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Satellite Data Application to Cover Lack of In-situ Observations for Mapping Precipitation and Direct Runoff in Semi-arid Basin

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Hydrological modeling in arid basins located in developing countries often lacks sufficient hydrological data because, e.g., rain gauges are typically absent at high elevations and inflow to ungauged areas around large closed lakes such as Lake Urmia is difficult to estimate. We tried to improve precipitation and runoff estimation in Lake Urmia, Iran as an arid basin using satellite-based data. We estimated precipitation using interpolation of rain gauge data by kriging, downscaling Tropical Rainfall Measuring Mission (TRMM), and cokriging interpolation of in-situ records with Remote Sensing (RS)-based data. Using RS-based data in estimations gave more precise results, by compensating for lack of data at high elevations. Cokriging interpolation of rain gauges by TRMM and Digitized Elevation Model (DEM) gave 4–9 mm lower Root Mean Square Error (RMSE) in different years compared with kriging. Downscaling TRMM improved its accuracy by 14 mm. Using the most accurate precipitation model, we modeled annual direct runoff with Kennessey and Soil Conservation Service Curve Number (SCS-CN) models. These models use land use, permeability, slope maps and climatic parameter (I_a) to represent the annual climatic condition of modeled basin in sense of wetness or dryness. In runoff modeling, Kennessey gave higher accuracy in annual scale. It was found that classification of years to wet, dry and normal states in Kennessey by default assumptions on I_a is not accurate enough for semi-arid basins so by solving this issue and calibration Kennessey model parameters, we made this model applicable for Urmia Lake basin. Calibrating Kennessey reduced the Normalized RMSE (NRMSE) from 1 in the standard model to 0.44. Direct runoff coefficient map by 1 km spatial resolution was generated by calibrated Kennessey. Validation by the closest gauges to the lake gave a NRMSE of 0.41 which approved the accuracy of modeling.