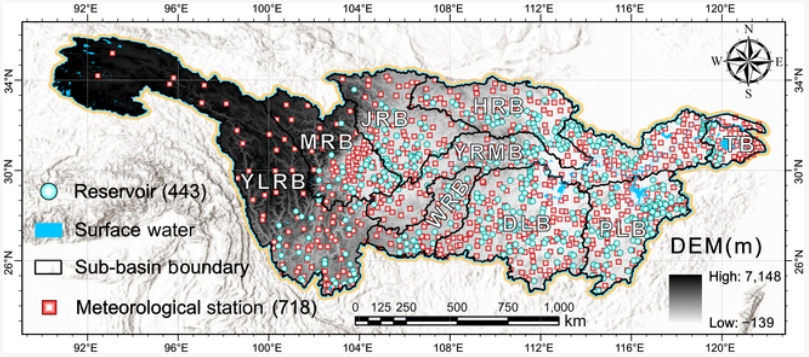
New multi-satellite dataset maps dynamic water storage changes across the Yangtze



Overview of the Yangtze River Basin (YRB).

GA, UNITED STATES, January 9, 2026 /EINPresswire.com/ -- Reservoirs form the lifelines of water and energy security, yet their long-term dynamics remain poorly quantified across large river basins. A new study harnessed multiple satellite missions to create the most detailed record yet of reservoir water storage in China's Yangtze River Basin (YRB) from 1990 to 2023. By combining radar and laser altimetry with optical and radar imagery, researchers tracked changes in 443 reservoirs and found a steady increase in total storage—averaging 1.58 cubic kilometers per year—with a major turning point in 2006. The findings offer unprecedented insights into how climate forces and human engineering jointly transform one of the world's most intensively managed watersheds.

Reservoirs are indispensable for hydropower, irrigation, and flood control, but their storage fluctuations often escape consistent monitoring. The Yangtze River Basin (YRB), stretching across diverse terrains and climates, supports more than 40 percent of China's population and hosts the world's densest network of dams. Yet persistent cloud cover, rugged topography, and data inaccessibility have long obstructed efforts to quantify how these reservoirs evolve through time. Ground-based surveys remain fragmentary, while existing satellite records lack the temporal and spatial resolution required to capture seasonal dynamics. Owing to these gaps and uncertainties, researchers recognized the urgent need for an integrated, long-term satellite-based approach to monitor reservoir storage throughout the YRB.

A research team from Southwest University, in collaboration with national and regional institutes, has produced the Yangtze River Basin Water Reservoir (YWR) dataset—a high-resolution, multi-source archive that monitors reservoir area, elevation, and storage each month from 1990 to 2023. Published in the Journal of Remote Sensing on September 25, 2025, the study integrates Landsat and Sentinel satellite imagery with ICESat and ICESat-2 laser altimetry to reveal how reservoirs across the Yangtze have expanded and shifted over three decades. The resulting dataset sets a new standard for tracking hydrological change in complex, cloud-prone regions.

By merging multi-source data from radar and laser altimetry with optical and SAR imagery, the team reconstructed monthly reservoir conditions at an unprecedented scale. Validation using in-situ records from 14 reservoirs achieved a correlation coefficient of 0.76 and an root mean square error (RMSE) of 4.19 m, while storage estimates showed a normalized RMSE of just 7.21 percent against ground measurements.

The 33-year analysis revealed a steady rise in water storage throughout the basin, punctuated by a major shift after 2006. Large hydropower projects such as the Three Gorges and Danjiangkou dams accounted for nearly 87 percent of the total increase, while smaller reservoirs played supporting roles in regional water balance. Upstream basins showed earlier growth spurts driven by dam construction and energy policy, whereas mid- and downstream zones exhibited delayed changes as urbanization and flood-control priorities rose. The results suggest that human activities—particularly hydropower expansion—have far outweighed climate influence in reshaping storage patterns. With its monthly continuity and basin-wide coverage, the YWR dataset opens new opportunities for evaluating how infrastructure and climate interact to govern Asia’s most important river system.

"Our findings show that the story of the Yangtze's reservoirs is ultimately a story of human ingenuity and its footprint on the water cycle," said lead author Yong Wang of Southwest University. "By fusing multi-satellite data over more than thirty years, we've built a tool that lets scientists and policymakers see how decisions on dam construction, energy, and flood control translate into measurable changes in storage. It's a window into the region's hydrological past and a compass for its sustainable future."

The YWR dataset establishes a foundation for next-generation water-resource management and climate-adaptation strategies. Its high-frequency records can aid in forecasting drought and flood risks, optimizing reservoir operations, and informing hydropower planning across the Yangtze region. Beyond China, the approach offers a template for large-scale monitoring in data-scarce basins worldwide, from the Mekong to the Amazon. Future work will refine storage estimates for narrow and mountainous reservoirs by integrating digital elevation models and advanced algorithms. Ultimately, this research demonstrates how Earth observation can transform fragmented data into actionable knowledge for sustaining water security in a warming world.

References

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