

Assessment of Global Reanalysis Precipitation Datasets for Hydrological Applications in Kenya



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Background

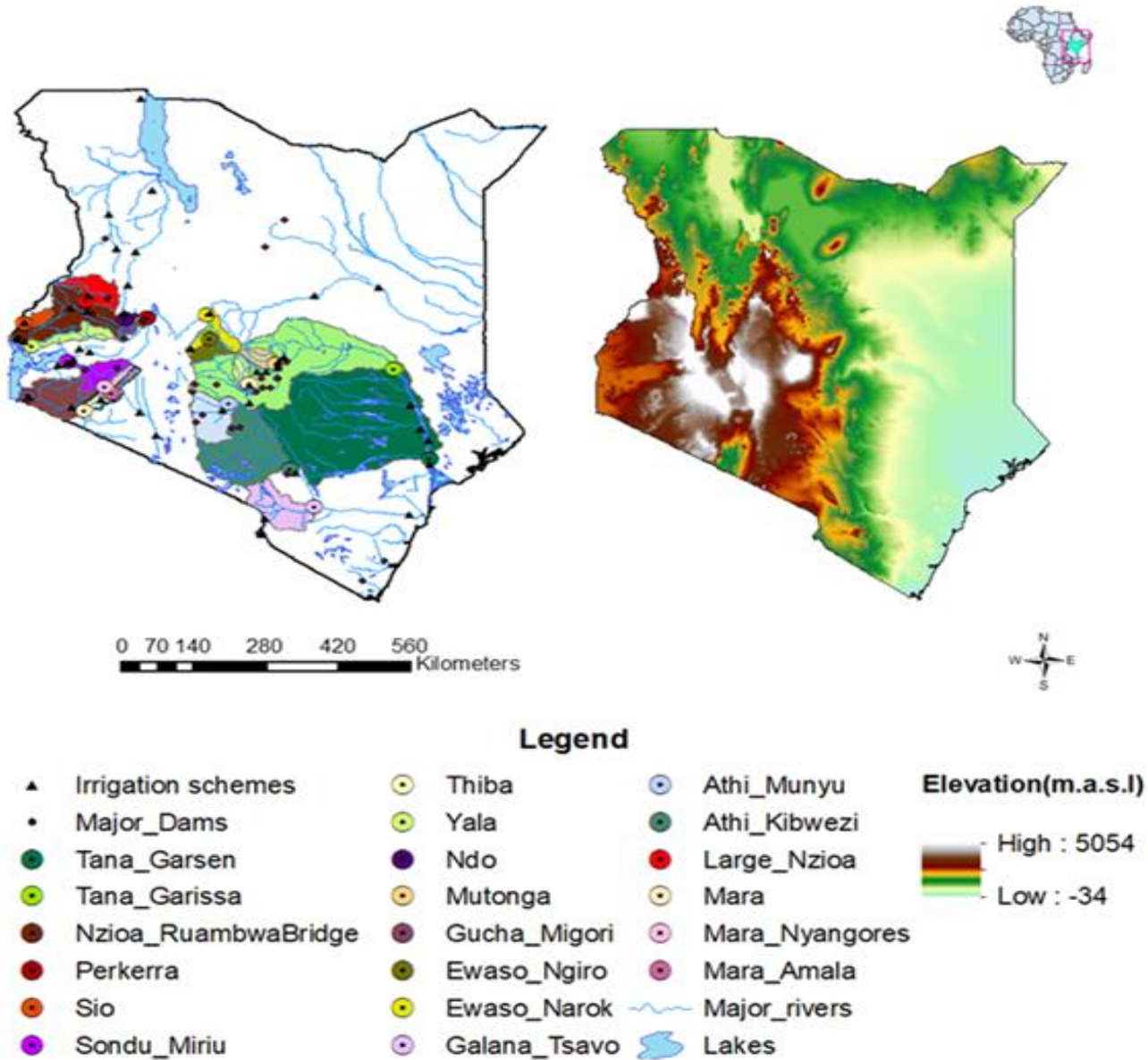
Reanalysis vary in **quality** and are used as substitutes to observations in data scarce regions:-

- Ground validation is key but very challenging, in sparse rainfall gauge networks regions
- Validation process uses ground proxies which fail to capture the real-time evolution and magnitude of events (e.g. floods and droughts)
- Thus, the need to assess the impact on the river discharge on a catchment-by-catchment basis due to the stark differences between the river basins

Objective: To assess different **reanalysis datasets** and identify which are the most suitable in **simulating streamflow** when coupling both the **performance statistics and sensitivity analysis**

Study Area

- The study is undertaken in **19 Kenyan catchments** with good and satisfactory streamflow data records
- Kenya lies astride of the equator at longitude 34°E–42°E and Latitude 5°S–5°N and along the quasi-meridional western edge of the Indian Ocean at the eastern side of Africa



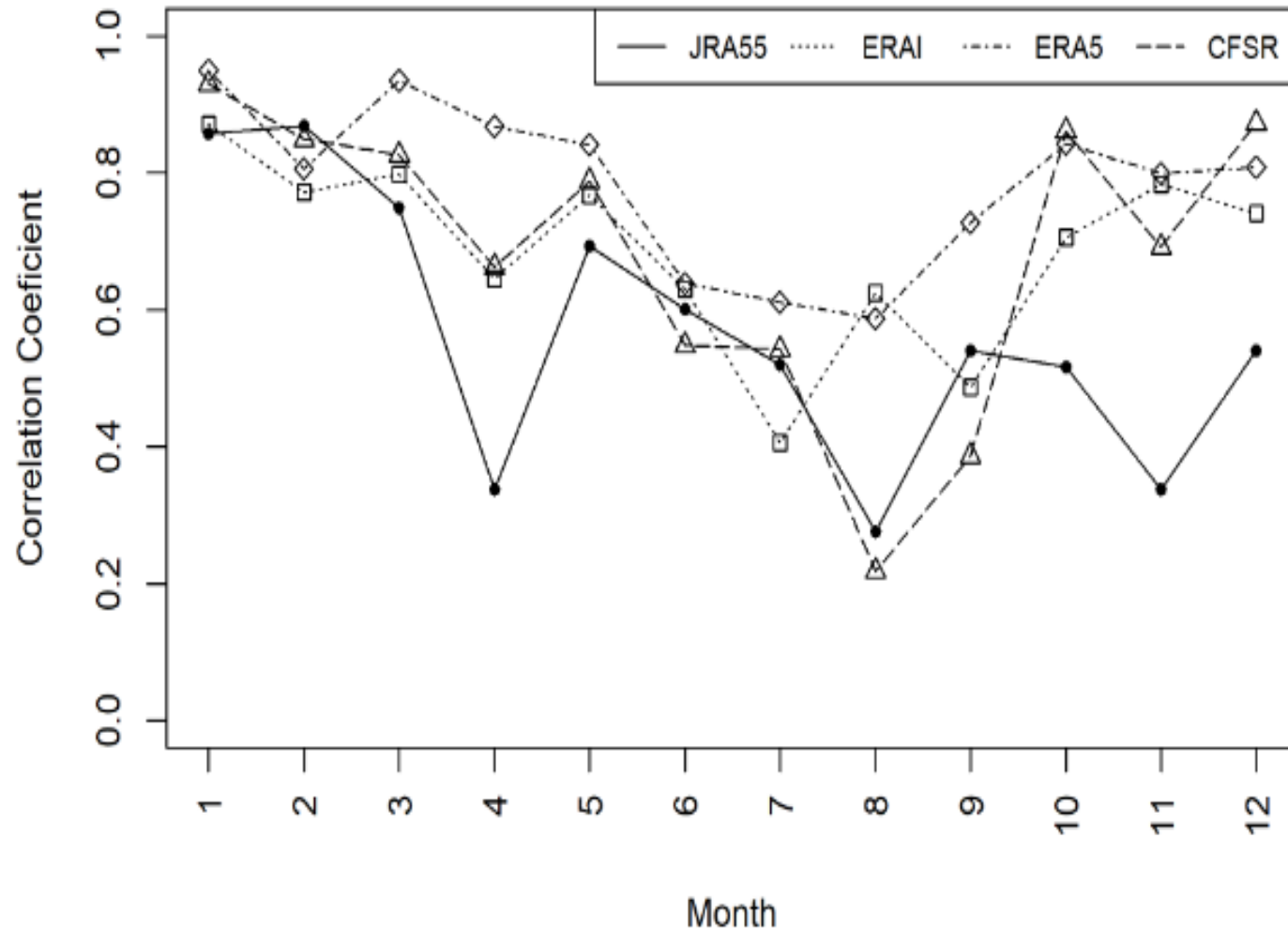
Study catchments, with the location of the outlet river gages used in this study and the main irrigation schemes and major dams across Kenya (left) and topography of Kenya (right)

Data and Methods

- Reanalysis datasets (ERA 5, ERA-Interim, NCEP/NCAR-CFSR, and JRA-55), and CHIRPS, as well as observed river discharge data for the period 1981-2016
- Using a lumped bucket-style hydrological model (**GR4J**, Perrin et al. 2003), we assess the **model performance** via the **KGE criterion and parameter uncertainty** via Sobol's Sensitivity Analysis
- Performance metrics: Correlation Coefficient (CC), Root Mean Square Error (RMSE), BIAS, Kling Gupta Efficiency (KGE), Sobol Total Sensitivity Index (TSI), Model Suitability Index (MSI) were computed from the calibration and validation using GR4J model

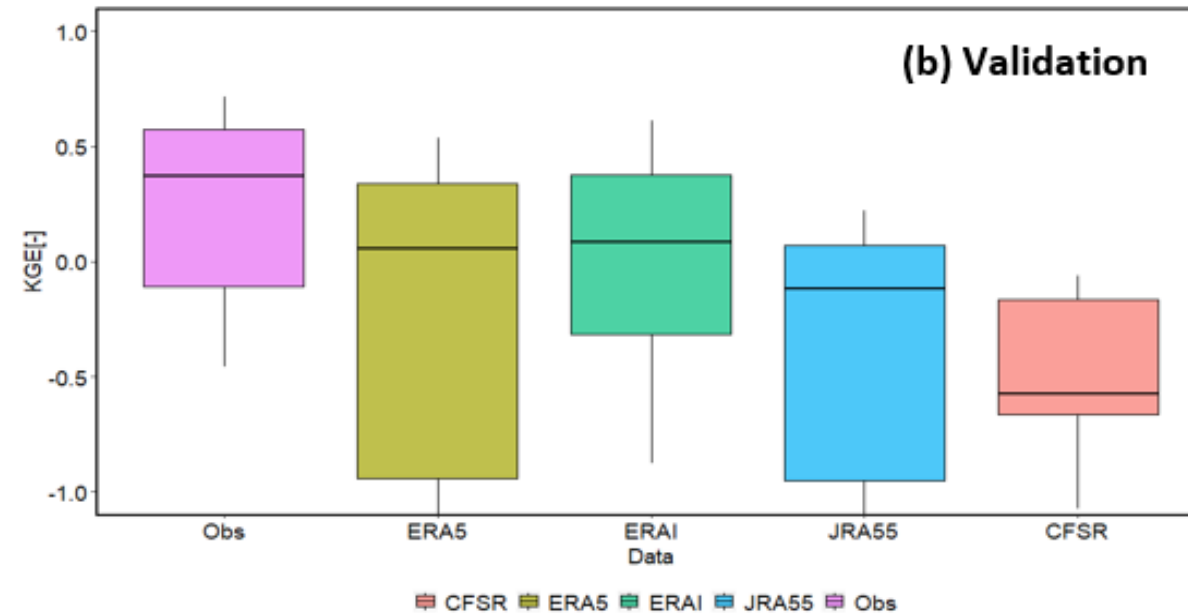
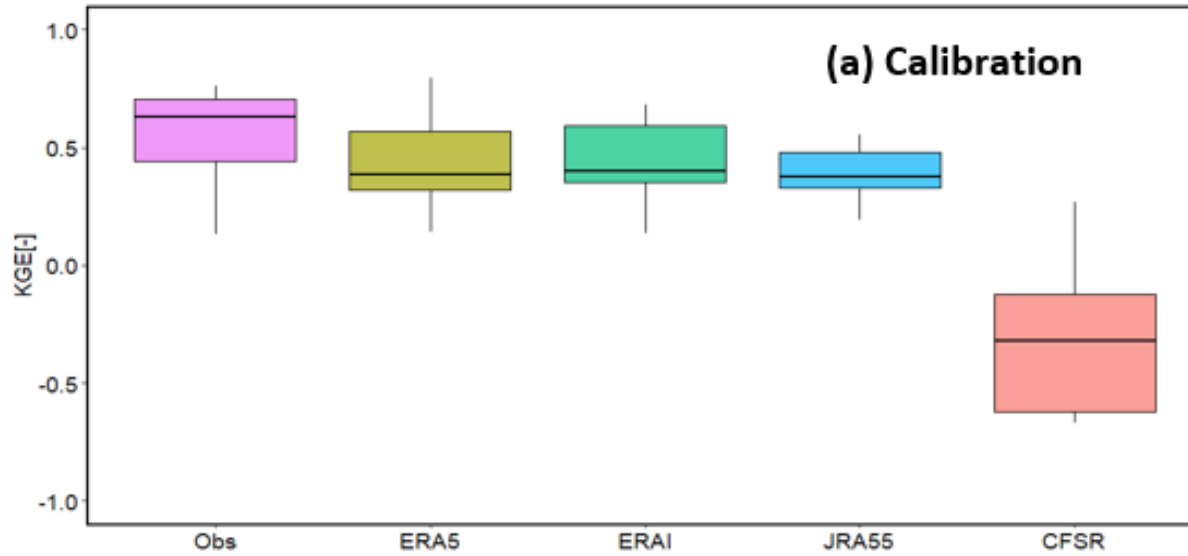
Key Results

Correlation Coefficient



- ERA5 has higher correlation coefficients (0.88) than JRA55, ERAI & CFSR in comparison to observations on monthly timesteps
- Same performance is observed on the seasonal scale (not shown)

Key Results

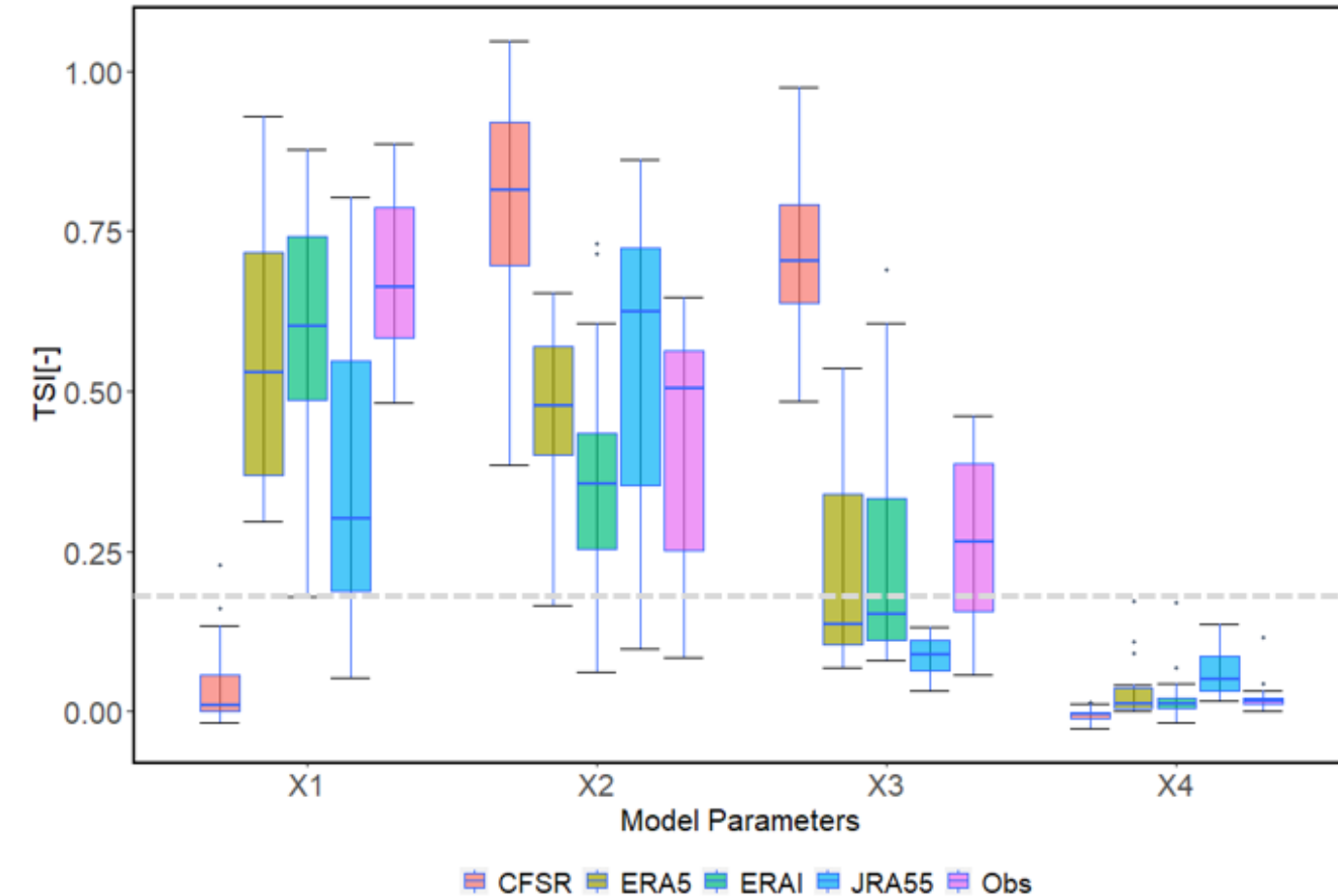


Kling Gupta Efficiency (KGE)

- ERA5, ERAI, & JRA55 obtained better KGE scores whereas CFSR had lower scores in both calibration and validation
- The 3 best performing datasets give similar scores to observations in calibration, but more variable and less robust results in validation (especially ERA5 and JRA55)

Key Results

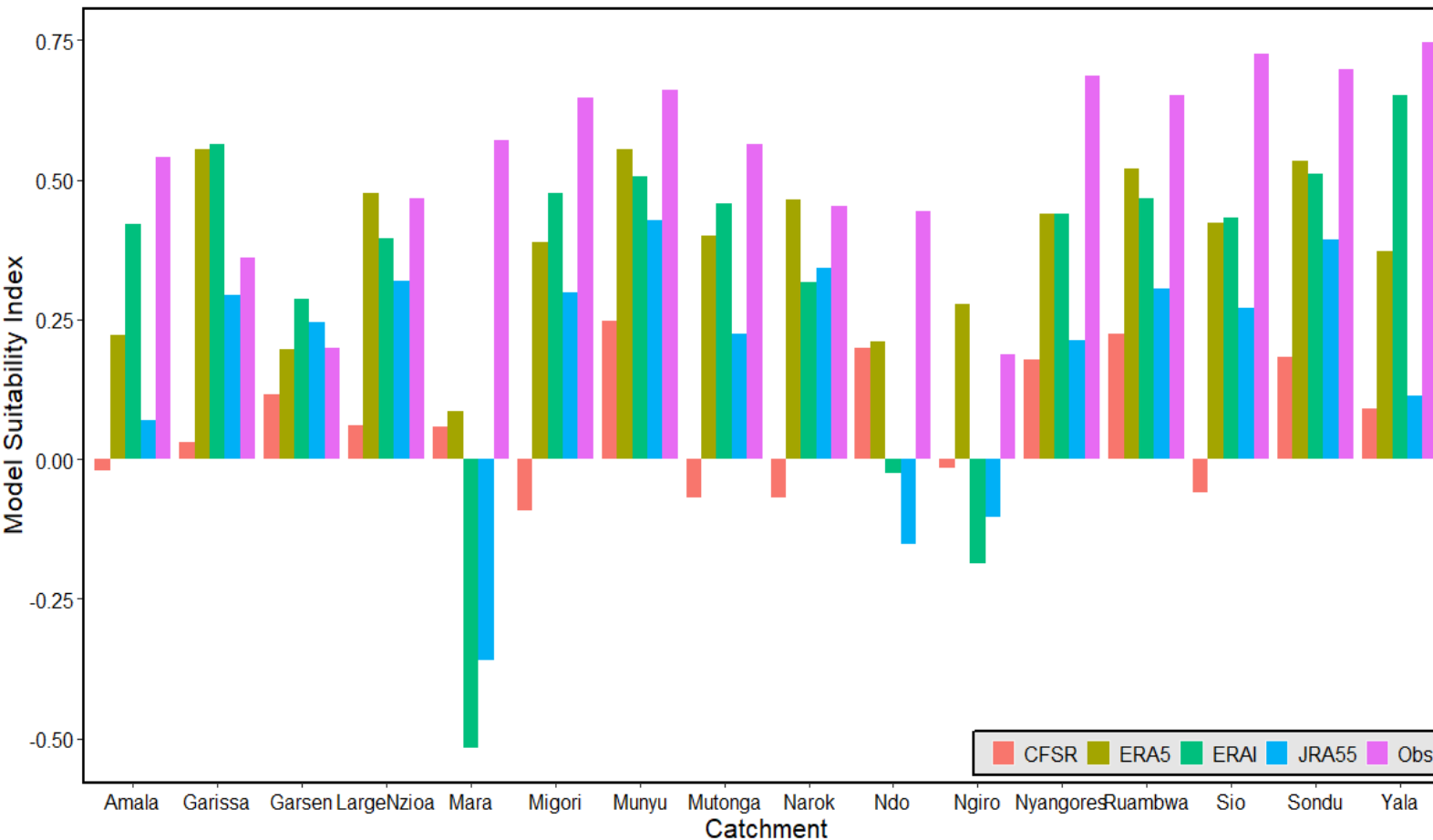
Total Sensitivity Index (TSI)



- In all datasets, the production store capacity (X1) has the highest total effects (Total Sensitivity Index) whereas the time base of the unit hydrograph (X4) is the least influential parameter
- ERA5 show similar sensitivity of each of the model parameters compared to observations, whereas CFSR has highest **uncertainty**

Key Results

Model Suitability Index (MSI)



- MSI considers both sensitivity indices and performance statistics, on average, ERA5, ERAI & JRA have better scores across most of the catchments
- **MSI** has the strength of ease and clearness to judge the **superiority and inferiority** of the reanalysis when compared to observations at catchment scale

Summary

- **Hydrological model performance**: ERA5, ERAI, & JRA55 obtained better KGE scores whereas CFSR had lower scores in both calibration and validation
- The 3 best performing datasets give similar scores to observations in calibration, but more variable and less robust results in validation (especially ERA5 and JRA55)
- **Sensitivity analysis**: ERA5 show similar Sobol's **sensitivity indices** for all model parameters compared to observations, whereas CFSR has highest **uncertainty**
- The MSI aggregates both **sensitivity indices & performance statistics**, providing a clear index to judge the **superiority** (or inferiority) of a reanalysis with respect to observations
- On average ERA5, ERAI (& JRA55) have better MSI scores across most of the Kenyan catchments: ERAI & ERA5 perform better than JRA55 & CFSR, and lead to more robust model parameters