



Drought analysis of African rivers: a study of non-stationary low-flow trends in the Volta and Nile

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The Volta and the Nile are each major transboundary river systems in Africa. They drain a combined area of 3,756,000 sq. km, approximately the size of the European Union. Droughts are common occurrences in each basin, and pose a threat to the food security of many riparian states. In a region where food production, and hence food security are unreliable due to adverse climatic events, and in which the probability of occurrence of such events may be affected by changes in global climate, improved knowledge concerning the spatial and temporal distribution of drought events can prove indispensable in the concerted effort towards realisation of the Millennium Development Goals.

Drought, in this study, is defined as a deficiency in the volume of streamflow, which acts as an integrator of the climate signal. The paper demonstrates an implementation of a hybrid statistical algorithm (HSA) to evaluate non-stationary low-flow trends in two major African rivers. Specifically, we propose a methodology for estimating parameters of Weibull and Gumbel distribution functions, typically used to evaluate absolute minimum flow rates. The number of intermediate parameters that are essential for reaching the final estimates will also be investigated. Simulated annealing and the generalized reduced gradient method, utilized consecutively as optimization algorithms, are explored as an efficient method for estimating maximum likelihood parameters. Tests are performed on discharge data consisting of monthly and annual minima obtained from gauging stations located in both the Volta and Nile basins. Bootstrap re-sampling is used for significance testing and trend analysis.

The study is expected to provide insight into the impact of extreme low-flow events on the design of reservoirs for irrigation. In combination with climate model simulations,

the proposed method can also serve as a tool for studying climate change scenarios, useful in the development of holistic stakeholder-driven water management policies fostering food security in Africa.