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From meteorological to hydrological drought in the Upper Niger Basin: trend and uncertainty analysis in the monitoring and the modeling of rainfall deficits and low flow responses

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From 1970 to 2002, the Sahel experienced a fairly abrupt, severe and continuous dry episode. The main reason is the oceanic forcing ruling the West African monsoon dynamic. Also, a combinative effect of climate and anthropogenic changes (demographic pressure on land associated to inappropriate land-use practices) initiates and supports the interactive processes of drying and land cover degradation forming a complex land atmosphere feedback convection. The Great Drought in Mali largely affected the regional food security, the human societies and economic development and the conservation of wet and semi-arid ecosystems. It results in an increasing competition and conflicts for water access between vulnerable local stakeholders (rainfed and controlled irrigation farming, nomad pastoralism, traditional fishing) and steers national investments with the construction of dams and diversion channels for development of hydropower energy and fully governed irrigated agriculture. To support drought adaptations in regional development strategies, climate and hydrological forecasting are thus of paramount importance. Whilst climate change is typically associated with an increase in mean global surface temperature, what matters regionally and still remains uncertain is the change in rainfall, discharge and drought patterns from daily intensity to large inter-annual and multi-decadal variability. Different climate data sources exist for investigation of climate variability and change: daily measurements, reanalysis data and climate scenarios using Global and Regional Circulation Models (GCMs and RCMs). This study aims at analyzing the suitability of the different data sources for drought investigation in the target area, the Upper Niger Basin.

First, the performance of meteorological data sets based on climate reanalysis is assessed in comparison of data of synoptic stations. Second, one statistical (STAR) and two dynamical regional RCMs (CCLM, REMO) are compared to IPCC-GCM data (ENSEMBLE) of the same region in order to classify their trends. Finally, rainfall deficit and meteorological drought are analyzed using of statistical methods and several drought indexes.

The eco-hydrological model SWIM, driven by the aforementioned different regional climate data sets, is then applied to simulate changes in water resources and discharges in the basin of the Upper Niger. The results are statistically analyzed quantifying the impacts of different climate data sources on hydrological processes and drought statistics.