Management of the Al Wahda Dam Using Hydro-climatic Forecasts

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Abstract: Reservoirs are critical infrastructure projects providing important socio-economic and environmental services including urban, agricultural, and industrial water supply; flood protection; energy generation; recreation; and environmental and ecological protection, among others. Reservoir management involves decisions over a wide range of temporal scales, from minutes and hours (as for the management of floods and the scheduling of hydropower) to seasons and years (as for managing droughts; meeting the growing water demands of cities, industries, and farms; and mitigating the adverse impacts of climatic change). Reservoirs are traditionally managed using empirical rules derived from historical operational experience. The last two decades, however, have seen unprecedented climate and socio-economic changes, creating new water and energy stresses, undermining traditional operational practices, and calling for new management paradigms.

These challenges are very real in Morocco, which during 2022–2024 experienced an unprecedented drought and in early 2026, an unprecedented flood. Moreover, climate projections indicate that such extraordinary oscillations will occur more frequently in the coming decades, exacerbating the socio-economic and environmental risks in most Moroccan river basins.

Reservoirs are important assets in the effort to mitigate climate risks. However, their effectiveness depends on whether their management procedures are climate-informed and adaptively optimized. The purpose of this article is to demonstrate the value of such integrated forecast-optimization approaches over traditional management practices for the Al Wahda Dam, the largest and most impactful storage project in Morocco. Key findings of the study include:

(a) Hydroclimatic forecasts can only be fully utilized through integrated forecast-optimization management procedures that are able to adapt their decision recommendations to current and anticipated climate conditions.

(b)The value of integrated forecast-optimization versus traditional empirical approaches in the management of Al Wahda *increases* as hydroclimatic uncertainty increases. This particularly applies to changing hydroclimatic and socio-economic conditions under which integrated approaches substantially mitigate risks while improving reservoir services and outputs.

(c) Sustainable multi-sectoral management (e.g., of the water-energy sectors or the water-energy-agriculture sectors) can only be fully achieved through a climate-informed optimization-based framework supporting an inclusive stakeholder decision process.

(d) Integrated forecast-management procedures can replace current practices through the development of decision support systems and their effective knowledge transfer to reservoir managers and practicing professionals.

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