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What is the real price of hydroelectric production on the Senegal River?

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Manantali is an annual reservoir on the Senegal River, located in Mali and serving Senegal and Mauritania. The reservoir is used to regulate the flow for hydroelectric production, in the face of the extremely variable seasonal climate of the region. Manantali has been operative for about 10 years now, exceeding the planned production capacity.

The economic benefit comes at a price. Before the dam's construction, the annual flood was the basis of flood recession agriculture, traditionally practiced by the local population. Hydroelectric production requires a more regular flow; therefore flow peaks that used to create the flood are now dumped in the reservoir. Floods are reduced because the current reservoir management privileges hydroelectric production to flood recession agriculture. Moreover, the local water authority is evaluating the construction of 6 more reservoirs, which will enhance even further the controllability of the river flow.

This study assesses the externalities of energy production for the agricultural production, quantifying the reduction of flooded surface when energy production is maximized, or alternatively, the loss energy production to maintain a minimum sustainable flood. In addition, we examine the system reliability against extreme events, and how a better use of hydrological information can improve the present reservoir management, in order to find a win-win solution.

In this study we employ Stochastic Dual Dynamic Programming (SDDP) methodology. SDDP is a leaner version of Stochastic Dynamic Programming (SDP). SDDP does not suffer of the "curse of dimensionality", and therefore it can be applied to larger systems. In this application we include in the model: i) A semi-distributed hydrological model, ii) the reservoir, iii) the hydraulic routing process within the catchment and from the reservoir to the floodplain.