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# Operational planning of WEF infrastructure: quantifying the value of cooperation in the Eastern Nile basin

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Integrating the operational planning of river, land and power infrastructure could safeguard the water, energy and food security in regions where these resources are under pressure by increasing demands and decreasing availabilities and production potentials. Our work focuses on the benefits of integration and cooperation in the operational planning of these resources and infrastructures between riparian states in transboundary river basins. Therefore we introduce a regional hard-linked WEF-nexus model that explicitly represents resource connectivity networks, gridded agro-hydrological potentials and constraints, national socio-economic demands and non-linear operational processes to optimise reservoir operations, water allocations, cropping patterns, electricity mixes and trade quantities on a monthly time-step over multiple years in a receding horizon fashion. This iterative process facilitates the modelling of changes as feedback against exogenous disturbances and, through the exchange of information between countries, different levels of cooperation. We optimize the total economic returns of resource allocation for four different transboundary cooperation scenarios over an historic planning period in the Eastern Nile basin, for each country and regionally, for multiple foresight settings and policy objectives. Compared to the reference scenario of unilateral planning, our results indicate an increase in regional economic returns for scenarios in which flow information is shared between countries (+8%), flow and trade information is shared (+9%) and resources are coordinated regionally (+13%), without this being accompanied by a significant decline in returns for any country. These increased returns successively come from an increase in the effectiveness of agricultural water consumption, especially in Sudan, a change in trade patterns for agricultural products and a shift in cropping patterns. These findings illustrate the importance of adequate representations of spatial and temporal heterogeneity and resource connectivity, and the need for a more diverse set of collaboration scenarios to quantify the costs and benefits of specific interventions and policies to facilitate comprehensively planning in transboundary river systems.

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