**Type**
Briefing

**Area**
Inkomati-Usuthu catchment

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# El Niño impacts in the Inkomati-Usuthu catchment


## Summary (August 2023)

Near normal but increasing temperature anomalies are predicted for the Inkomati-Usuthu catchment from August 2023 to January 2024

Predicted near-normal rainfall anomalies turn negative as summer 2023/34 approaches in the catchment

A reduction in rainfall, higher than normal temperatures and evaporative demand, along with drought conditions induced by the 2023 El Niño event can be expected for the Inkomati-Usuthu catchment from January to March 2024 and likely until the next wet season.


## El Niño is here

As of August 2023, there is widespread consensus among climate prediction centers will continue through December 2023 – February 2024.

Reports from the National Oceanic and Atmospheric Administration (NOAA) of the United States, show that the initial "weak" El Niño is very likely to transition into a "moderate" to "strong" event towards the Northern Hemisphere winter 2023-2024.

An El Niño event is declared when a sustained increase in sea surface temperatures (SST) is observed over the central and eastern equatorial Pacific Ocean, as a result of weakening in trade winds from the west, allowing the accumulation of anomalously warm waters (**see Box 1**).

Seasonal forecasts from dynamical climate models are now available with higher reliability, since the "spring predictability barrier" of the El Niño-Southern Oscillation (ENSO) has been overcome (Jin et al., 2008).

Monthly predictions of sea surface temperature anomalies indicate that El Niño conditions will most likely reach a maximum during October to December 2023.

## What can we expect for the Inkomati-Usuthu catchment?

In spite of near normal values, a dipole of positive (to the north) and negative (to the south) rainfall anomalies is expected to characterize rainfall in August. Monthly rainfall could transition to near-normal conditions and then to generalized negative anomalies in the summer months (**Figure 1**).

This period covers part of the dry season, so that the forecast anomalies are generally low. However, it is important to continue monitoring the seasonal predictions as they become available in the following months, while taking preventative to measures to protect maize yields and conserve water sources.

The experience of previous El Niño years in the Inkomati-Usuthu catchment suggests that in 2024, low rainfall, higher evaporative demand and higher temperatures could lead to drought and a negative impact on crop yields in the catchment.

However, not all El Niño years have produced these conditions: variations in sea surface temperatures and other seasonal phenomena could impact crop growing conditions in 2024.

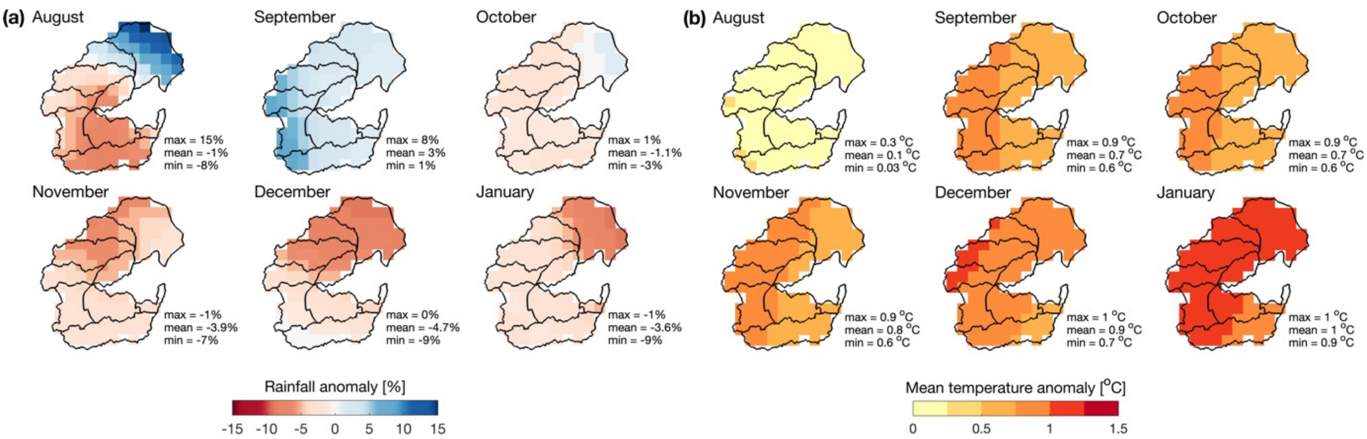


**Figure 1.** Maps of anomalies of (a) monthly total rainfall and (b) mean air temperature predicted by eight General Circulation Models from C3S for the months of August 2023 through January 2024 in the Inkomati-Usuthu catchment. Forecasts are initiated in August.

# Expected impacts of the El Niño event on agroclimatic conditions in the Inkomati-Usuthu catchment in 2024

Reliable forecasts are not yet available for the summer of 2023/24. However, an analysis of the impacts of previous El Niño years gives an idea of what to expect.

The maps in **Figure 2** show: a) total rainfall, b) temperature, c) reference evapotranspiration (ET0) calculated using the method from Allen et al. (1998), and d) the 3-months Standardized Precipitation-Evapotranspiration Index (SPEI) in January-March during El Niño years.

The maps show that El Niño causes rainfall and temperature anomalies that imply unfavorable conditions for crops and water resources. The combination of low rainfall and high temperatures should lead to drought conditions over the region, which is captured by the SPEI drought index. Consequently, higher thermal and water stress and a reduction in crop yields should be expected.

Evapotranspiration anomalies (**Figure 2c**) suggest higher atmospheric water demand and water consumption by plants, which could increase the negative water balance throughout the growing season.

The impact could be compounded by the negative values of SPEI (**Figure 2d**), which are associated with lower rainfall amounts and higher air dryness, and consequently with reductions in maize yields (Lobell et al., 2013).

Experience shows that the water deficit stress during the flowering and grain filling stages significantly reduces maize yields in non-drought tolerant cultivars (Sah et al., 2020).

Potential conditions of water scarcity and environmental stress for crops such as maize in the Inkomati-Usuthu catchment should raise concerns in the region.

Decisions must be taken to try to maintain yields using maize cultivars tolerant to water and thermal stress, or promoting management practices to retain soil moisture, increasing water use efficiency.

Similarly, anomalies of number of warm days (days with a maximum temperature above 35 °C) and dry spells (consecutive days with rainfall < 1 mm), presented in Figure 3, show a significant increase during El Niño years in the Inkomati-Usuthu catchment, especially over eastern areas, which can result in environmental stress conditions for crops.

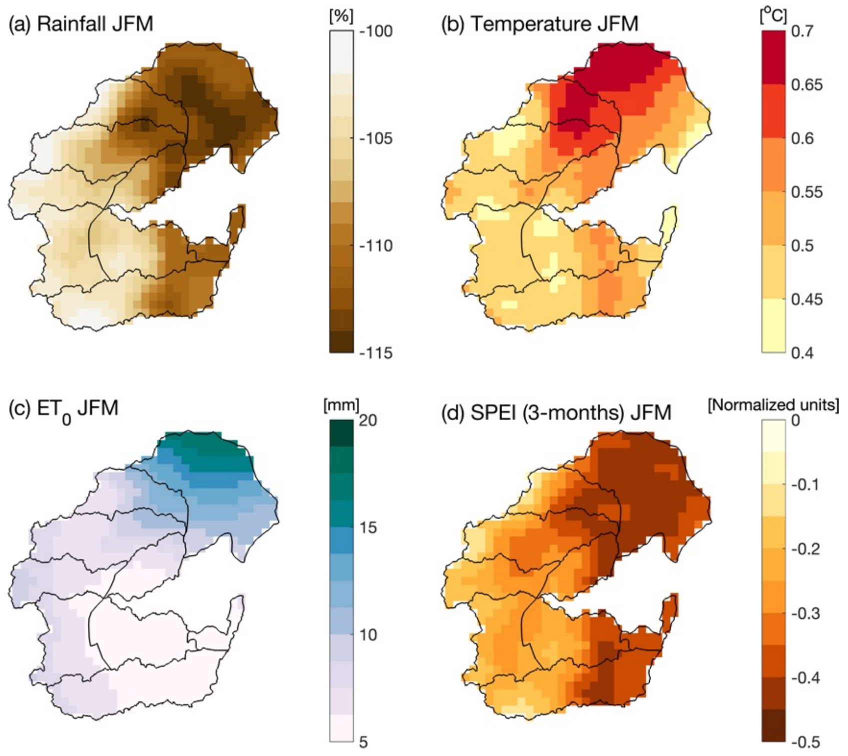


**Figure 2.** Maps of average (January-February-March, JFM) **(a)** total rainfall, **(b)** air temperature, **(c)** reference evapotranspiration (ET0), and **(d)** 3-months Standardized Precipitation-Evapotranspiration Index (SPEI) during El Niño years. Maps are generated from monthly ERA5-Land reanalysis data for the period 1950-2022.

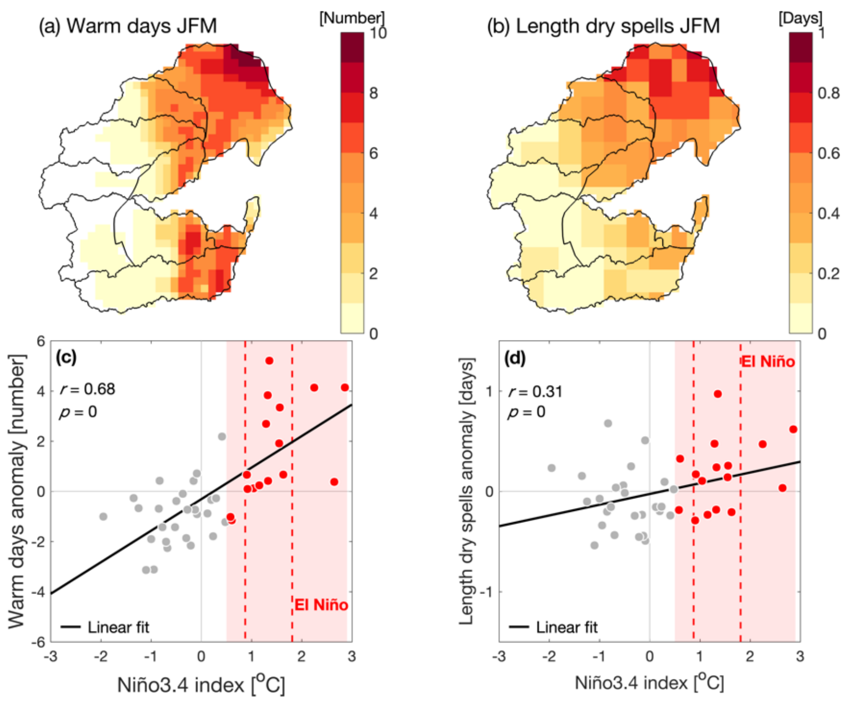


**Figure 3. (a)-(b)** Maps of average (January-February-March, JFM) number of warm days and length of dry spells, respectively. **(c)-(d)** the relationship between El Niño 3.4 index and the anomaly in number of warm days and length of dry spells, respectively. Maps and scatter plots are generated from daily AgERA5 reanalysis data for the period 1979-2022.

## Understanding variation in El Niño impacts in the Inkomati catchment

**Figure 4** shows that not all El Niño events are associated with a lower rainfall amounts and an increase in temperatures, evapotranspiration and drought conditions, as summarized in **Figure 2**.

These "discrepancies" might be explained by differences in sea surface temperatures in the Pacific Ocean, timing and other seasonal phenomena such as the Madden-Julian Oscillation (MJO), which can affect maize seasonal climate anomalies in the Inkomati-Usuthu catchment, especially during El Niño years (Pohl et al., 2007).

As MJO consists of two main parts, the "wet" and the "dry" phases lasting between 30 and 60 days, the intensity of these phases could determine seasonal anomalies for the summer of 2023/24 in the Inkomati-Usuthu catchment.

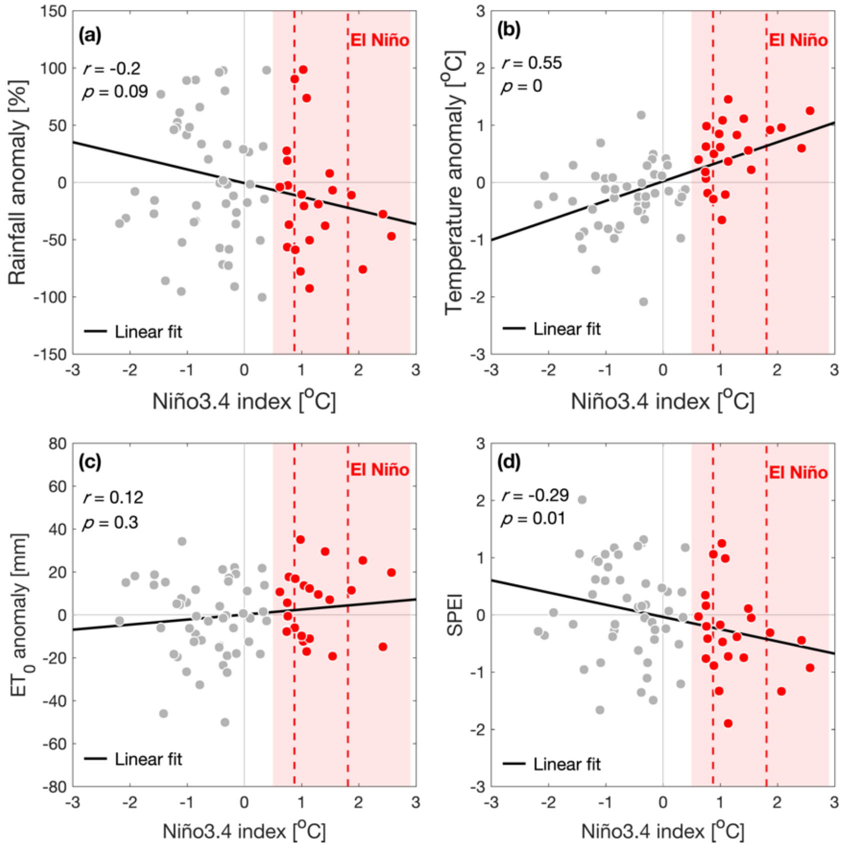


**Figure 4.** Scatter plots between El Niño 3.4 index and mean (a) total rainfall, (b) air temperature, (c) reference evapotranspiration (ET0), and (d) the 3-months Standardized Precipitation-Evapotranspiration Index (SPEI) in the Inkomati-Usuthu catchment. Each point represents a specific year and regional mean. Regional means are calculated using monthly data from ERA5-Land reanalysis for the period 1950-2022. The Spearman correlation coefficient (r) and the p value for statistical significance are displayed. Solid line is the linear fit. The red dotted rectangle represents the predicted range of El Niño 3.4 index from August 2023 to February 2024 by dynamical models.

## Box 1. Tracking and predicting El Niño

El Niño results from higher-than-normal sea surface temperatures (SST) in the tropical Pacific Ocean. The region 5N-5S, 170W-120W (white rectangles below) is looked at to monitor and predict global ENSO conditions. The maps below show predictions of SST anomalies from August 2023 to January 2024.

The **El Niño 3.4** index is calculated by taking the mean three-month SST anomalies over the 5N-5S, 170W-120W region. A global El Niño or La Niña event is declared when the index shows anomalies exceeding +/- 0.5°C that persist for three consecutive months.

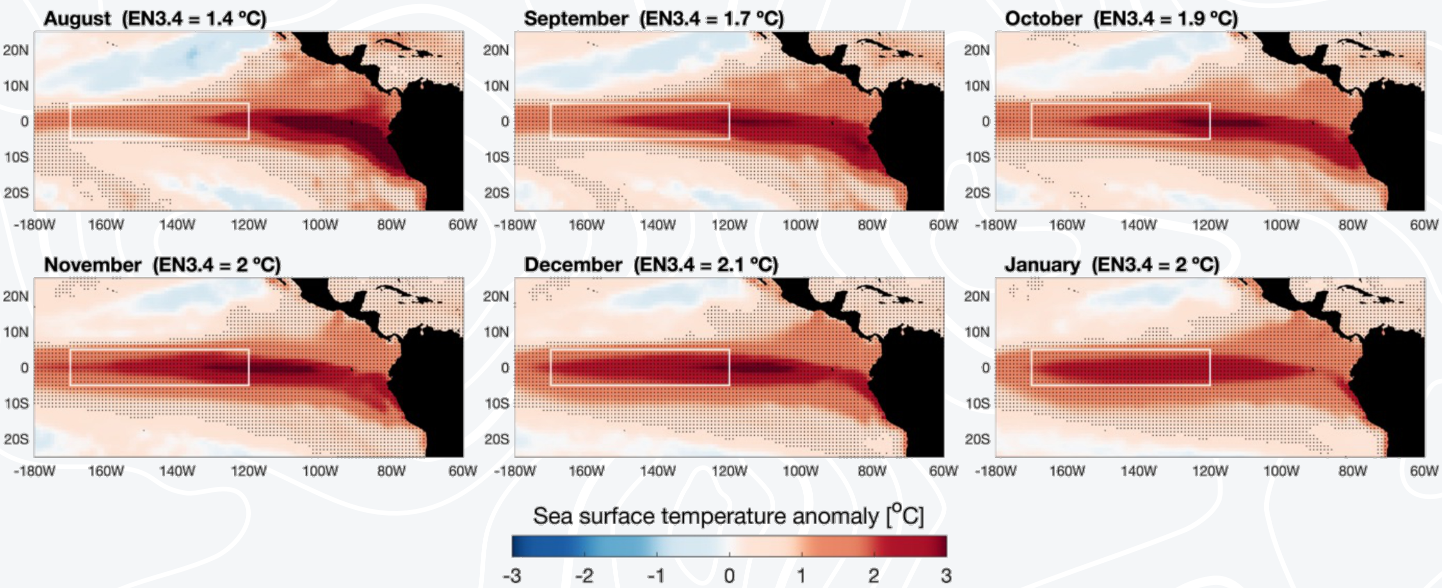


**Figure 5.** Maps of sea surface temperature anomalies (SSTa) predicted by eight General Circulation Models from C3S for the months of June through November 2023. Forecasts are initiated in June. The white rectangle shows the El Niño 3.4 region. Black dots represent the area with SSTa higher than 0.5 °C.

## Management of river flows in an El Nino event.

Declining rainfall will result in reduced river discharge (flow), resulting in negative impacts for users of the water for livelihoods, and placing stress on the river ecosystem. The e-flow directions produced by IWMI for the neighbouring Limpopo River (see Volume 7 https://limpopo-eflows.iwmi.org/) provide tables of flow that are required to protect the ecosystem as well as the beneficiaries of a functional ecosystem. Note that the eflows in the Inkomati-Usuthu are different but follow the same principles.

The recommended e-flows are lower during dry years such as due to El Nino, mimicking natural processes and helping build resilience of the ecosystem without compromising its quality. The Digital Innovation Initiative of the CGIAR is working to assist with implementation of e-flows and is providing digital tools that will enable water resource managers to manage river flows to ensure a sustainable river and use of the water.

## Conclusion

The occurrence of an El Niño event in 2023/24 is certain. The historical record is also clear regarding the average anomalies that El Niño induces in the Inkomati-Usuthu catchment and its potential to impact seasonal climate during the growing season of the main crops.

It is important to keep tracking seasonal anomaly forecasts in the following months, and also to continue the transfer of information to farmers from meteorological and agricultural extension services, and to take timely decisions regarding possible options to mitigate the potential impact of seasonal rainfall deficits and other factors.

As the maize growing season approaches, it is important to monitor the status of the MJO, which could be decisive in terms of the magnitude of the influence of El Niño in the Inkomati-Usuthu catchment.

## Methodologies

### 2023-2024 projected rainfall and temperature anomalies

6-months (August 2023 – December 2024) seasonal forecasts were obtained from the Copernicus Climate Change Service (C3S) multi-system (released in August 2023) (https://cds.climate.copernicus.eu/). Eight General Circulation Models (GCMs) were used, which have a variable number of ensemble members, which were averaged to obtain one forecast per model. Finally, the multi-model ensemble was used to generate the forecasts of this document.

Anomalies of sea surface temperature, total rainfall, and mean temperature from the following models were used:

- CMCC (SPS3.5)
- DWD (GCFS2.1)
- ECMWF (System 5)
- Météo-France (System 8)
- UKMO (GloSea6)
- JMA (CPS3)
- ECCC (GEM5-NEMO)
- NCEP (CFSv2)

### ERA5 and AgERA5 reanalysis data

Obtained from the Copernicus Climate Data Store (https://cds.climate.copernicus.eu/cdsapp#!/home).

## References


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