WaterAid Africa Drought Analysis

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Broad objective:

To analyse the patterns and rates of drought over Africa over the past 40 years, and the potential impacts on lives and livelihoods.

Data and Methodology:

Drought is defined as a prolonged decrease in water supply (net rainfall) to the ground relative to a long-term average. Therefore, for any location, drought is defined relative to its long-term rainfall – so drought in a humid place is not the same as drought in a dryland place.

To investigate drought trends, we use a drought metric called SPEI (Standardised Precipitation-Evapotranspiration Index) at 0.1 degree resolution over the whole of Africa – this accounts for both changes in rainfall supply and evaporative demand.

To calculate SPEI we use monthly rainfall estimates from:

1) Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), a gridded rainfall dataset and
2) Monthly potential evaporation estimated from an hourly evaporative demand gridded dataset called hPET (produced by our team and published in *Scientific Data*)

The data period used for this analysis is 1983 – 2021 (39 years).

Monthly precipitation (P) data from CHIRPS was downloaded from (https://data.chc.ucsb.edu/products/CHIRPS-2.0/africa_monthly/tifs/) processed to a 0.1 degrees spatial resolution.

Monthly potential evapotranspiration (PET) data was processed from the hPET data repository (https://data.bris.ac.uk/data/dataset/qb8ujazzda0s2aykkv0oq0ctp).

Below we show some key results of this analysis over Africa (excluding the main deserts):

1) Trend in drought (or increasing wetness) between 1983-2021
2) Trend in number of dry months and severe dry months between 1983-2021
3) Trend in land area under drought and under severe drought between 1983-2021
4) Comparison of area under drought between 1983-1992 and 2012- 2021
5) Difference in area under drought between two historical decades: 1983-1992 and 2012-2021
6) Comparison of area under severe drought between 1983-1992 and 2012- 2021
7) Difference in area under severe drought between two decades: 1983-1992 and 2012-2021

Katerina Michaelides, Michael Singer and team, 25/10/22

8) Ranking of most vulnerable African countries using a combination of physical and socio-economic metrics.

Figure 1 shows the trend in drought over the last 40 years over Africa. White masked areas include deserts (Sahara, Namib). Several key points from this analysis are:

- **Hotpots of increasing drought trend** (warmer colours) are **Eastern Africa**, **Southern Africa** and large parts of Central Africa. However, need to emphasise that because drought for any location is defined relative to its long-term rainfall, drought in a humid place is not the same as drought in a dryland place. The drying trend in humid regions starts from a much wetter baseline. Central Africa is a largely humid region, so although there is a significant drying trend, drought impacts are not widely felt as in dryland countries.
- **Wetting trends** are seen in the western Sahel, e.g. Senegal, Burkina Faso and parts of Mali and Niger
- Some countries are exhibiting **contrasting trends** – with one half of the country trending towards drought and the other half getting wetter. This is occurring particularly in Kenya, Ethiopia, Nigeria, and Angola.

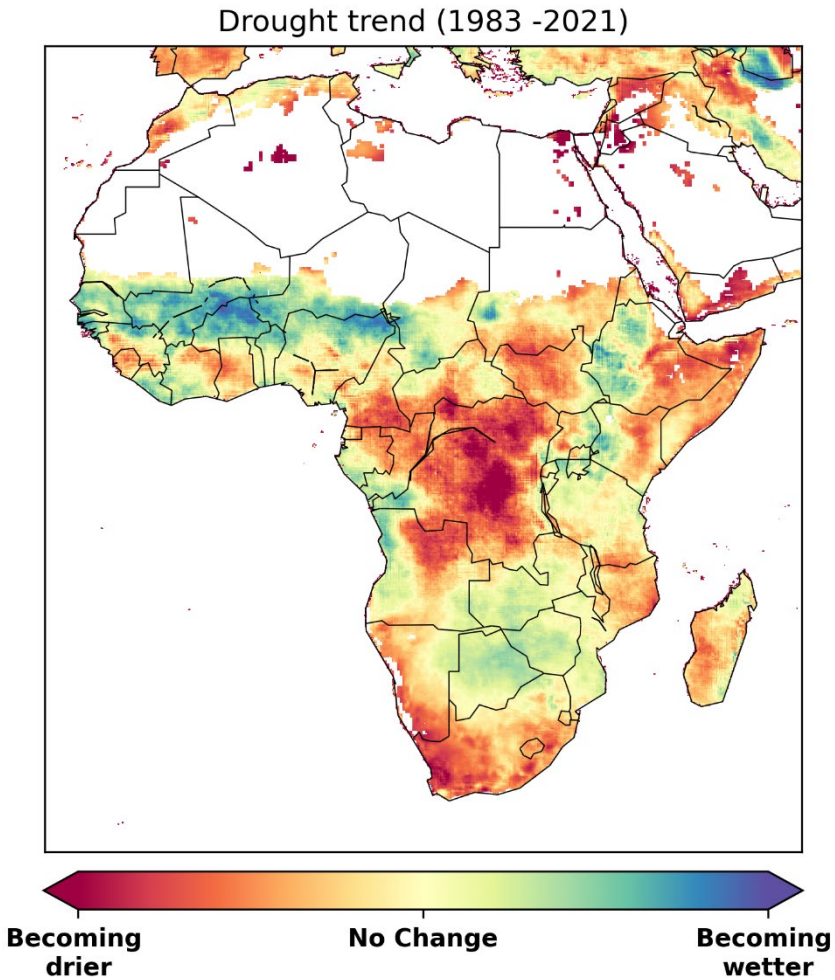

Figure 1

Figure 2 shows the trend in the number of dry months (a) and severe dry months (b) over the period 1983-2021. As with Fig 1, hotpots of an increasing trend in dry and severe dry months are mainly located in **Eastern Africa**, **Southern Africa** and large parts of Central Africa.

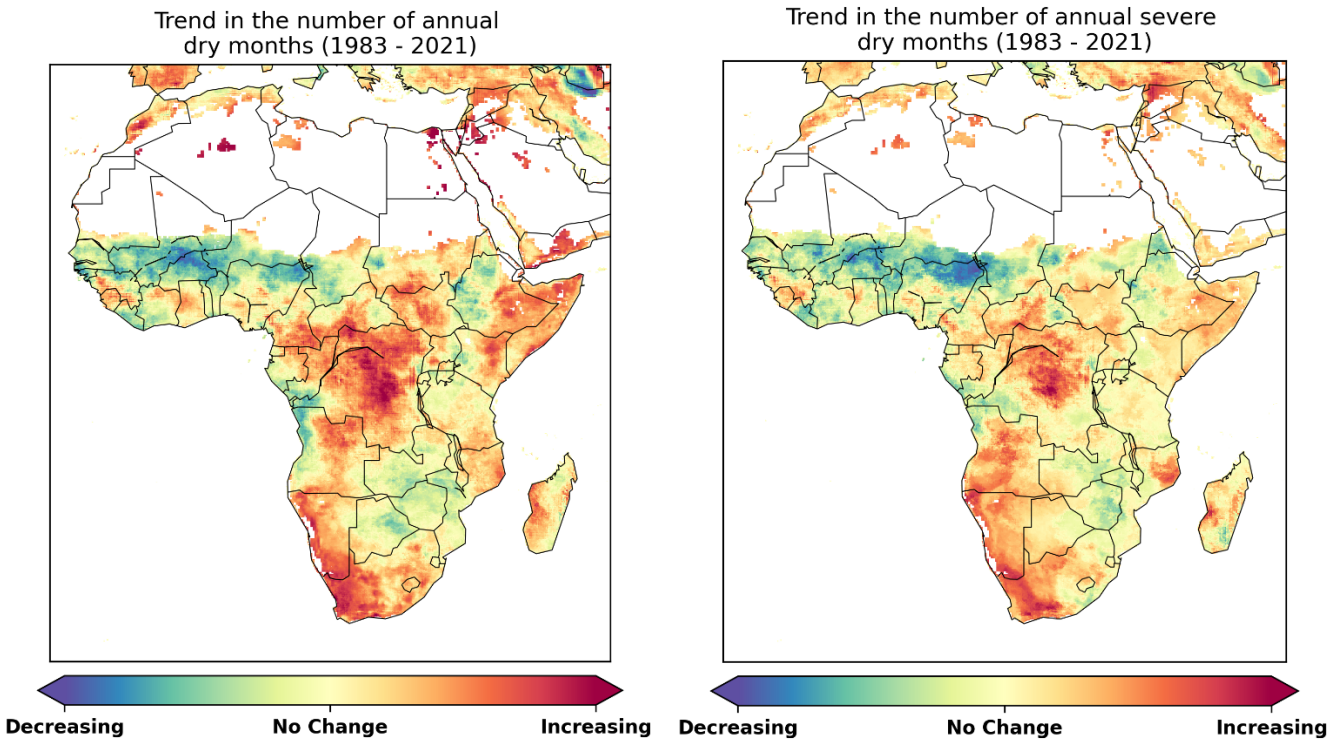

Figure 2

Figure 3 shows the trend in the land area under drought (a) and severe drought (b) during the period 1983-2021.

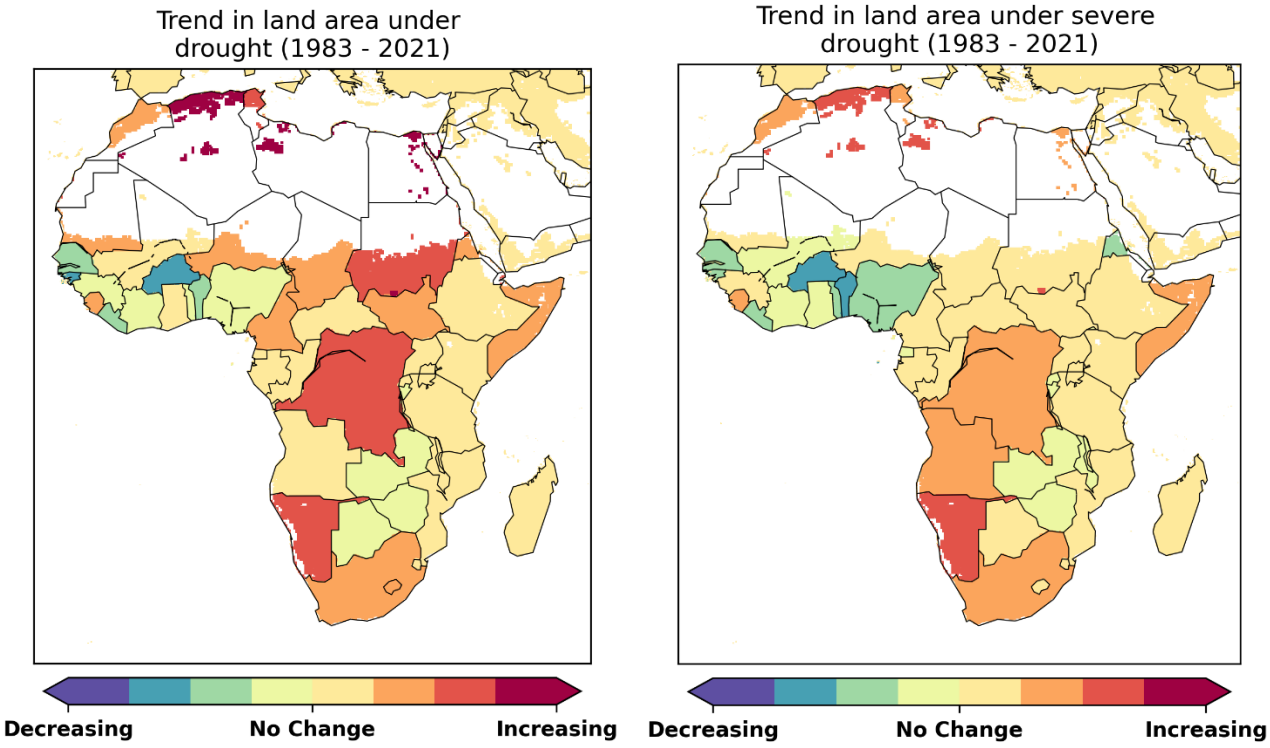

Figure 3

Figure 4 compares the relative percentage of the area under drought between 1983-1992 and 2012-2021.

On average between 1983-1992, most African countries had 10-20% of their land mass under drought, but between 2012-2021 this area increased to 35-50%.

However, there are also countries that have experienced increased rainfall (less drought); most of these countries are in the Sahel and South-central part of Africa.

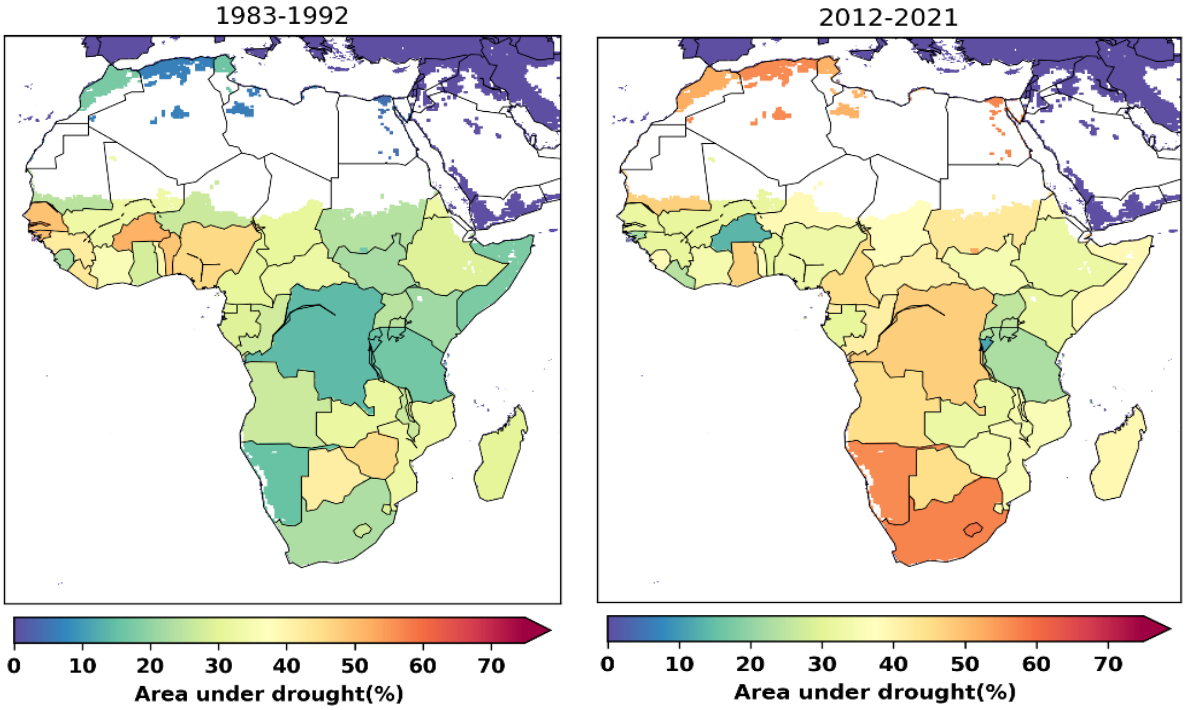

Figure 4

Figure 5 shows the difference in area under drought between the decades (2012-2021 and 1983-1992). Countries like Namibia, South Africa, Somalia, and Sudan experienced an increase in drought affected area greater than 15%. On the contrary, countries like Burkina Faso, Senegal, Nigeria, and Botswana show a decrease in drought-affected area.

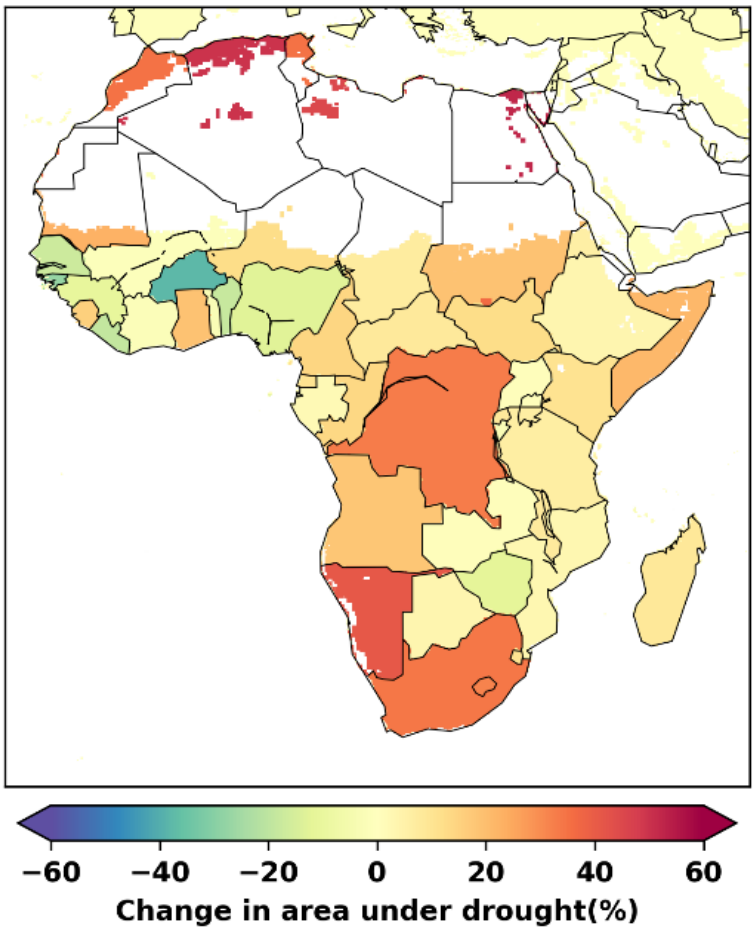

Figure 5

Figure 6 compares severe drought coverage between two decades: 1983-1992 and 2012-2021. On average from 1983-1992 the percentage of the land under severe drought was small (<5%) for most of the African countries, but in the last decade (2012-2021) many countries experienced an increase in the severe drought occurrence and much of the land was affected. There are, however, also countries which have seen a decrease in severe drought occurrence (West Africa and Sahel).

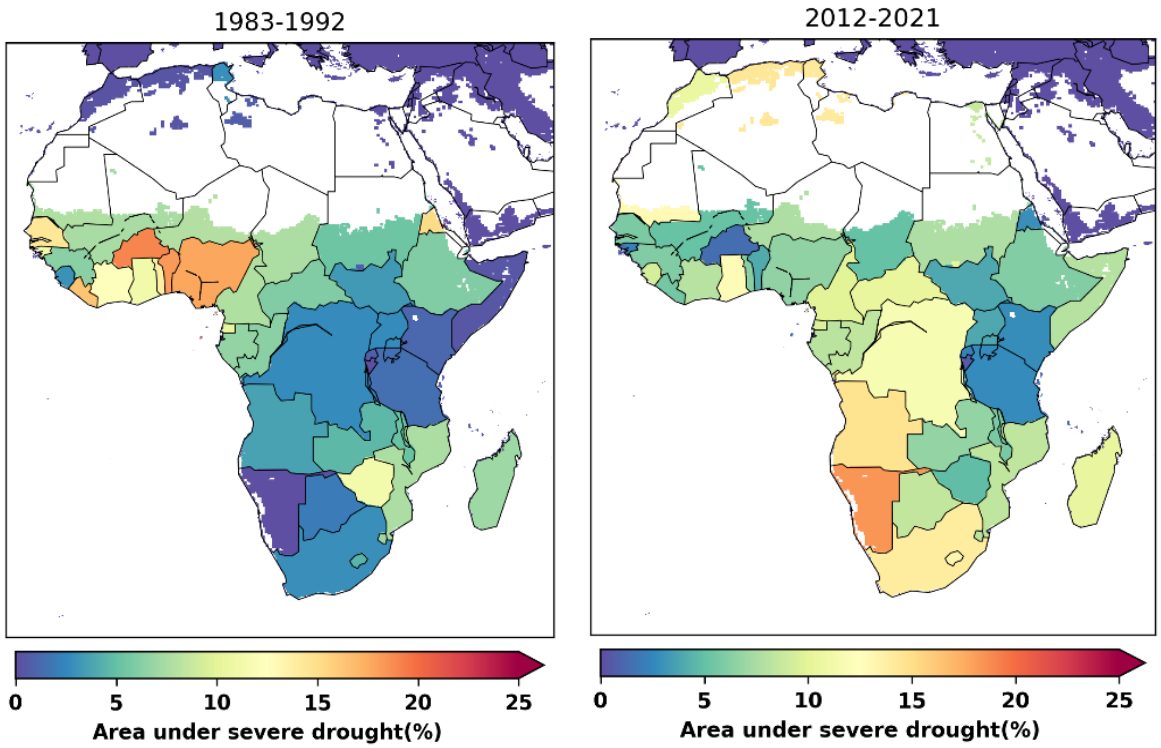

Figure 6

Figure 7 shows the %-age change in severe drought coverage over African countries. Countries like Namibia, South Africa and Somalia are experiencing a huge increase in severe drought, while countries like Burkina Faso, Nigeria, Benin, and Botswana showed a decrease in the spatial extent of severe drought. Central African countries like DRC and Sierra Leone are showing strong increasing trends in drought and severe drought, but due to their high annual rainfall the meteorological drought (rainfall deficit) is not expected to be fully impacting society (yet) in terms of livelihoods. It may well be having an impact, but not to the extent that is felt in the dryland regions.

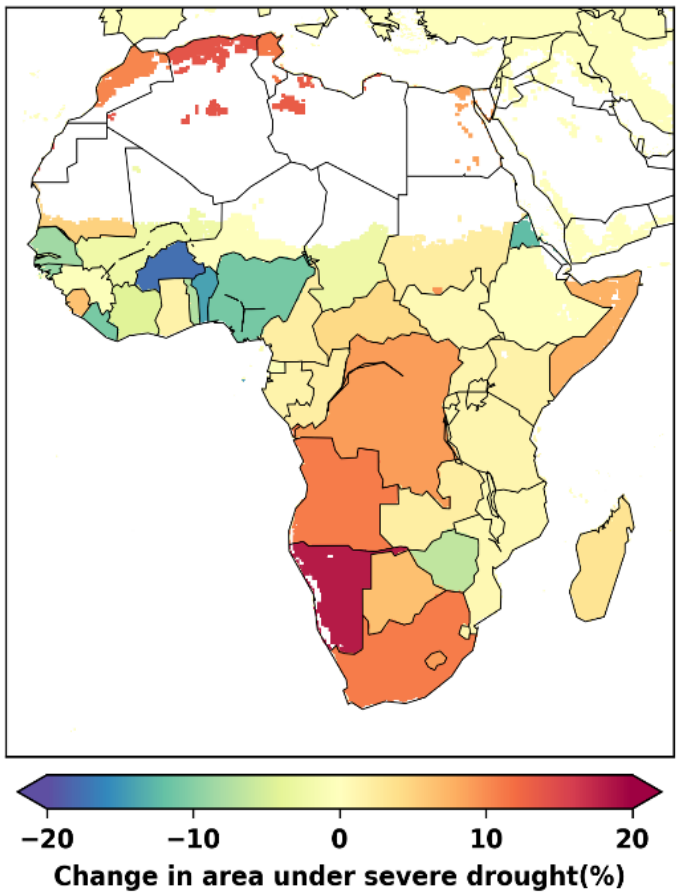

Figure 7

Figure 8 shows the drought trend in 12 major sedimentary aquifers provided by the British Geological Survey (as used in Bonsor et al 2018) overlaid with the trend in total water storage (TWS) obtained from GRACE analysis provided in Scanlon et al., (2022). Blue arrows indicate in increasing trend in TWS and red/yellow arrows indicate a decreasing trend in TWS.

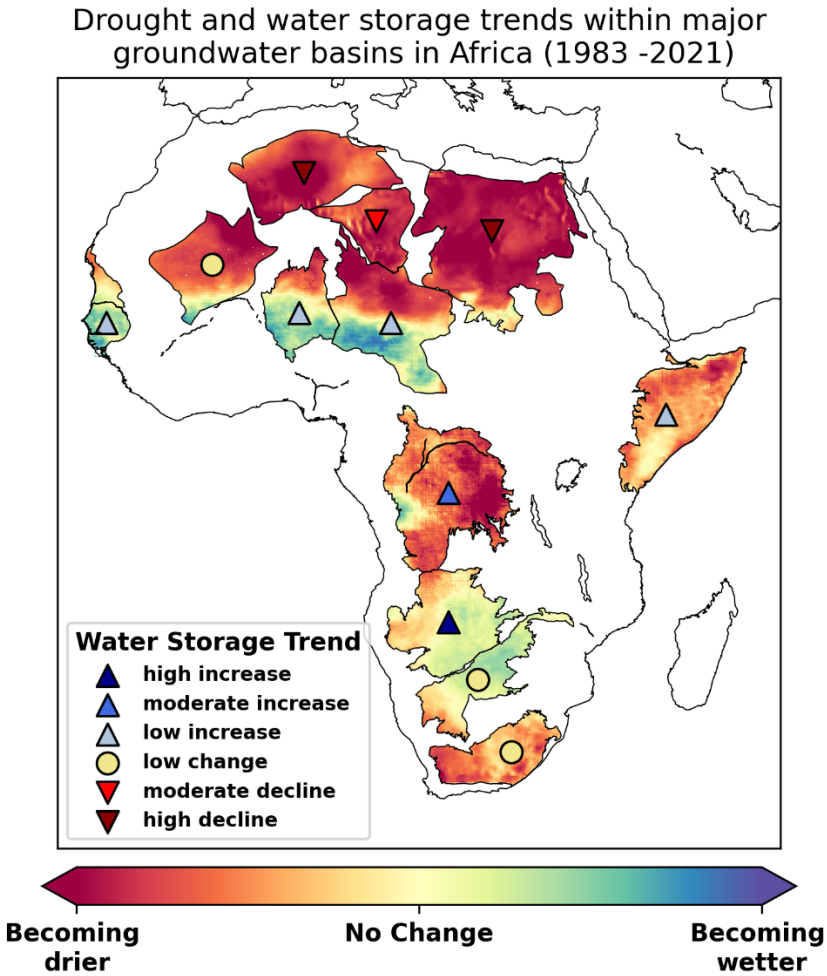

Figure 8

Bonsor et al., (2018) Seasonal and Decadal Groundwater Changes in African Sedimentary Aquifers Estimated Using GRACE Products and LSMs, *Remote Sensing*, 10(6), 904; https://doi.org/10.3390/rs10060904.

Scanlon et al., (2022) Linkages between GRACE water storage, hydrologic extremes, and climate teleconnections in major African aquifers. *Environmental Research Letters,* 17, 014046. https://doi.org/10.1088/1748-9326/ac3bfc.

Ranking countries vulnerability to drought

It is not straightforward to produce a robust "drought impact" calculation due to the multitude of factors involved. The available data on food insecurity do not distinguish causes (e.g. climatic or political). For this reason, it is more robust to use recent averages of people affected by food insecurity to determine future vulnerability to drought impacts that would likely result based on the calculated drought hazard trends.

In order to assess **societal vulnerability** to drought trends on a country-by-country basis, we took an approach that combined **drought hazard** factors with **population exposure** factors. We considered dryland countries (countries with low mean annual rainfall and high evapotranspiration, aridity index < 0.65) separately from humid countries (countries with high mean annual rainfall, aridity index > 0.65) because dryland countries are inherently more vulnerable to drought due their perpetual condition of water scarcity.

For both dryland and humid countries, this is the list of all factors we considered:

Drought Hazard Factors

1) Proportion of the country expressing a drought trend (%)
2) Average magnitude of the drought trend within a country
3) Change in area of country under drought (km^2)
4) Change in area of country under severe drought (km^2)
5) Average magnitude of trend in number of severe annual dry months

Exposure/vulnerability Factors

6) Number of people in severe food insecurity averaged over the last 4 years (not directly attributed to drought)
7) Proportion of the country's population in severe food insecurity averaged over the last 4 years (%)
8) GDP Per Capita
9) Total population of country

Each country was ranked for each factor listed above. A score for "drought hazard" was produced as a sum of each rank for the five drought factors separately for dryland and humid countries. A score for "exposure/vulnerability" was produced as a sum of each rank for the four exposure factors. The two score were then added together for each country and re-ranked to arrive at a final drought vulnerability ranking.

Dryland countries start from a drier baseline, so even a small trend in drought can lead to poor outcomes. Humid countries are significantly wetter so they can buffer even a large drying trend. However, it is important to highlight countries where this is occurring as drought may become a significant problem in the future.

The ranks of drought vulnerability for the **dryland countries** are as follows:

Rank	Country
1	Somalia
2	Sudan
3	South Africa
4	South Sudan
5	Namibia
6	Angola
7	Mozambique

8	Niger
9	Ethiopia
10	Mauritania
11	Kenya
12	Lesotho
13	Tanzania
14	Zambia
15	Djibouti
16	Botswana
17	Eswatini

The ranks of drought vulnerability for the **humid countries** with significant drying trends are:

Rank	**Country**
1	DRC
2	CAR
3	Cameroon
4	Madagascar
5	Sierra Leone
6	Congo
7	Malawi
8	Uganda
9	Ghana

Food security indicators and GDP per capita data were obtained from FAOSTAT (https://www.fao.org/faostat/en/#data/FS). Food security data are averaged over 4 years (2018-2021) while the GDP per capita is averaged over 5 years (2017-2011).

There are no systematic data on deaths attributed to drought. Likewise, there are no systematic data on pastoralist livelihoods. **Note**: that if we accounted for the dependence on agriculture and pastoralism, the rankings would likely shift slightly.