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Climate clues and forgotten floods in Maharashtra's ageing reservoirs

Sediment cores from centuries-old talavs trace El Niño-linked deluges and human impact, raising concerns about India's readiness for a new era of climate extremes

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Beneath the still waters of Maharashtra's talavs, reservoirs shaped by centuries of water management practices, lie the buried signatures of a changing climate.

A new study¹ suggests these sedimentary layers hold evidence of strong El Niño years — typically linked to drought in India — unleashing turbulent flash floods that overwhelmed the structures.

In talavs such as Matwali and Indira Bazar in the Bhima basin, geoscientists extracted sediment cores that reveal abrupt spikes in erosion and deposition — evidence of flood fury that scoured catchments and dumped sediments into reservoir beds. These deposits left lasting geological scars, which researchers link to the El Niño–Southern Oscillation (ENSO), a powerful Pacific climate pulse that ripples across the globe.

When soils are dry and the land lies bare, even a short, sharp burst of rain can be catastrophic, said Atreyee Bhattacharya, lead author of the study and a geoscientist at the University of Colorado Boulder. “This is the first time we’ve linked local climate events and disasters in India’s semi-arid interiors to ENSO variability of the Indian summer monsoons.”

The clearest marker emerged from Matwali talav: a thick ‘plug’ of coarse sediment, supplied rapidly during the intense rainfall of 1988–89, the year marked by El Niño conditions. The sedimentation rate shot up to nearly 20 to 30 times the typical average of one centimetre per year. “Dry areas such as Matwali are at risk of more erosion from deluge events associated with local expressions of the monsoon,” she said.

Local land use made things worse. Farming on dried reservoir beds, grazing along embankments, and widespread cash crop cultivation had already destabilized the terrain. When the rains came, the weakened soil gave way. “These structures were not designed with today’s extremes in mind,” said Bhattacharya. “Our reservoir

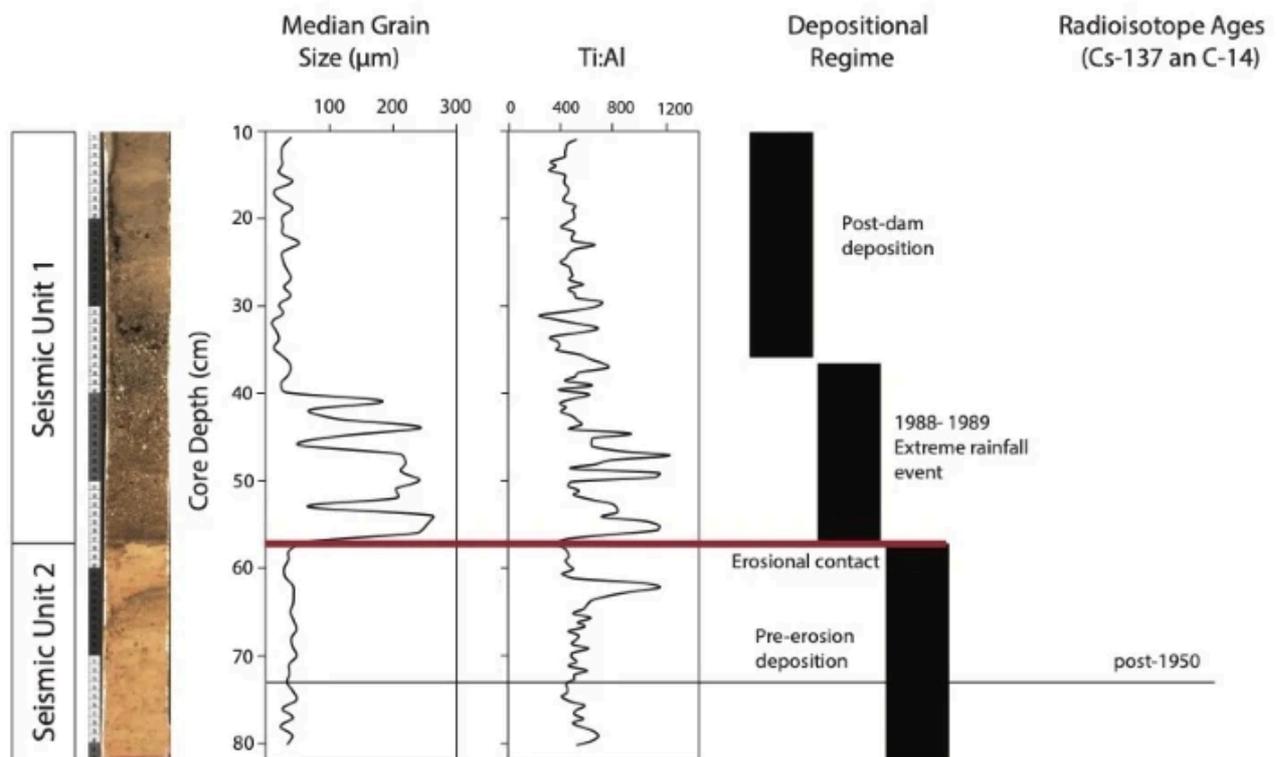
infrastructure now needs to account for intensifying weather linked to climate change.”

Water security expert Anamika Barua has observed similar patterns in northeast India, a region marked by many dams and currently roiled by protests against new hydropower projects. “We’re seeing fewer rainy days, but the rainfall is more intense,” said Barua, who teaches at the Indian Institute of Technology Guwahati. “Many of our ageing, and even newer, structures weren’t built for this. Prolonged dry spells punctuated by intense rainfall shift risk onto already vulnerable communities.”

Ancient engineering, modern warning

Talavs have a long and layered history. The earliest of these reservoirs were built by the Mughals around the 16th century to store monsoon water in semi-arid landscapes. They were later expanded under British colonial rule to fuel the cotton and sugarcane economy. Post-independence, a wave of dam construction further deepened India’s reliance on these reservoirs for agriculture, employment, and power generation. “They helped prevent food shortages in drought years and laid the foundation for urban and port development,” Bhattacharya said.

To study them, researchers used boat-mounted geophysical equipment to map subsurface layers. At Matwali, they targeted a spot with both old riverbed sediments and more recent overlying reservoir deposits. At Indira Bazar, the deepest point offered a continuous archive, with bedrock basalt embedding the timeline, said co-author Sudipta Sarkar at the Indian Institute of Science Education and Research (IISER), Pune.



Reconstruction of marker events in the Matwali talav's sediments. The 1989-90 event deposited a coarse-grained, poorly sorted sediment layer. Sediments accumulated after 1990 were in more controlled conditions. Credit: Bhattacharya *et al*

Satellite imagery dated the shift to reservoir sedimentation, confirmed by radiometric methods pinpointing the 20th and 21st century floods. To trace erosion, the team analysed titanium-to-aluminum ratios in core samples: high titanium levels signalled heavy upstream erosion. While Matwali showed sharp spikes, reflecting intense land disturbance, Indira Bazar appeared more buffered, its catchment less degraded.

“Our landscape model suggests that peaks in rainfall correspond well with high sediment discharge. While anthropogenic factors may play a role, they appear to be minor, at least for the sites we have studied. One cannot totally rule out the influence of land disturbance, but its intensity needs to be further assessed at other sites if this method is applied elsewhere,” said Sarkar.

The trouble with quick fixes

State programmes such as Maharashtra’s Galmukt Dharan and Galyukt Shiwar Abhiyan aim to boost water storage by removing silt from reservoirs. But these efforts

often ignore degraded upstream catchments, the very source of the silt. Without comprehensive soil conservation or climate planning, desiltation may simply perpetuate a damaging feedback loop.

“We need geological assessments. Will water even percolate in these tanks?” asked Eshwer Kale, a watershed management expert with the Watershed Organisation Trust in Maharashtra. “In low-percolation zones, silt removal may not solve anything. Meanwhile, bare lands are heating up, adding another layer of stress.”

Building resilience

Amir Bazaz, co-author, and climate infrastructure expert at the Indian Institute for Human Settlements, argues for a shift from engineering-centric fixes to community-driven, climate-informed planning. “We need to align decentralized institutions, landscape-sensitive design, and long-term projections,” he said. “That’s how we build adaptive, equitable systems, not just hardware.”

Ritesh Kumar of Wetlands International–South Asia, urges a deeper understanding of ecological history. Sediment records from Odisha’s Chilika lagoon show the system has oscillated between fresh and saline states over millennia. “What we often consider disruptions may, in fact, be natural shifts,” he said. “We must let go of static baselines and reframe what resilience really means.”

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References

1. Bhattacharya, A. *et al. Quat Env Humans* **3**, 100061 (2025).
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