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Modes of streamflow variability in western and Central Africa between 1950 and 2005, role of catchment properties and teleconnections

Moussa Sidibe (1), Bastien Dieppois (1,2,3), Gil Mahé (4), Jean-Emmanuel Paturel (4), Nathalie Rouché (4), Ernest Amoussou (5), Babatunde Anifowose (6), and Damian Lawler (1)

(1) Coventry University, Centre for Agroecology Water and Resilience (CAWR), EEC, Coventry, United Kingdom (moussa.sidibe01@gmail.com), (2) Department of Oceanography, University of Cape Town, Cape Town, RSA, (3) School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, UK, (4) HydroSciences Montpellier (HSM), IRD, Montpellier, France, (5) Département de Géographie et Aménagement du Territoire (DGAT), Université de Parakou, Parakou, Benin, (6) School of Energy, Construction & Environment, Coventry University, UK

Quasi-decadal to multi-decadal climatic fluctuations are known to play a significant role in driving rainfall variability over western and Central Africa. However, due to data scarcity, very little is known about the impact of these climatic fluctuations and catchment properties on streamflow variability. In this study, we aim at extending the understanding of hydrological variability beyond the common catchment perspective through an investigation of key large-scale controls determining and modulating climate-river flows relationships at the subcontinental scale between 1950 and 2005.

Using the first complete monthly streamflow data set (1950-2005) over western and central Africa, modes of variability are highlighted and extracted using the Continuous Wavelet Transform (CWT) method and the Maximum Overlap Discrete Wavelet Transform (MODWT) method, respectively. The relative importance of catchment properties in modulating streamflow modes of variability is assessed using Multivariate analysis (PCA). Teleconnections with climatic variables (SST, OLR, moisture fluxes) from two reanalysis datasets (NCEP/NCAR and 20CR) are investigated to detect suitable predictors for streamflow prediction models.

The results underline the importance of streamflow interannual components along the Gulf of Guinea and the coastal regions of Central Africa, where annual rainfall amounts are higher, and runoff mostly generated from surface and sub-surface processes, whereas stream gauges along the Sahelian band present a stronger multi-decadal component resulting to some extent, from the prominent role of geological formations in damping high frequency signals. These modes of variability (also significantly detected in rainfall) are likely related, at the large-scale, to ocean-atmosphere climate modes of variability. This is here examined through sea-surface temperature (SST) anomaly patterns (e.g. the tropical Atlantic SST variability, the Atlantic Multidecadal Oscillation, the Interdecadal Pacific Oscillation and the Pacific Decadal Oscillation) and associated atmospheric circulations, which are together modulating the West African monsoon.

More than a clearer picture of streamflow variability in Western and Central Africa, this study opens the prospect for robust multi-timescale streamflow predictions, as a means for improving the development of future scenarios for water resources in data scarce environments.