Exploring Trends, Patterns, and Drivers of African Surface Water Dynamics

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Water, a fundamental resource for both ecosystems and human populations, faces escalating challenges in Africa due to water stress and changes in climate, demography, and socioeconomics. Because these changes are happening at a rapid pace, it is essential to understand the dynamics of water bodies and the factors that impact them to ensure sustainable usage strategies. Our research aims to analyze the long-term trends of surface water availability in Africa, identify the causal impacts on major water bodies, and explore the similarities between different lakes.

We use daily time series based on Earth observation, including the MODIS-based Global WaterPack for a daily uninterrupted time series of the continent's surface water area. Furthermore, we incorporate daily time series of hydrologically relevant variables such as precipitation, total evapotranspiration, groundwater, soil moisture, and Gross Primary Productivity (GPP) to analyze their impact on surface water dynamics of major African lakes. For this, we employ the Peter and Clark Momentary Conditional Independence causal identification algorithm. Our findings reveal subbasin-wide surface water and GPP to be the dominant drivers of surface water dynamics in most cases. We further find that dynamically similar lakes often share common drivers, allowing the generation of regional lake clusters. Understanding the drivers of African lakes may significantly help in the formulation of sustainable development strategies.

In conclusion, our continent-wide analysis provides valuable insights, particularly beneficial for stakeholders engaged in international development and ecosystem protection and restoration. As we deal with the challenges of water resource management in Africa, our research aims to contribute substantively to the formulation of strategies that foster sustainability and resilience in the face of evolving environmental and socio-economic conditions.