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Estimation of Lake Urmia Evaporation from the Combined Ground-based and Satellite Imagery Data

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Lake Urmia (LU) has been the second-largest hypersaline lake in the world located in the northwest of Iran that encountered a drastic drawdown in the water level over the past two decades. Accurate estimation of the water balance components, particularly evaporative loss from the water surface as the main component of the LU water budget, is important for the lake water management and restoration programs. In this study, long-term evaporation from the LU surface was estimated between 2000 and 2017 using the Bowen Ratio Energy Balance (BREB), Priestley-Taylor, DeBruin-Keijman, Penman, and Stephans-Stewart methods that leverage meteorological observations and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) satellite earth observation data. The impact of water salinity on evaporation was also considered through dynamic water activity coefficient as well as water density. Given observations from the saline water pan evaporation located in the Lake vicinity, the Debruin-Keijman method yielded the most accurate estimation with the correlation coefficient of 0.93, the root means square error (RMSE) of 121 mm in annual scale. The minimum and maximum annual evaporation were estimated as 783 mm and 1216 mm in 2011 and 2000, respectively, with the annual average evaporation for the entire period, were 1077 mm. By extracting monthly lake surface area from image classification techniques, monthly and annual volumetric evaporation were estimated, indicating that the annual average of the lake volumetric evaporation approximates to 3.6 BCM, which exceeds LU annual environmental requirement water of 3.1 BCM.