26th International Congress on Modelling and Simulation, Adelaide, SA, Australia, 30 Nov–4 Dec 2025
mssanz.org.au/modsim2025

Changes in water availability and dryness under global climate change

Muhammad Abrar Faiz [a], Faisal Baig [b], and Yongqiang Zhang [c]

a School of Water Conservancy & Civil Engineering, Northeast Agricultural University, Harbin, Heilongjiang 150030, China
b Department of Civil and Environmental Engineering, United Arab Emirates University, Al Ain, United Arab Emirates
c Key Laboratory of Water Cycle and Related Land Surface Processes, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

Email: faiz_ma@neau.edu.cn

Abstract: Global climate change has significantly changed the spatial and temporal distribution of water resources, making water availability (WA) more complex and increasing the risk of droughts. Understanding these changes is vital for securing water, protecting ecosystems, and maintaining agriculture. In this study, we examine past and future changes in WA and dryness using an integrated modeling approach that combines satellite data, reanalysis datasets, and drought indicators outputs. Water availability was measured using a water balance approach that relates precipitation, evapotranspiration, and storage changes, and was validated against observed water balance data. Results show a general decrease in WA where evapotranspiration is dominant, with key hotspots in Asia, Africa, and South America. Strong links with large-scale climate patterns (e.g., Southern Oscillation Index) highlight the influence of atmospheric circulation on WA variability. To evaluate dryness, we used a Composite Drought Index (CDI), which combines precipitation anomalies, water deficits, and moisture indices. CDI outperformed traditional indices (PDSI, Evaluation Integrated Drought Index), effectively detecting severe droughts in regions such as the Yangtze Basin and correlating well with changes in crop yields and streamflow. Global analysis revealed gaps between meteorological droughts and vegetation water stress, showing the need for multiple indicators. Future projections under high-emission scenarios (SSP5-8.5) suggest increases in drought frequency and crop water needs, with rice requiring up to 146 mm/month, raising agricultural vulnerability. These findings underscore the importance of advanced modeling in predicting water shortages, informing adaptation strategies, and supporting sustainable water management in the face of accelerating climate change.

Keywords: *Drought; Climate models; Extremes; Global water availability*