Recent drying of central Congo surface waters

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1. Introduction

- The **Congo River basin (CRB)** constitutes the second largest tropical rainforest in the world covered by rivers, swamps and savannas, and about 20% of the world's remaining tropical moist forests (Justice et al 2001).
- Recent studies have shown a **significant and sustained decrease in precipitation** during the past 40 years in the tropical Africa (Ndehedehe and Agutu 2022).
- However, little is known about the **potential drivers and impacts** of this drying in hydroclimatic variables in a spatially distributed manner, mainly due to the lack of observations or reliable model results.

2. Objectives

1. Here we explore the trend of hydroclimatic conditions at the **meteorological** and **hydrological** levels over the last 42 years **(1981-2022)** in the central region of the CRB (10˚S-4˚N and 22˚E-29˚E) by using **multiple datasets**.
2. We also identify possible **large-scale climate mechanisms** by examining the trends in the vertically integrated moisture flux **convergence** and in the **atmospheric subsidence**.

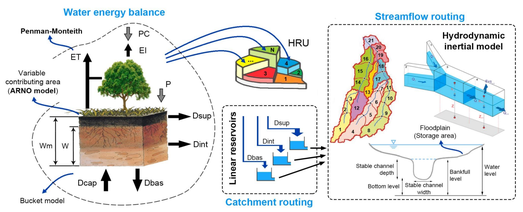
3. Data and methods

3.1. Ancillary data

- **Precipitation** (P) was performed with the ***CHIRPSv2*** dataset. The ***MSWEPv2.8***, ***MERRA-2*** and ***ERA5*** datasets were evaluated in addition.
- **Potential evapotranspiration** (PET) was evaluated from ***GLEAM***, the second ***eartH2Observe-WRR2*** water resources reanalysis and the ***Global PET 5km***.
- ***ERA5*** dataset was used to estimate the moisture flux **convergence**, the zonal and meridional wind components at 850 hPa and the vertical **wind component**.

3.2. The hydrological-hydrodynamic MGB model

- The **hydrological-hydrodynamic MGB model** (Collischonn et al. 2007, Pontes et al., 2017) is a large-scale, distributed, process-based hydrological and hydrodynamic model.



4. Results

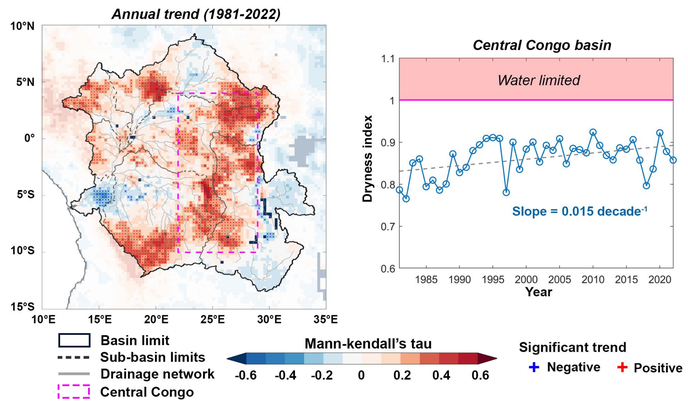
Meteorological level:

- The central CRB (magenta rectangle) shows a decreasing trend in **P**, with an average of **-94 mm** per decade, and an increasing in **PET** of **27 mm** per decade.
- The **dryness index** (PET/P) significatively increases, in the least pessimistic case, at a rate of **0.015** per decade, reaching **water-limited** conditions before the end of the century.

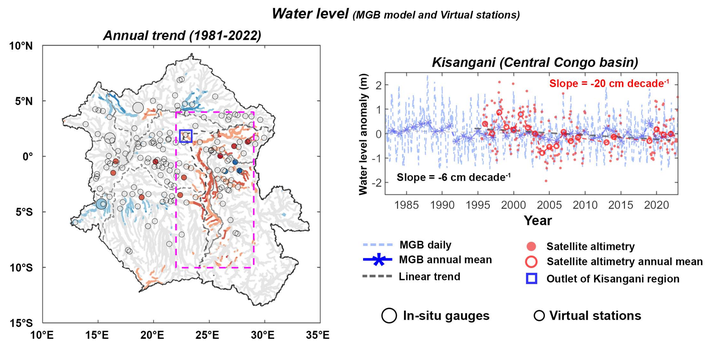
Hydrological level:

- **River discharges** (not shown) and **water levels** are significantly decreasing over the central CRB, around **-240 m³ s⁻¹** and **-6 cm** (**-20 cm** from radar altimetry) per decade, respectively at the outlet (blue square) of **Kisangani** region, close to the main town.

Dryness index (PET/P) *(GLEAM/CHIRPS)*

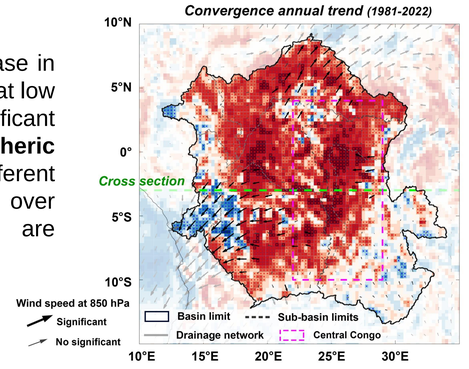


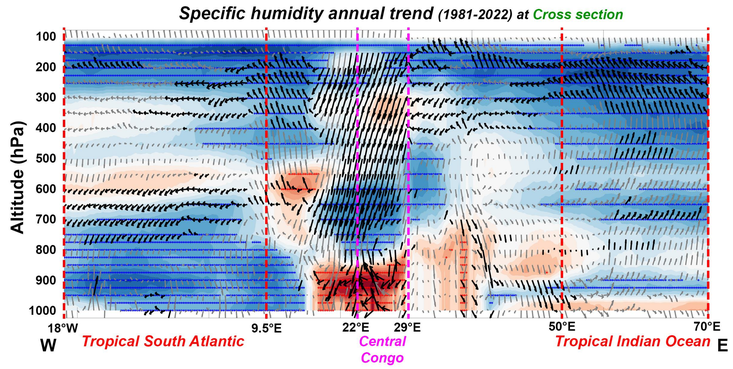
Water level *(MGB model and Virtual stations)*



Potential drivers:

- There is a significant decrease in the vertically integrated moisture flux **convergence**, which is often associated with convective precipitation.
- The **850 hPa zonal and meridional winds** significantly diverge from the central CRB mainly to the Northeast and Southwest.
- A significant decrease in **specific humidity** at low levels, and a significant increase in **atmospheric subsidence** at different atmospheric levels over the central CRB are observed.





5. Conclusions

- The increase in the rate of drought, induced by large-scale modifications of the climate or by changing local conditions, may lead to a **savanization** of the central CRB **in the coming decades**.
- A decrease in water availability at the hydrological level may have an impact on **water security** in the CRB's second most populated city, Kisangani, and in the **ecosystemic services** in the central CRB.
- Potential large-scale drivers that impede the development of **convective precipitation** in the central CRB were identified as a trend of **decreasing convergence of atmospheric moisture fluxes** associated to **increased atmospheric subsidence**. How is this process connected to others such as the sea surface temperature remains a question to be analyzed.

References

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