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POLICY BRIEF
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Better Reservoir Management Practices Can Reduce the Threat of Sedimentation to Saudi Arabia's Water Security[1]

Source: ©Shutterstock/Khawaja Umer Farooq.
Note: Wadi Qanuna Dam, Saudi Arabia.

Reservoir Sedimentation Poses a Threat Nationwide

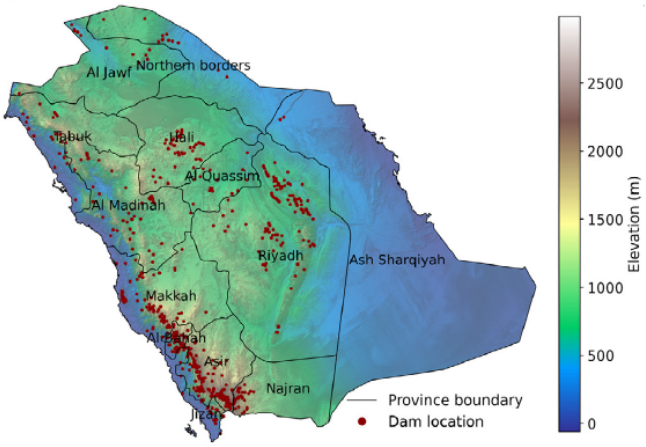
Saudi Arabia has 574 water reservoirs located at dams (Figure 1) — designed to hold nearly 2.6 billion cubic meters of water — and plans to build another 1000 dams. It faces significant challenges from sedimentation because of its arid conditions, with long dry periods punctuated by short and intense storms, sparse vegetation cover, and erosion-prone landscapes.

Sedimentation happens in reservoirs located at dam sites when eroded soil, rock, and other materials travel from upstream catchments and accumulate in reservoirs. It can reduce storage capacity and water quality and make it harder to protect against floods and to supply water to agriculture, industry, and consumers. Without management, sedimentation can jeopardize water security in regions that rely heavily on dam reservoirs.

The Bottom Line

- This innovative KAUST-led[2] study argues for adopting integrated, well-coordinated, evidence-based management strategies to reduce capacity losses from sedimentation in Saudi Arabia's dam reservoirs.
- The study suggests mutually reinforcing measures to cover the full lifecycle of the country's reservoirs and catchments, starting with design. It also proposes addressing substantial knowledge gaps with further research and data collection.
- Reservoir sedimentation may have already claimed almost a third of the country's reservoir capacity across 574 dam sites.
- Plans to build 1000 new dams could nearly double the Kingdom's reservoir capacity if the sites are well managed, further highlighting the need for improvements in management.

Fig. 1 Reservoirs in Saudi Arabia



Source: Dash et al. 2025.[3]
Note: The dam locations, which are denoted with red dots, indicate the presence of reservoirs.

Integrated Interventions Can Reduce the Threat of Sedimentation

The study argues for prioritizing improvements in reservoir management to safeguard Saudi Arabia's limited water resources. An integrated and well-coordinated management strategy would cover both the reservoirs and their upstream catchments (Table 1), based on the best available evidence. For example, a strategy could pair sediment sluicing and desilting with upstream erosion control and silt traps.

To support these measures, the study suggests developing integrated catchment-reservoir management plans, preferably before building dams, to coordinate land use practices, erosion control, and reservoir operations. This planning can extend the lifespan of reservoirs in arid environments such as Saudi Arabia's, where sporadic but intense rainfall greatly aggravates sediment flows.

The study also proposes steps to improve the evidence for policy decisions. Among them, the study includes better quantifying the processes of erosion, collecting additional data on sediment accumulation in reservoirs, more-closely monitoring flash floods and sediment transport, increasing access to data on climate, and undertaking more assessments of management interventions under real-world conditions, in-reservoir and at catchments.

The Study Identified Problems and Solutions

The study asked and answered sequential research questions, including:

Are the reservoirs holding less water?

Satellite-based data on water coverage,[4] an indicator of water holding, suggests a widespread pattern of gradual water loss from 1986 to 2024. Conditions varied widely by site, but water coverage trended downward at more than 60% of the reservoirs. Overall, the median trend in water coverage was negative, about -1.5% annually.

What factors are driving the losses?

Neither climate nor water use appears to explain the declines, but estimates from models of erosion and sediment yield, combined with visual satellite evidence, suggest that sedimentation is the main culprit.

How much has sediment accumulation reduced storage capacity?

While "design capacity," which is the original capacity when a dam is constructed, has increased over time, actual capacity has been declining because of sediment accumulation. By 2024, the study estimates that cumulative usable storage capacity had decreased by as much as 32% relative to the design capacity. Figure 2 compares the cumulative design capacity and the estimated actual capacity of Saudi Arabia's reservoirs from 1950 to 2024.

Table. 1 Management Options for Reservoirs and Catchments

Target location	Potential measure
Reservoir	• Sluicing to pass sediment-laden inflows through the reservoir with minimal deposition of sediment, timed to the onset of flash floods when inflow sediment concentrations peak • Flushing reservoirs to scour and evacuate deposited sediment, by lowering the level of the reservoir using low-level water outlets at times when the release capacity of the reservoir and water availability are acceptable • Excavating and dredging reservoirs to systematically remove and relocate sediment to geotechnically stable disposal sites and reduce re-entry during subsequent storms

Target location	Potential measure
Catchment	• Constructing check dams or silt traps to intercept sediment before it reaches the main reservoir • Terracing and contouring agricultural land and practicing conservation agriculture to reduce erosion • Enforcing erosion controls on construction activities to reduce runoff • Increasing vegetative cover by curbing overgrazing or implementing ecosystem restoration to reduce erosion

Source: Policy Institute synthesis of material presented in Dash et al. 2025.

How can policy help safeguard Saudi Arabia's water future?

The study offers specific proposals (set out under 'Integrated Interventions Can Reduce the Threat') for improvements in reservoir management (Table 1) and highlights opportunities to fill the major research and data gaps that might impede it.

The Study Is the First of its Kind

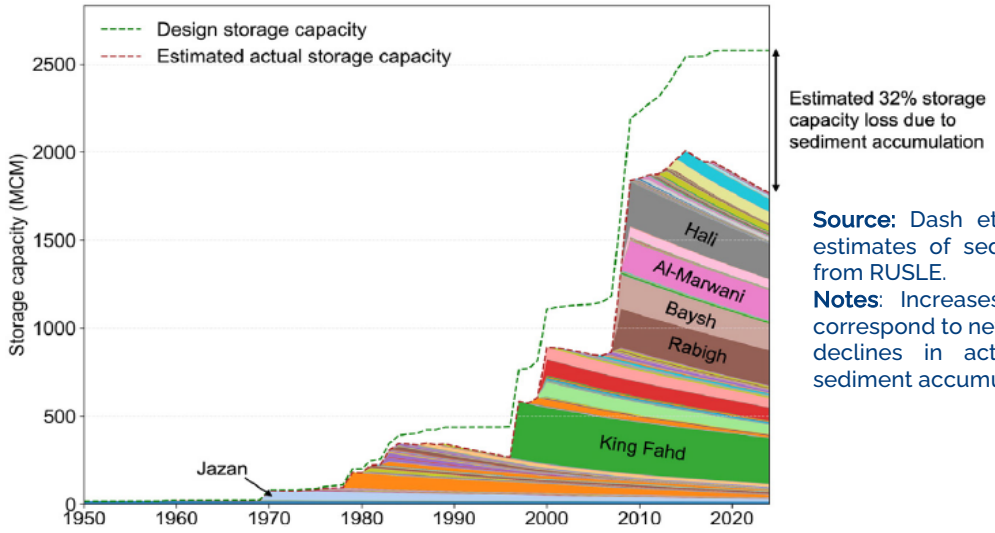
Using an innovative approach to collecting and analyzing evidence, the study quantifies the scope of reservoir sedimentation in Saudi Arabia by analyzing the drivers of trends in water coverage across 574 reservoirs (Figure 1) from 1986 to 2024, and it draws out the implications for policy. The study triangulated among:

- Landsat satellite imagery, which provided evidence on water coverage for most of the 574 sites.
- Estimates of sediment yields and reservoir infill times — the expected number of years needed for sediment to fill the reservoir — derived from the Revised Universal Soil Loss Equation (RUSLE) for all 574 sites.
- Data on climate and water use
- Geological assessments and fieldwork in the Wadi Baysh Basin.

Summing Up

Reservoir sedimentation threatens Saudi Arabia's water security, by reducing storage capacity, functionality, and water quality. It may have already claimed almost a third of the country's reservoir capacity across 574 dam sites in the Kingdom. This new study argues for adopting integrated, well-coordinated, evidence-based management strategies that would cover the full lifecycle of reservoirs and catchments, starting with design. It suggests pairing the strategies with measures to close substantial research and data gaps. In the first study of its kind, the KAUST-led researchers have combined evidence on long-term trends in water coverage (1986 to 2024), garnered from satellite imagery, with other evidence on sedimentation, derived from a time-tested simulation model. The government plans to build 1000 new dams in Saudi Arabia. They stand to double the country's reservoir capacity if the sites are well managed, further highlighting the need for the proposed improvements in management.

Fig. 2: Design capacity compared with estimated actual storage capacity from 1950 to 2024



Source: Dash et al. 2025,[3] based on estimates of sediment yields derived from RUSLE.
Notes: Increases in design capacity correspond to new dams, while gradual declines in actual capacity reflect sediment accumulation over time.

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1. This Policy Brief summarizes findings from Dash, Sonam S., Nikola Ivanović, Raied Alharbi, Gregory R. Hancock, Yoshihide Wada, Matthew F. McCabe, Debasish Pal, Hannu Marttila, and Hylke E. Beck. 2025. "Sedimentation in Saudi Arabia's 574 Reservoirs: Nationwide Assessment Using Remote Sensing and Erosion Modeling." *Journal of Environmental Management* 394. https://doi.org/10.1016/j.jenvman.2025.127199. All rights and any third-party permissions remain with the respective rightsholders.
2. King Abdullah University of Science and Technology (KAUST) with international collaborators.
3. Reused under Creative Commons license (CC), ©Dash et al. 2025; no changes were made except formatting.
4. Known as "extent water," this is the surface area occupied by the water.