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Artificial flood support on the Senegal River: a challenge to protect natural resources in the valley

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In West Africa, the Senegal River drains a catchment area of 343 000 km2 across the territories of Guinea, Mali, Mauritania and Senegal. Before reaching the Atlantic Ocean at St. Louis, Senegal, it travels 1 790 km from the source of its main parent branch, the Bafing, located in the mountains of Fouta Djallon in Guinea.
The natural flow regime of the river, a pure tropical entity, is characterised by a high-water season from July to October and a low water season from December to June. Monsoon rains in the upper basin produce most of this flow, which averaged 19.5 km3 per year during the period 1950-2011 as measured at the Bakel station. Downstream of Bakel, the river enters its lower course - commonly called “the valley” - where it receives only a negligible additional contribution to its flow. Then it travels about 800 km to its mouth, with only a very slight slope (roughly 0.0015%). The natural estuarine portion of the river is very wide, with a maritime influence that extends more than 150 km in terms of level and 350 km with regard to salinity during low water.
In the valley, the annual flood inundates a major bed of 10 to 20 km wide containing multiple channels and floodplains and which can be regarded as an inland delta. In the middle of a very arid region this flooding provides precious eco-systemic services (biodiversity, aquifer recharge, maintenance of grasslands, forests and fish stocks) benefiting notably the riparian peoples by allowing for recession cropping, breeding, forestry, fishing, etc.
This annual flooding, must be maintained despite the presence - on the river’s Bafing tributary - of the Manantali reservoir dam, which controls half of the river flow through the valley. In addition to a number of other objectives (energy production, low water support for irrigation and navigation, mitigation of excessively high flooding), this dam also provides flood support, designed to maintain adequate flooding in the valley. This work presents a calculated system dedicated to flood support that aims to: 1) define a flood hydrograph-based goal for the valley mouth, focusing on a targeted area where recession crops are grown; 2) to define the optimal date for flood support in order to reduce energy production at the dam by as little as possible; 3) to calculate the dam’s release discharges to support the flooding in accordance with the real-time hydrological situation. The chronological evolution of the river’s flooding is also analysed in order to distinguish the effects of natural climate fluctuations from the operation of the Manantali dam, in service since 1987 and prone to causing an overall reduction in flooding compared to a natural ebb and flow regimen. Until 2002 it has however supported flooding to a sufficient extent so as to ensure a target yield of 50 000 ha of potential recession crops. Since the complete installation of the dam’s equipment required for energy production in 2003 no flood support has taken place, yet the target of 50 000 ha continues to be achieved, owing mostly to high flow observed during this period on the river’s natural tributaries Bakoye and Faleme.