to be effective an EWS must be embedded in the local social processes. This leads to tensions between the essentially top-down, technologically driven approach described in the Meteorological Value Chain (Figure 8) and those responsible for bringing the efforts along the chain to fruition. The delivery of an early warning needs to consider who is the target of the communication, what options they have once they receive the warning (e.g., remove assets from a potential flood zone versus fleeing), the sequence of warnings that best enable and encourage people to act, and what sort of ongoing communication is necessary. Preparation at this level is as important as the other steps in the Meteorological Value Chain.

Some have suggested that the focus should not be on the last mile, but the 'first' mile, meaning that local communities need to be engaged from the beginning of the design of an EWS.[23] This requires that the circumstances of the target communities needs to be known (e.g., the strength of their housing in high winds; vulnerable crops and livestock; cultural norms that may affect responses, etc.) as well as their options such as access to shelter, whether stock can be moved to safer areas, etc. The Red Cross and Red Crescent is increasingly looking to link impact-based forecasting with early warning systems. Impact-based forecasting provides the information in terms meaningful to the recipient and designed to facilitate early action to reduce risks. For example, rather than stating that "a tropical cyclone of category 4 with winds of 170 km/hr is expected to strike within the region within the next 6 to 8 hours", the warning will also state "the winds are likely to be strong enough to de-roof all but the most compliant cyclone-resistant structures; and storm surges and river flooding will damage roads and bridges connecting X and Y, making transport between them impossible for several days." Impact-based forecasts and warnings should communicate a sequence of information that allows those at risk to make timely decisions to safeguard against the impact of forecasted extreme weather or climate events.

The challenge ahead

Climate variability and change are already affecting the lives and livelihoods of people across Africa, and as the planet warms, extreme weather will become increasingly likely across the continent. The recently released first volume of the IPCC Sixth Assessment suggests that it is becoming increasingly difficult to avoid reaching a global warming of 1.5°C above pre-industrial levels within the next decade or so and 2oC or more by mid-century. Even with the lower-emissions pathways, African climates are likely to be more erratic, with much of Africa becoming so hot that outdoor work and tourism will be threatened for some of the year. Droughts and floods already threaten livelihoods and trap people in poverty. Both are likely to increase in intensity and frequency in the future. Africa is particularly vulnerable to climate extremes, or even shifts in weather norms such as the start of the monsoon, as so much food production is dependent on rain-fed cropping and pastoralism. Infrastructure that supports the wider economy is also highly exposed to extreme events.

Adaptation is now more urgent and challenging than ever. This chapter has simply set the scene—where we stand now and the increasing climate challenges that are coming. The rest of this report begins to outline solutions to how we might effectively achieve continued climate-informed development for all of Africa.

"We have to insist that equal attention be paid to climate adaptation and mitigation in climate finance. Africa calls on the developed nations to shoulder the historic responsibility and to join the program to accelerate the adaptation in Africa."

H.E. President Ali Bongo Ondimba of Gabon, and Chair of the African Union-led Africa Adaptation Initiative
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021


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Photo: Anna Dunlop/Shutterstock

Scaling up the use of Modernized Climate Information and Early Warning Systems in Malawi

Geography: Malawi

Adaptation measures: This project worked to strengthen early warning and climate forecasting infrastructure and to build the capacity of Malawi's Department of Climate Change and Meteorological Services (DCCMS) to provide climate services (weather forecasts and local climate advisories) and disaster management training. It also implemented participatory planning processes among farmers to increase the reach of climate services.

Key outcomes: As of 2019, the project had improved the climate resilience of more than 420,000 people directly and 1.2 million people indirectly[24] through raising awareness, improved weather forecasts and access to information and trainings to integrate climate services into farm management, fishing and disaster response operations.

Partners and funding: UNDP in partnership with the Department of Disaster Management Affairs of Malawi (DoDMA), government line ministries, climate centers, the National Smallholder Farmers' Association of Malawi (NASFAM) and other CSOs and community level actors. 2017-2023. Green Climate Fund (US$12.2 million), Government of Malawi (co-financing US$ 2.1 million) and UNDP (co-financing US$ 1.8 million).

PROJECT SUMMARY

Malawi is a densely populated, landlocked country in southern Africa with one of the world's poorest economies (it came in 174th out of 189 countries on the Human Development Index for 2020),[25] and the vulnerability of the population has been further exacerbated by climate change. Floods and droughts pose a significant and recurring threat, with over 100,000 and 1.5 million (10 percent of the population) people affected on average every year, respectively.[26] Malawi has seen eight major droughts, affecting over 24 million people, in the last 36 years.[27]

Major flooding in the southern districts, driven by a one-in-500-year rainfall event, killed nearly 200 people, displaced more than 200,000 and caused more than US$400 million in damages in 2015. Compounding this, a drought in 2016/2017 in the southern and parts of the central region left more than 6 million people in need of food assistance, with damages over US$ 365 million and recovery costs of about US$ 500 million.[28] These recurrent climate disasters are particularly detrimental because agriculture—primarily smallholder subsistence farming—accounts for 40 percent of the country's GDP and makes up more than 85 percent of its total export earnings; and the threats are likely to increase in the coming years.

Mean temperatures in the region are expected to increase by 1-3°C by 2050, and although future overall rainfall trends are uncertain, the amount of rainfall during extreme events is expected to increase by 19 percent by 2090.[29] The success of efforts to alleviate food insecurity and poverty will be contingent upon the country's ability to address climate impacts and disasters through early warning systems (EWS) and strengthened disaster risk reduction (DRR) coordination mechanisms.

UNDP's M-CLIMES project was designed to provide tailored and context specific (demand-driven) climate services for vulnerable communities, including smallholder farmers, fishers and flood-prone communities. The project scales up climate information and EWS through the establishment of weather observation infrastructure (33 weather stations, eight lightning sensors, two lake-based water buoys and a data processing system). It also focused on capacity development, training seven Department of Climate Change and Meteorological Services (DCCMs) staff on installation and maintenance of infrastructure and data integration for improved forecasts and storm advisories, locally tailored advisories, a dissemination strategy based on complementary and tailored channels (mass media, SMS, extension services and lead farmers).[30] Finally, it aimed to improve last-mile access[31] and use of information through farm-level participatory management approaches.[32]

The scaling strategy for providing access to information was based on a training of trainers approach, building the capacity of lead farmers who, in turn, shared the information and skills they gained with other farmers. Lead farmers disseminated information about seasonal and short-term forecasts to more than 162,000 smallholder farmers to improve seasonal planning. A cadre of trainers was empowered to provide courses to 208 frontline disaster managers and 20 school staff in collaboration with the Malawi University of Science and Technology (MUST). Tailored climate information products and decision-support platforms for end-users were developed based on facilitated planning sessions between extension workers and farmers to identify the most needed responses which resulted in local advisories, including seasonal forecasts. Flood forecasts and water catchment information were provided in 13 districts; the project also strengthened the district climate information centers as hubs to promote learning, knowledge sharing and community-based early warning systems.

The project has improved the national coverage of weather-stations by 17.5 percent, capacities of NHMS to downscale seasonal forecasts at a resolution useful at district and sub-district levels and on translation of weather information into advisories and their dissemination at district and sub-district levels.

Participatory planning processes were scaled across ten districts by training 60 expert trainers and 264 extension workers (28 percent of them women) who, in turn, trained more than 16,000 lead farmers (53 percent of them women). Scaling was also achieved by translating capacity-building materials into local languages and through outreach and awareness campaigns using digital media resources like SMS, radio and television programs. More than 17,000 farmers received short-term forecasts through different SMS platforms. Tailored and cost-effective advisories (i.e. storm early warnings) were also issued to fish processors and fisheries. Overall, as of 2019, the project had increased the resilience and enhanced the livelihoods of more than 1.6 million[33] people.

The project also improved the enabling environment for climate services in several ways. Extension services' capacity to support communities and livelihoods was improved, increasing their social standing; coordination between institutions in translating weather information into local advisories for agriculture and fisheries was enhanced; and the efficiency of service delivery was improved through extension services and through the training of trainers and lead farmers. The integration of information communication technologies such as digital based advisories and smartphone apps, has been identified as an area for improvement.

Adaptation – What is it and how to measure it?

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A simple dictionary definition of adaptation is "the process of changing to fit some purpose or situation." After several decades of debate by researchers, practitioners and governments, the IPCC definition (Box 1) still reflects that dictionary definition. The IPCC definition is specific to climate change, it recognises that the driver of adaptation can come from experienced or anticipated climates, and that the process of adaptation must be deliberate in that it specifically seeks to moderate harm or exploit opportunities. The deliberateness was a recent addition to make it clearer that actions that do not specifically take climate change scenarios into account, such as generic efforts to promote good development or more productive agriculture, should not be claimed as adaptation activities, especially when accounting for money spent on adaptation.

Despite the relative clarity of what is meant by adaptation, it has taken decades for adaptation to become a fully integrated part of our approach to reducing the impacts of climate change. There are several reasons for this, but one that is often overlooked is that for a long period the scientific community misunderstood to need for adaptation.

Box 1: Definitions from IPCC AR5 WGII Glossary 2015

Adaptation - The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Vulnerability - The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Adaptive capacity - The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Resilience - The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Vulnerability index - A metric characterizing the vulnerability of a system to a change in climate. A vulnerability index is typically derived by combining, with or without weighting, several indicators assumed to represent hazards or physical impacts, exposure, sensitivity, resilience, or adaptive capacity.

In the early years of the twentieth century the Swedish scientist, Arrhenius,[34] was one of the first to conclude that continued emissions of carbon dioxide (CO2) would mean that in the centuries to come we would be living in a very different environment But he hoped to enjoy a future with *"more equitable and better climates … when the earth will bring forth much more abundant crops than at present"*.

This optimistic view of the impact of climate change persisted throughout much of the 20th century, gradually morphing in the latter half to recognising that more pleasant climes may not always await us, but still retaining the hope that natural and human systems could adapt sufficiently and largely autonomously, i.e. with minimal human action, as the climate changed. This was the basis for the Convention on Climate Change at the close of the century (UNFCCC 1992) that set mitigation targets to *"prevent dangerous anthropogenic interference with the climate system" and to be reached "within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner"*.

But views on adaptation were changing rapidly, partly driven by a better understanding summarised in the early IPCC Assessment Reports that adaptation needed to be proactive, and partly by pressure from developing countries for substantial support for the adaptation challenges that were being left to them to deal with. But in the pressures of the climate negotiations, some still feared that a discussion of adaptation was an implicit admission that mitigation efforts might fail, or that adaptation might for some countries provide a potential disincentive, or even a pretext for inaction, in pursuing mitigation.[35] Progress on implementing adaptation was also mired by the complexity of the technical discussions of how to describe the process of adaptation, and the lack of clear measures of effectiveness of actions and of progress in adaptation.

Depending on the debates of the time many different forms of adaptation have been described, such as pro-active and re-active adaptation depending on whether adaptation actions were stimulated by anticipation of a changing climate or by the experience of the unanticipated impacts of a climate event. Currently there is a focus on the need for more adaptation that goes beyond being simply incremental adjustments to better cope with climate change, but instead seeks transformations in our perception and paradigms about adaptation and profound changes in the structure of our institutions and livelihoods that will be necessary if we are to thrive in a radically changed world.

Much of the recent debate about adaptation has related to how to place adaptation within the well-established risk management framework and this has led to a confusing, and often confused, debate over terms and their meaning.

Climate change is one of many *hazards* faced by human communities; other hazards include natural events such as earthquakes and human actions such as conflict and malpractice. The challenge is to manage the consequences of a hazard to reduce the *risk* of damage and losses. Some of the consequences of climate change will come in the form of sudden onset shocks or disasters and others through slower, chronic changes in conditions that bring negative outcomes, and sometimes opportunities, to those exposed to them.

There are a series of concepts and terms used to describe the link from the occurrence of an hazardous event to the experiences of consequences. The risk of consequences is governed by the *likelihood* of a hazardous event occurring, the degree of *exposure* of people, their means of livelihood, assets and other objects of value (e.g. ancestral graves) to the hazard, and their vulnerability to negative consequences. Some items can be exposed but not sensitive to damage, such as a well-constructed dwelling in a cyclone, and some assets can be readily replaced (e.g. chickens more readily than a cow) or insured by some means depending on the *adaptive capacity* of those experiencing the hazard. Adaptive capacity is the ability to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

So there is a sequence of concepts leading from the likelihood of a hazard, through the exposure to that hazard, the sensitivity to damage and the adaptive capacity to prevent that damage becoming a loss with long term consequences. These concepts are grouped in various ways and sometimes new concepts introduced.

A core concept is *vulnerability*, which is the susceptibility to being adversely affected by a changing climate. Vulnerability was initially described as encompassing exposure, sensitivity and adaptive capacity, although now most prefer a formulation of adaptation based on risk management where exposure is a separate component of the risk function described above.[36] The term *resilience* is often treated as the obverse of vulnerability in the sense that it is the capacity to cope with, rather than be susceptible to, current and future hazardous events. However, there has been a long and continuing debate over the meaning of resilience in the wider context of complex systems.[37]

The concept of resilience usually includes the rider that resilience involves responding to hazards or shocks in a way that maintains the essential identity, structure and function of the original system. This is an apt goal in the original context of resilience in describing ecosystem stability, but is somewhat discordant when used in the context of now common goal of transformative adaptation which seeks more to disrupt than return to the status quo.

A goal of adaptation is to seek that the losses from the occurrence of an hazardous event are reduced to a tolerable level. But here two different schools of thought come into play. Initially most adaptation thinking was dominated by the impact-response model described above. It focusses on estimating the likelihood and intensity of an hazardous event (e.g. extreme heat), and the impact on assets (e.g. the reduction in crop yield) leading to the view that adaptation meant finding less vulnerable crops (i.e. more heat resistant crops). This is essentially a biophysical approach to vulnerability.

Another school of thought focusses more on the complex underlying causes of the vulnerability of individuals, households and communities. In the above example they start with the question did the farmers have access to resources to better protect their crops, such as emergency irrigation during the heatwave, and if not why not? Did those affected have access to different livelihoods and food sources? There is a greater focus on the social, economic, political and institutional factors that affect societies' sensitivity to climate impacts and their capacity to adapt. This reflects the increasing recognition of the importance of considering social vulnerability alongside biophysical vulnerability.

The challenge for the two schools is not to seek dominance over the other, because both approaches are needed to bring about an effective transition to societies that are adapted to changed climates. Social vulnerability is seeking to tackle the root causes of inadequate adaptation, including inequality, inclusion and voice, while biophysical vulnerability is more amenable with current governance and business norms. And that brings us to another challenge to progressing adaptation; namely the need for ways to measure adaptation effectiveness and progress.

The need for adaptation metrics

It has been often observed that adaptation has no baseline metric such as tonnes of green-house gas emissions as used for mitigation measurement and tracking. Nor is it likely that adaptation will ever have the equivalent of the flawed but much used proxy of GDP as a measure of economic and larger social advancement.[38]

Photo: Monkey Business Images/Shutterstock

However, modern management practices and international agreements require that we have some agreed upon measures to track performance and progress. Performance at adaptation project and program levels can be tracked within management-relevant time frames by reporting against inputs and outputs, especially if there is a strong Theory of Change that links inputs and outputs to adaptation outcomes.

Tracking progress in adaptation outcomes is more difficult as the process of adjustment leading to adaptation usually plays out over longer periods than are relevant to management feedback. They also take place against a highly variable background of a changing climate and ultimately face questions of counterfactuals and attribution.

The technical literature is replete with material discussing this problem. This literature includes frameworks for elaborate, and yet to be agreed upon, measurement systems. Others focus on who should choose the most appropriate measures. Should they be determined top-down to meet national and international monitoring requirements, or should they be chosen by those most affected by climate change.[39]

Leiter et al (2019)[40] provided some pragmatic advice to the Global Commission on Adaptation that included: start with the purpose of the measurement and not the metric; draw upon the experience from development indicators; and be prepared to use qualitative measures when necessary. Their paper, and others,[41] go on to identify the purposes for which metrics might be needed and the characteristics of a useful metric.

This State and Trends Report appears only a year before the first stocktake of mitigation and adaptation under the Paris Agreement. The goal is to assess every five years the overall progress towards the Paris goals; not necessarily by country in 2023 but by a system that can aggregate results across scales and contexts, assess collective progress and inform, update and enhance of national level actions.

The 2023 stocktake for adaptation will be very unlikely to use an agreed set of metrics. Most likely the UNFCCC will eventually adopt a mix of tracking outputs (such as NAPs and NDCs, among others). It could also could take an SDG approach by assessing how many countries reached defined goals in adaptation relevant metrics.[42,43]

Developing metrics will be a long journey and such journeys can only begin by taking some brave first steps. Here we take one such step by asking whether two often cited measures of progress in adaptation, one, a measure of impacts of climate change and, the other, a measure of vulnerability, have any capacity in measuring progress in adaptation. The first is a measure of the direct impacts on people from climate related disasters records[44] and the second is an often cited and used index of vulnerability. Data for each is available at national and often sub-national levels and annually for many decades in the past.

Despite the frequent citing of extreme disaster statistics as evidence of the need for adaptation a focus on extremes is not particularly informative for tracking progress (see Present and Projected Climate Risks chapter). Disasters are fortunately relatively rare and they are difficult to classify in terms of their intensity; for example not all category 4 cyclones are the same. Also, the reporting of the impact of a disaster is problematic. The number of deaths is even more stochastic than the occurrence of a particular hazard itself and fortunately the number of deaths is declining partly due to efforts to minimise them and partly due to changes in reporting. For example, very few people are now described as dying from a drought but instead deaths are attributed to more direct medical causes such as disease or malnutrition.

An alternative measure is the number of people affected by a disaster as within Africa 8,000 people are affected for every death by a disaster. This measure is also subject to variability in what is identified as affected. In a developing country 'affected' may mean the number of people injured or displaced from their damaged homes, while a developed country may report as affected the number of people without electricity for more than 24 hours after a wind storm.

Here it is important to ask whether sets of African countries grouped by income or by region show any potentially meaningful change in the impact of disasters (Fig 1 a&b). The results suggest that by pooling information over 5-year periods and averaging across all the countries within a group may offer some value as a metric. Pooling countries across cross all of Africa suggest that the impacts of climate related disasters has been falling for at least the past two decades. This may also be true across the 23 low income countries (LICs). The 22 lower middle income countries (LMICs) have a smaller portion of their population affected by disasters, but there is no apparent trend over the past two decades. There are only a few upper middle and high income countries (6 and 1 respectively) and they show very variable results.

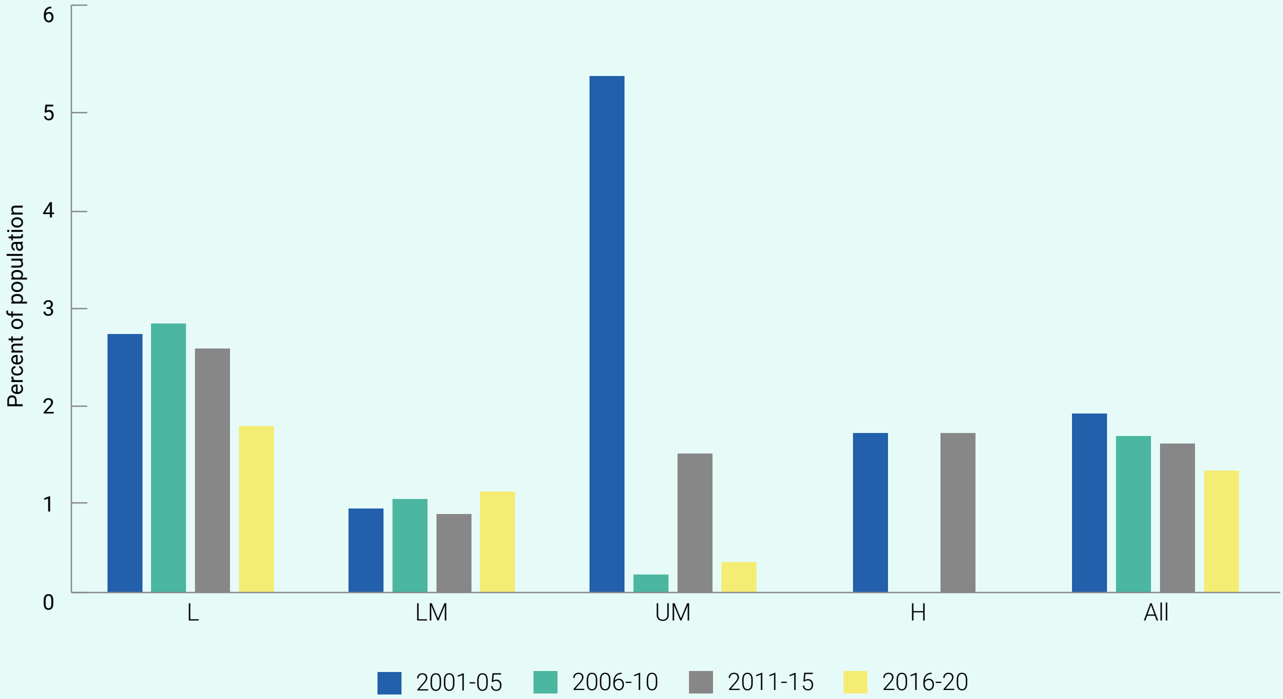
When grouped by regions the results are less clear, possibly because some climate disaster events have a wide spatial spread and affect multiple countries within a region leading to high stochasticity.

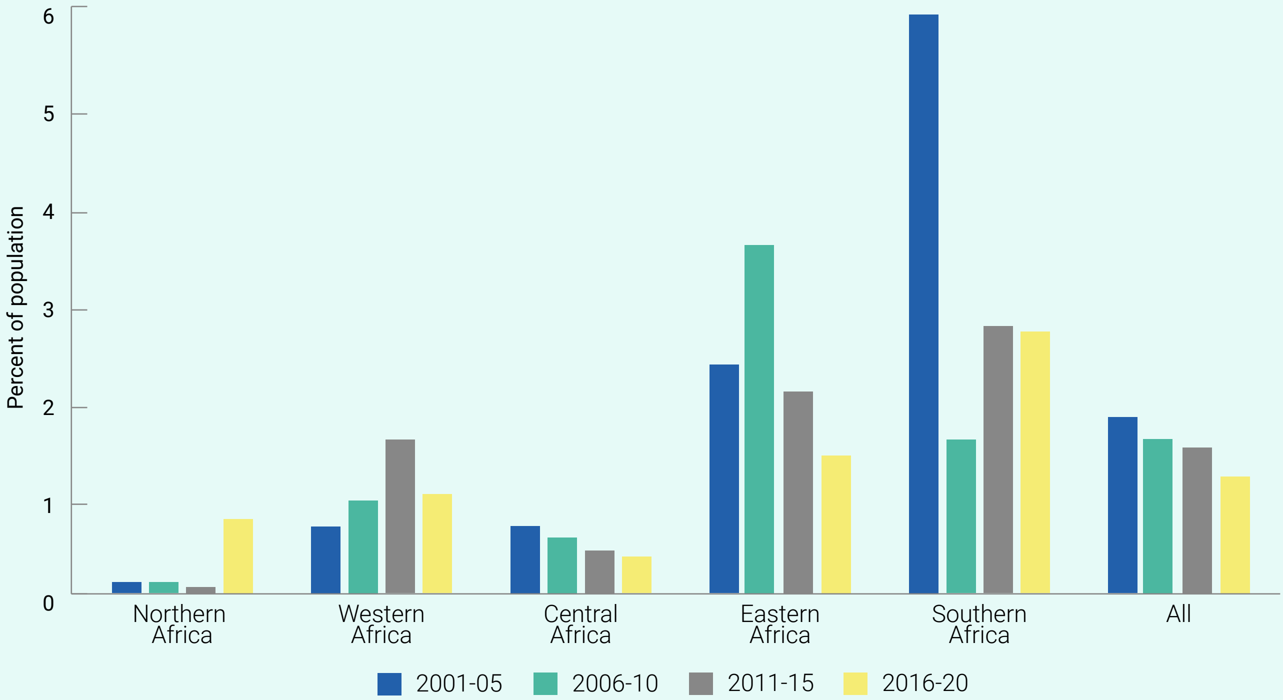
It is not suggested here that this type of disaster-related metric should be used for monitoring, but this first step does raise some interesting questions. Does the difference between LIC and LMIC countries reflect the observation that LICs attract more support for disaster management and hence their improvement, while LMICs find it more difficult to attract support and do not show improvement? Does the approach provide similar interesting information in other regions?

An even more important criticism is that climate hazards are only partially experienced as disasters. To many people, it is the increasingly erratic seasons, or the hotter summer days making work in a field or a factory ever more exhausting etc. that make livelihoods unproductive or even unsustainable. We

Photo: Vadim Petrakov/Shutterstock

Figure 1a & b: Percentage of people affected by disasters averaged per group over 5-year periods based on the CRED EM-DAT database. In the upper graph the income groups are L = Low Income Countries (23 countries); LM = Lower Middle Income (22); UM = Upper Middle Income (6) and H = High Income countries (1) all based on current income rankings. 'All' refers to all 52 African countries for which data are available.





can capture statistics on these types of impacts through household and business surveys, and even track households being pushed back into poverty.[45] This is a promising line of research, but it is resources-intensive and much of the effort is piecemeal.

The second faltering step we take is to perform a similar analyses with the ND-GAIN index.[46] It brings together 45 different indicators, similar to the SDG indicators, to represent two components; a measure of a country's vulnerability to climate change and a measure of a country's readiness to absorb funding and resources to reduce its vulnerability. The index has been used in many reports, especially as a measure of vulnerability of countries. It has also found use in the business community as a measure of readiness.

The ND-GAIN analysis finds that vulnerability is falling across the continent as a whole and in most income and regional groups. This is good news for Africa and also surprising as one of the criticisms of the vulnerability component during the development of the ND-GAIN index was that it was relatively unresponsive.

The analysis also confirms the well-known finding that readiness increases with income level, but the LICs and LMICs are declining in readiness as are all regions except Western Africa (Fig 1c). Maybe this is a shortcoming of the index or it may reflect part of the decline of several important developmental measures within Africa as reported elsewhere in this Report. It begs further analysis.

The purpose of these analyses is not to suggest that these metrics are the best we can find for assessing progress in the stocktake. Further analysis of their detail or their application to other regions of the globe may uncover more insights or greater inadequacies. Instead, the analyses are presented as a challenge to all within this field to move on from debating the ideal solution to taking those first steps on the path to solutions.

Figure 1c: Changes in the ND-GAIN Readiness metric averaged across countries within each of the African Union's regions.

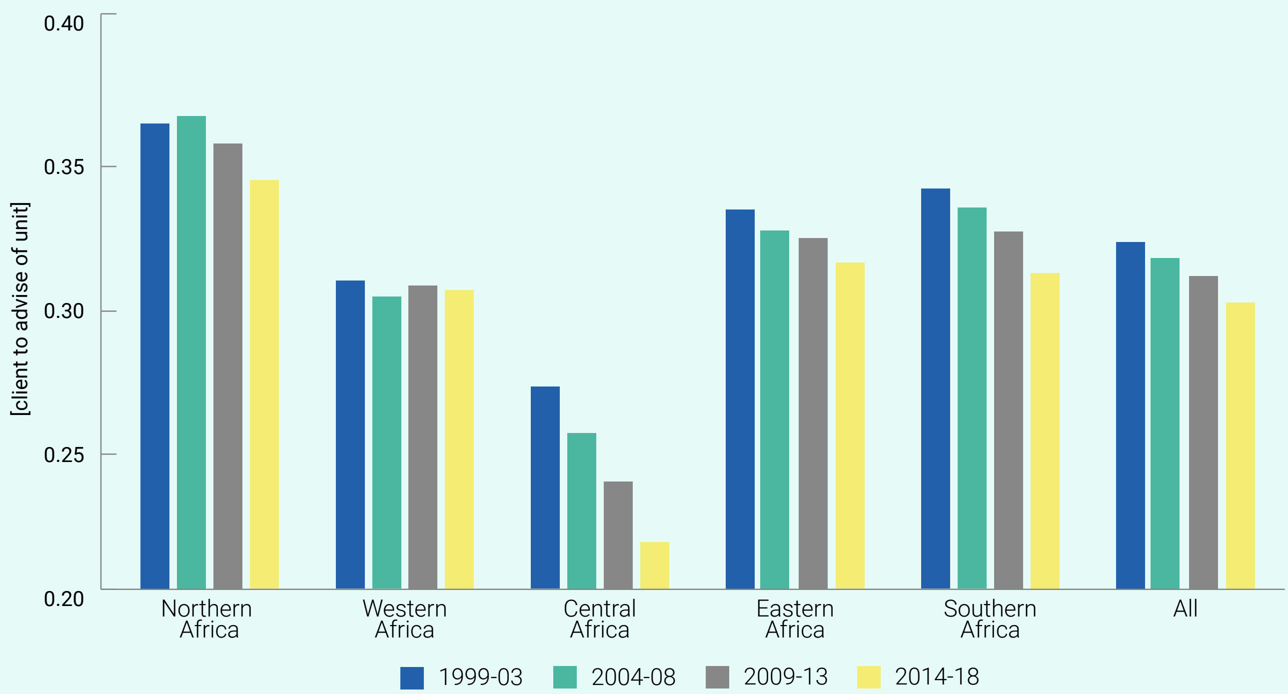


Photo: Piyaset/Shutterstock

Reaching the most vulnerable through weather advisories in Tanzania

Climate Action Network Tanzania

Year after year, season after season, smallholder farmers, pastoralists, and fisherfolks in Tanzania work hard to increase productivity in livelihoods that are extremely climate-vulnerable, with no significant improvements. Their efforts are stymied by extreme weather events – especially prolonged droughts and severe floods – in addition to poor soil fertility, limited markets, poor access to technologies, and limited farm extension services. The result is increased vulnerability, poverty, and food insecurity.

In 2017, Climate Action Network Tanzania (CANTZ), a network of 50 non-government organizations (NGOs) working on climate change and renewable energy, initiated a project funded by Bread for the World to support communities in Chalinze, Lushoto, and Pangani districts through the provision of weather and climate advisories, to enable them to make informed decisions and improve their livelihoods.

The project aims to ensure access, integration, and utilization of downscaled and locally-relevant weather and climate services, including seasonal forecasts and advisories, by farmers, pastoralists, and fisherfolk, to help them adapt to climate change. Training is provided to intermediaries and extension agents, including local NGOs; farmer, pastoralist, and fisherfolk associations; and village leaders on the importance of integrating weather and climate information into livelihood decisions. The phone numbers of trainees are shared with the Tanzania Meteorological Authority (TMA), which uses them to send out weather forecasts and advisories. The intermediaries, in turn, train more farmers, pastoralists and fisherfolk, increasing the reach of the services.

Trainings of trainers

Source: Author

Source: Author

Information is disseminated through SMS, WhatsApp groups, radio, local governments, community-based organizations, farmer groups, village assemblies, and, to a limited extent, with direct contact with CANTZ and TMA. The project has also motivated end users without access to electricity, such as Maasai pastoralists and fisherfolk, to get access to renewable energy to charge their phones and radios, so they can receive the advisories. This has helped the project reach remote communities and sparsely populated areas who have no access to the grid. Over 2,000 stakeholders were trained as of September 2021, and registered to receive the advisories.

Once the information is received, intermediaries and end users work together to interpret it, and facilitate decisions on what type of crops to grow and when; how many cattle to keep and where to go for pasture and water; and when and where to go for fishing, to avoid strong wind and storms. The fishing community in Pangani, for instance, combines the information they receive with indigenous knowledge to decide where to go for certain types of fish. In Kihangaiko village, in Chalinze district, the information service has helped reduce long-standing conflicts between pastoralists and farmers during the dry season, and reduce the losses suffered by pastoralists. The project also trains farmers and pastoralists on how to select drought resistance breeds; implement soil and water management practices; manage livestock; diversify livelihoods; and make budgets and keep records.[47]

A fisherman enjoying a fish catch at Ushongo village in Pangani district


Source: Author

The success of the interventions is due to the trust built over time between the providers and recipients of information, the timely delivery of information, just before the start of the growing season, when it is most needed; and the close collaboration with local knowledge providers. Meetings between TMA and CANTZ staff, local NGOs, local media, district, ward and village extension workers, village leaders, and women groups are held before the start of the growing season, to discuss and interpret seasonal forecasts. These meetings, which allow room for discussion and mutual learning between forecasters, intermediaries, and end users, are followed by smaller group meetings to tailor the information further to local needs, and to decide the dissemination strategy.

The project demonstrates the close collaboration and trust that is necessary between researchers, meteorologists, extension agents, farmers, pastoralists, fisherfolks and other end users to deliver meaningful weather and climate advisories to the most vulnerable. To sustain such efforts, institutional frameworks, from the national to community levels, are necessary. Future plans aim to target the delivery of advisories for the harvest and post-harvest seasons.