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A hydrological model for the Sudd wetland using remotely sensed and ground data

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Modeling of wetland hydrology and quantification of water inputs and outputs are requisites to understand flooding dynamics, to determine wetland vulnerability to change, and to better inform water-related decision-making.
Located in the Upper Nile river basin in South Sudan, the Sudd wetland is one of the largest floodplain swamps in the world. Its complex system is characterized by a seasonal inundation that is essential to the hydroecological functioning of the Sudd but is also the main cause for intensive water losses (nearly half of the inflow) by evaporation in the Nile river basin. The hydrologically characterization of the area is therefore key to assess and predict the water balance in the region
The main difficulties in modeling the system are due to the inaccessibility of the area, to the vast extension, to the complexity of the dynamic behavior throughout the year (permanent and seasonal flooded areas), and to the political and institutional setting.
This study integrated hydrologic data and remote sensing techniques to analyze the dynamics and spatial response of the wetlands. A new methodology using MODIS data and MNDWI–Modified Normalized Difference Water Index was designed to profile the area of the wetland throughout the years. In particular, the threshold for the MNDWI values was obtained using average annual land cover data and their temporal trends were analyzed to classify the different types of wetland (permanent, seasonal and non-wetland). A characterization of wetland dynamics was then achieved over the 10-years period Jan 2000–Dec 2009.
In the second step of the research, other driving forces of the system were studied: new hydrological models were created for the Torrents and Sobat basins, existing river routing models were computed for the reach of Mongalla and Malakal, and estimates on precipitation and evapotranspiration rates were acquired from different projects based on remotely sensed data. All these information were then used to model the hydrology of the wetland system and provide the relationship between the wetland extent and the hydrological indexes.
Results highlight the relative differences in inundation patterns across the Sudd over multiple flood cycles, characterizing the intra- as well as interannual flood dynamics. Moreover, they offer a crucial tool for managing Upper Nile water resources.