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Implications of climate change and anthropogenic activity for the water security of West African river basins

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1. Rationale

- Predicting freshwater resources is of upmost importance in West Africa, where the availability of freshwater directly influences food security, human health, economic activity and development.
- In recent decades, West Africa has experienced some of the most extreme climatic variability anywhere in the world. There is growing evidence that the long-term climate across West Africa is changing. It is important to understand *how* and *where* these changes might take place, as the resulting floods or droughts can directly affect people's lives, homes, and businesses.

Aims

- To provide an integrated approach towards water resource assessment in West Africa in the context of climate change via the use of a water resources model, producing quantitative information about plausible future states of the regions freshwater resources.
- To use model output to inform water planners, managers and decision makers of the potential scale of water deficits or surpluses, and help support climate-compatible development within the West African region.

2. Methods

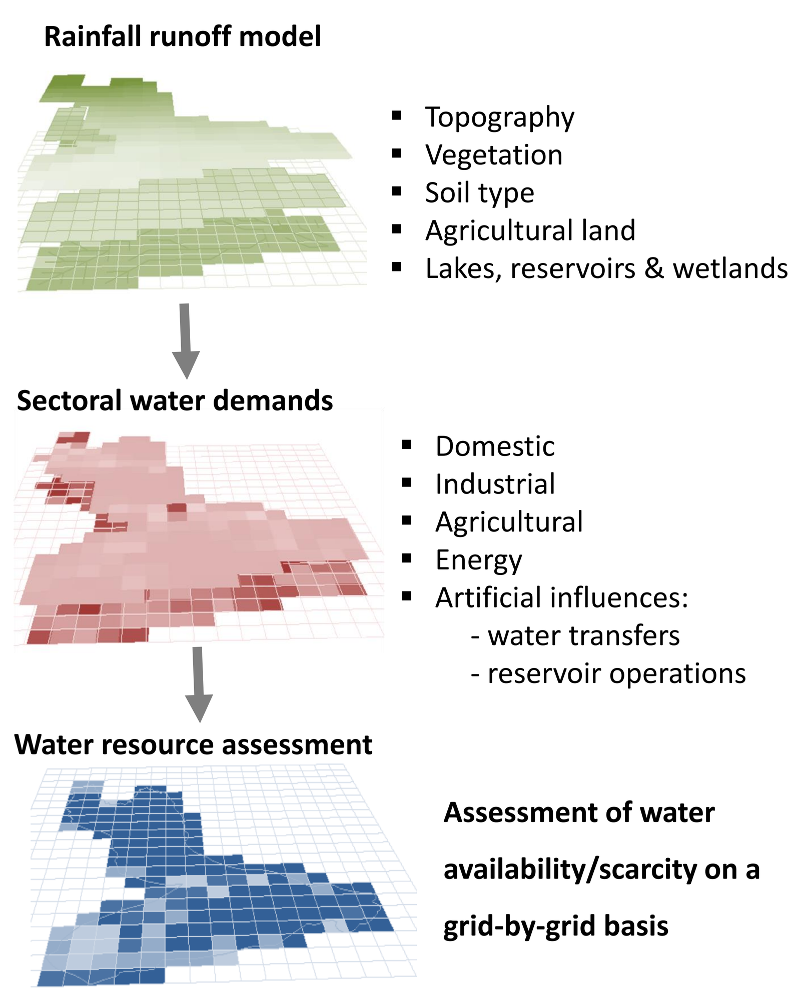
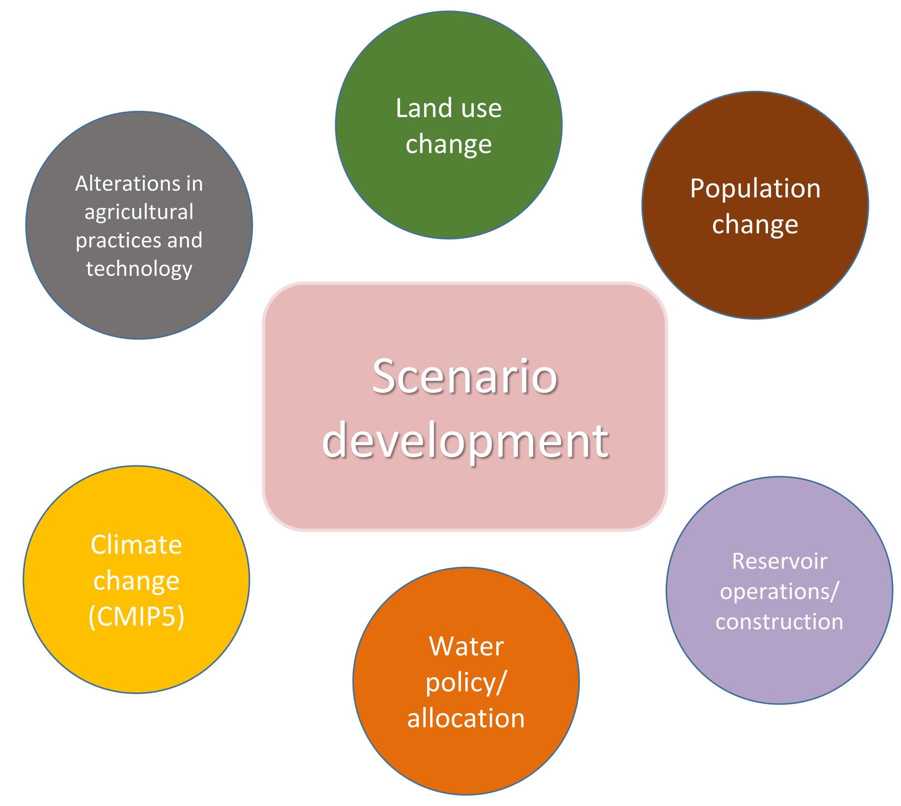


Figure 2.1: The GWAVA model structure

GWAVA

- The **Global Water AVailability Assessment tool (GWAVA)** is a gridded, semi-distributed hydrological model, incorporating a rainfall-runoff model structure with components of river infrastructure and sectoral demands (Fig. 2.1).
- GWAVA was parameterised for the West African region using observed daily EWEMBI weather data at a resolution of 0.5° x 0.5°. The model was then forced with bias corrected **CMIP5** climate ensemble data for historical and future periods (1986-2005 & 2040-2059, resp.).

Figure 2.2: Elements used in the design of future scenarios



Scenarios

Future scenarios were developed to include changes in land use, population and climate up to the year 2059 (Fig. 2.2). Associated water allocation scenarios were also incorporated, such as irrigated crop demand and reservoir releases.

Model configuration & performance

- Calibration and validation were conducted for over 30 subcatchments across the region (Fig. 2.3). All major reservoirs and wetlands were included, alongside key sectoral water demands such as domestic and agriculture.
- GWAVA performed well in simulating flow for the major basins in the region (Fig. 2.4), and was therefore suitable for the analysis of future flows.

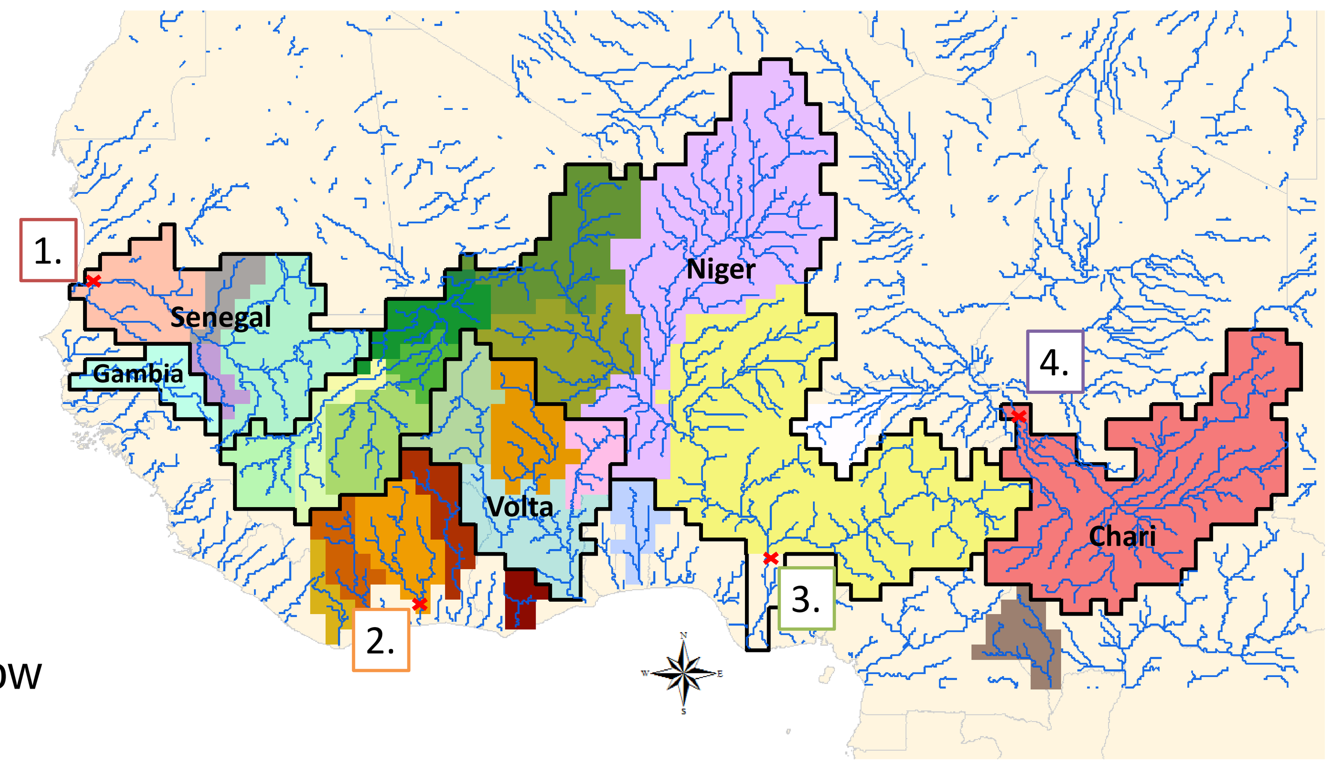


Figure 2.3: Subcatchments used for the calibration of GWAVA; watersheds highlighted, key basins outlined

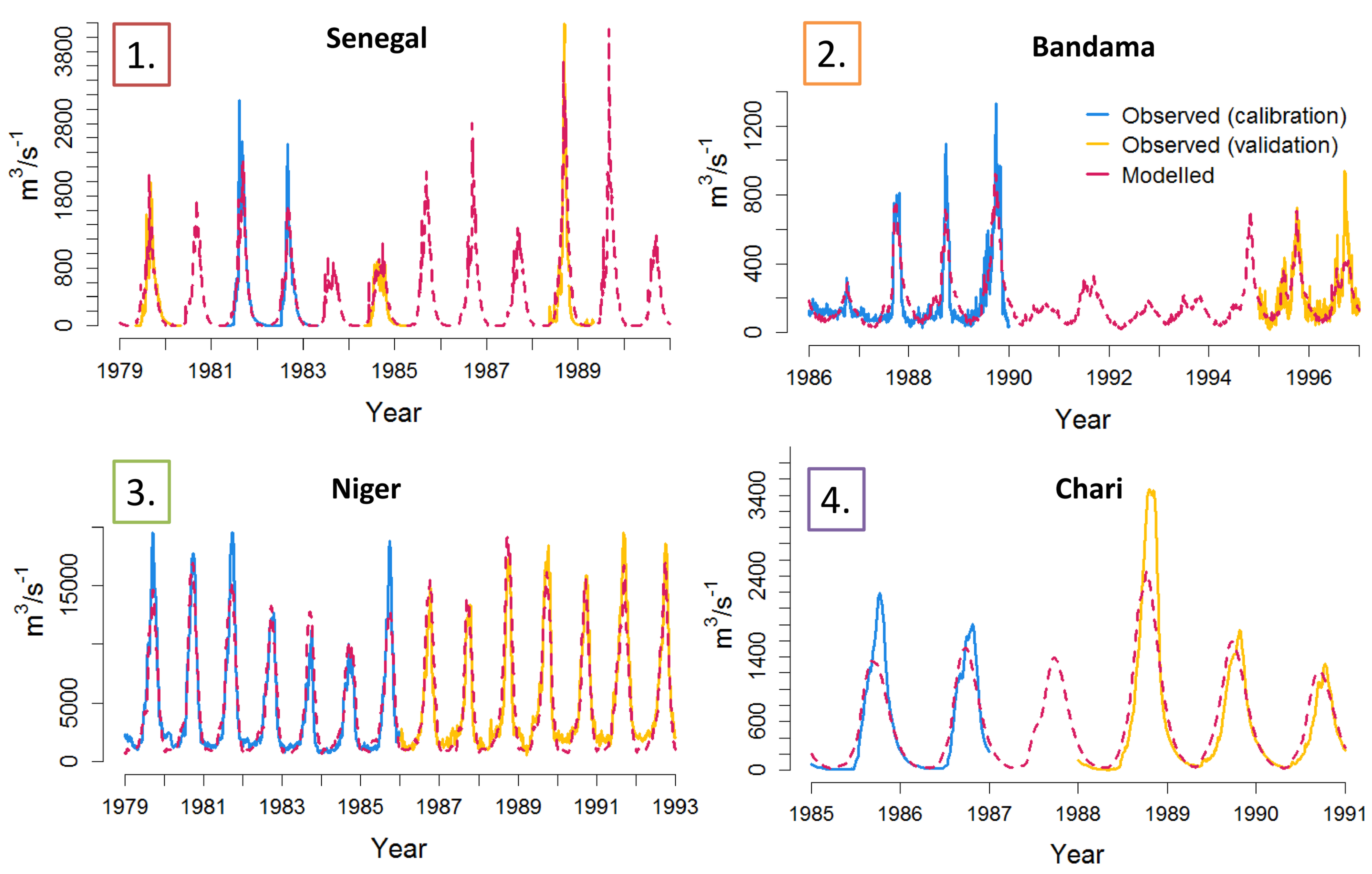


Figure 2.4: Calibration and validation results for key river basins

3. Results

Initial results suggest large regional variation in future water resources across West Africa. The CMIP5 ensemble data displays high variability, and this results in large uncertainty in future flows (Fig. 3.1).

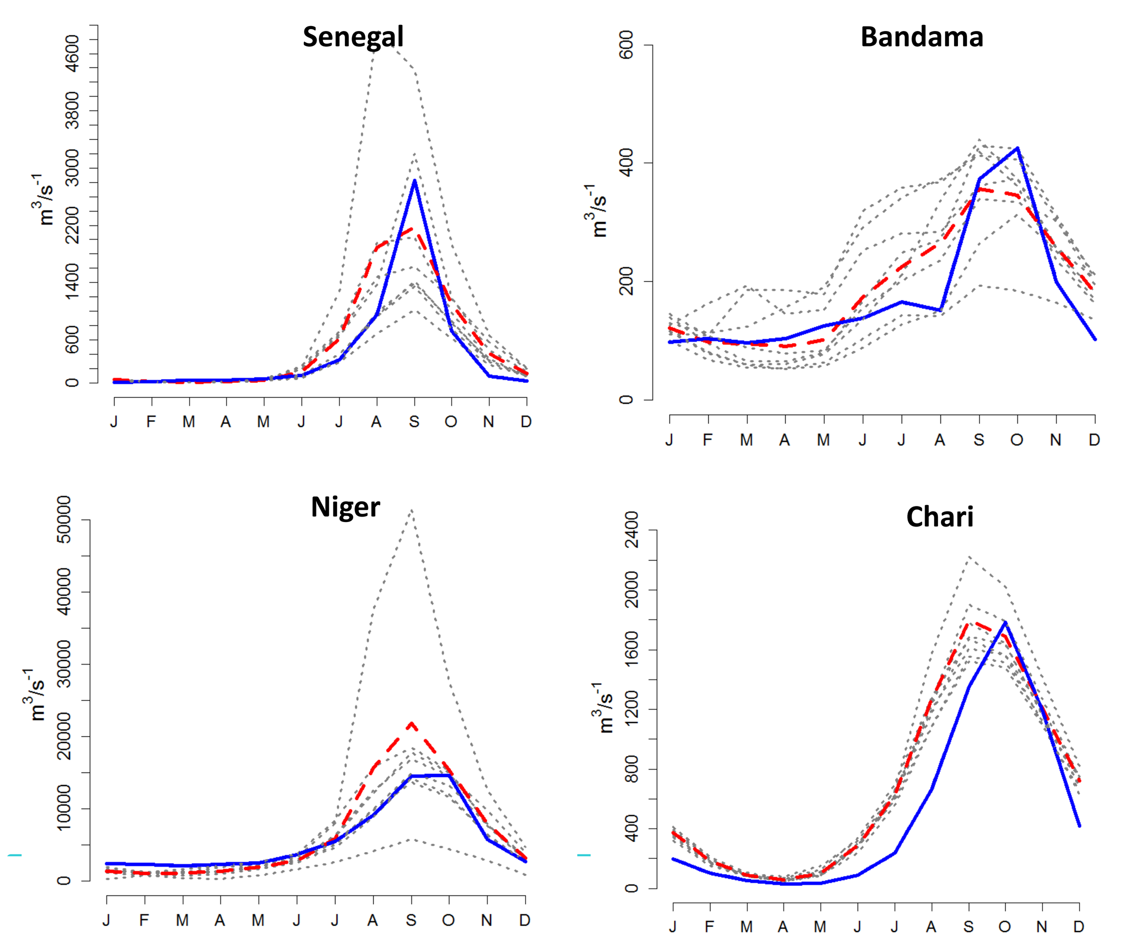


Figure 3.1: Ensemble results for future climate. Blue=Baseline; Red=Ensemble mean; Grey=Individual ensemble models

Water supply and demand conflicts can be used to give an indication of water stress. Fig. 3.2 shows the potential change in water availability for West Africa between the baseline and future time horizons. Large spatial heterogeneity can be seen across the region, with output suggesting water scarcity will increase in the Senegal and Gambia basins along with the downstream catchments of the Niger.

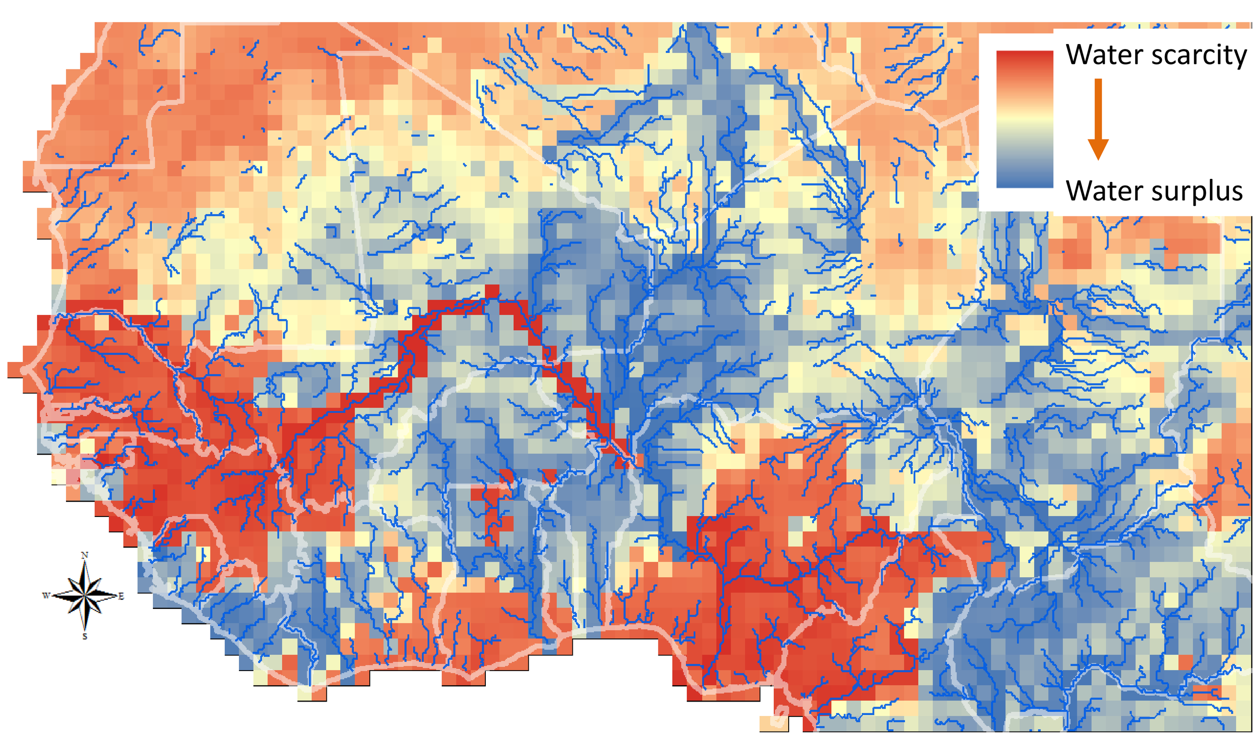


Figure 3.2: Example of potential change in water availability between baseline and 2050s (NorESM1-M)

These trends are in part driven by climate, but may also be the result of an increase in water demand for a growing population and intensified agricultural activity. Further analysis of the ensemble output is needed to improve understanding of the drivers of water stress, and the combination of these drivers, within the region.

4. Future work

The research for this study is ongoing, with the next stages focusing on quantifying the key drivers of changes in water resource availability, and potential mitigation and adaptation strategies with regard to water resource management policy and water-efficient technologies within agriculture.

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