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Spatio-temporal drought characteristics of the tropical Paraiba do Sul River Basin and responses to the Mega Drought in 2014-2016

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The Paraiba do Sul River Basin (56.000 km^2) supplies water to the Brazilian states Sao Paulo and Rio de Janeiro. Their large metropolitan areas were strongly affected by a Mega drought during the years 2014 and 2015 with severe implications for domestic water supply, the hydropower sector as well as for rural agricultural downstream regions. Longer drought periods are expected to become more frequent in the future. However, drought characteristics, low flow hydrology and the reasons for the recurrent water scarcity in this water abundant tropical region are still poorly understood.
In order to separate the impact of human abstractions from hydro-climatic and catchment storage related hydrological drought propagation, we assessed the spatio-temporal distribution of drought severity and duration establishing relationships between SPI, SRI and discharge threshold drought anomalies for all subcatchments of the PdS based on a comprehensive hydro-meteorological data set of the Brazilian National Water Agency ANA.
The water allocation model “Water Evaluation and Planning System (WEAP)” was established on a monthly basis for the entire Paraiba do Sul river basin incorporating human modifications of the hydrological system as major (hydropower) reservoirs and their operational rules, water diversions and major abstractions. It simulates reasonable discharges and reservoir levels comparable to the observed values. To evaluate the role of climate variability and drought responses for hydrological drought events, scenarios were developed to simulate discharge and reservoir level the impact of 1. Varying meteorological drought frequencies and durations and 2. Implementing operational rules as a response to drought.
Uncertainties related to the drought assessment, modelling, parameter and input data were assessed. The outcome of this study for the first time provides an overview on the heterogeneous spatio-temporal drought characteristics of the Paraiba do Sul river basin and useful tools to support decision making and stakeholders as the River Basin Authority AGEVAP (Water Management Agency for the Paraiba do Sul).