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Assessing trade-offs and vulnerabilities to global changes in the Senegal River basin.

Étienne Guilpart[1], Amaury Tilmant[2], Marc-André Bourgault[3], and René Roy[4]
[1]Département de génie civil et de génie des eaux, Université Laval, Québec, Canada (etienne.guilpart@gmail.com)
[2]Département de génie civil et de génie des eaux, Université Laval, Québec, Canada (amaury.tilmant@gci.ulaval.ca)
[3]Département de géographie, Université Laval, Québec, Canada (marc-andre.bourgault@ggr.ulaval.ca)
[4]Hydro Météo, Notre-Dame-des-Prairies, Canada (rroy@hydrometeo.net)

West Africa is one of the regions of the globe that is expected to face massive global changes in the coming decades due to sustain population growth rates and climate change. Pressures exerted on water resources are likely to rise as water demands will increase to meet the water, food and energy demands from an ever-increasing, mostly urban, population, while supplies dwindle.

The Senegal River basin is a mostly underdeveloped river basin with a significant hydroelectric and agricultural potential. Policy makers are facing a challenging decision-making problem to identify climate-relevant investments because: (i) the strong divergence of the climate models and the associated uncertainties about future water availability, (ii) conflicting visions regarding the future of the basin: the first emphasizes modern uses such as energy production and irrigated agriculture; the second focuses on traditional uses such as flood recession agriculture and fisheries.

We propose a modeling framework to assess trade-offs and vulnerabilities to both climate and policy factors. First, we generate 1210 GCM-based hydrologic projections for the Senegal River basin from the CORDEX-Africa ensemble and the GR2M hydrological model. The projections are then clustered based on their hydrologic properties, using hydrologic attributes describing the flow regime of the Senegal River. For each cluster, the projection closest to the centroid is selected as the representative one. The next step involves the construction of alternative development and management scenarios of the river basin for the horizons 2050 and 2080. The development scenarios essentially assume different sets of dams and irrigation schemes. Management scenarios, on the other hand, assumed different priorities attached to the operating objectives (water uses).

For each triple projection-development-management scenarios, a stochastic hydroeconomic model determines the optimal operating policies, which are then used in simulation over all GCM-based hydrologic projections belonging to the same cluster. The analysis of simulation results reveals three categories of water uses: (i) high climate-sensitive sectors (hydropower production and navigation), (ii) high allocation policy sensitive sectors (flood recession agriculture and fisheries), and (iii) fairly robust sectors (irrigated agriculture).