

RUNNING OUT OF WATER OR MANAGING CLIMATE EXTREMES?

Bridget R. SCANLON¹

¹ Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas, USA

Keywords: GRACE satellites, floods and droughts, managed aquifer recharge

Concerns about global water scarcity are intensifying due to population growth, expanding irrigation, and declining water supplies. Beyond scarcity hotspots, rising hydroclimatic extremes—more frequent and longer droughts and more intense flooding—pose major challenges for water resources management.

This study evaluates spatiotemporal variability in water resources using an integrated approach, combining satellite observations, modeling, and in situ monitoring. Data from GRACE satellites reveal diverse trends in total water storage over the past two decades, including declining, stable, and rising trends across different regions globally. Longer-term analyses from regional modeling and groundwater monitoring over the past century highlight contrasting patterns, with increasing water storage in the northwestern United States, northwest India, and central Pakistan linked to surface water irrigation, and substantial declines associated with groundwater irrigation in the U.S. High Plains and Central Valley.

Increasing drought frequency and duration are depleting surface water resources—often viewed as a “checking account”—and driving greater reliance on groundwater reserves, the “savings account.” At the same time, intensified flooding events, sometimes considered “droughtbusters”, remain difficult to capture and manage effectively.

Addressing these challenges requires rethinking water management to better balance climate extremes. Key strategies include enhancing managed aquifer recharge (MAR) to store floodwaters for drought periods and leveraging subsurface storage capacity in depleted aquifers—often exceeding that of surface reservoirs—through approaches such as Flood-MAR, Ag-MAR, and Forecast-Informed Reservoir Operations. As climate extremes intensify, water management will become increasingly energy-intensive and costly. Sustainable water resource management will require greater emphasis on water storage for climate extremes to build more resilient water systems.