Research Paper

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Validation of Doppler Radar in Estimating Intensive Daily Rainfall in Urmia Lake Catchment

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1-Introduction

Precipitation is one of the main variables for a wide range of hydrological programs, meteorology and climate models (Qin & et al., 2014, 650). Therefore, accurate estimation of heavy rainfall is a very important and effective factor for planning related to water resources management, flood forecasting and quick warning, and natural disaster management and reduction. (Sun et al., 2018; Tan et al., 2017; Prakasha et al., 2016). Meteorological radar systems are considered suitable for recording the spatial variability of extreme precipitation, including events with limited spatial extent (Borga et al., 2008, 3884). Radar is becoming more accessible day by day and is used in the analysis and designing of storms (Haberland and Brandt, 2016, 81). The main advantage of using weather radar data is to provide a complete picture of storm events at different temporal and spatial scales, since many short-term and small-scale storm events are not recorded by the conventional network of rain gauges. It can provide a more reliable spatial image than interpolation station data (Lengfeld et al., 2019, 363).

2-Methodology

In this research, daily ground rainfall data and Doppler weather radar have been used. We have used from the data of heavy daily rainfall (rainfalls of 25 mm and above using the 90th percentile) of 9 synoptic stations in the catchment area of Lake Urmia in the period of 8 years from 2014 to 2021 which is shown in Figure 1. They were selected as other stations were not covered by the radar and they were not suitable for this research due to the blocking of the radar waves and the long distance from the radar. To evaluate the accuracy of GPM satellite precipitation data, with the data measured in ground synoptic stations and the ability of GPM satellite to detect the amount of precipitation from statistical indices such as correlation coefficient (R), Root Mean Square Error (RMSE), Nash-Sutcliffe Efficiency (NSCE), Slope, False Alarm Ratio (FAR), Probability of Detection (POD) Critical Success Index (SCI) were

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applied. Also, Kolmogorov-Smirnov two-sample test was used to compare between ground and radar databases.

3- Results and Discussion

Examining the values of the correlation coefficient between the observed and estimated rainfall by radar in the study area shows different degrees of accuracy of the rainfall estimated by this gauge in the stations of different regions of the basin (R value at the basin level from -0.20 varies up to 0.80). This shows that in terms of correlation coefficient, the accuracy of daily rainfall obtained from radar is very suitable in some areas and less correlated in others. The correlation coefficient of more than half of the stations is above 0.40. Bostan Abad station has the highest correlation with 0.80 and Oshnavieh station has the lowest correlation with -0.20. Calculation of the slope index showed that in most areas of the studied area, the data estimated by radar are relatively far from the regression line (1:1) and the slope value of the line varies from be -0.1 to 1. Also, FAR, POD and CSI statistical indices were checked between the observed and estimated data of the stations and the results showed that more than 90% of the daily rainfalls were correctly identified by radar, which indicates that the accuracy of the radar is very good at detecting daily rainfall and the radar's performance and the best correspondence of these data with the ground stations in the studied area. Also, the results of Kolmogorov-Smirnov test showed that considering that the obtained p-value (0.000) is smaller than the error value of the test (0.05), then the difference between radar precipitation data and ground observations is significant. In other words, it can be concluded that the rainfall values recorded in the ground and radar stations do not provide a single result, and none of the statistical populations have a uniform distribution, and finally satellite data cannot replace the data. The rainfall data of the stations in the area should be used for the study.

4-Conclusions

In this research, the rainfall data estimated by Doppler radar was evaluated with the rainfall recorded by ground stations as observational data, and it is a statistical index that shows the relationship and error evaluation between two series of data, are used. Comparison of the maps obtained from Doppler radar and ground stations showed that the spatial distribution of precipitation from the two databases were not the same and the low and high rainfall areas did not match each other. Therefore, the spatial correlation coefficient between radar and observed rainfall is 0.25. Also, the results of Kolmogorov-Smirnov test showed that considering that the obtained p-value (0.000) is smaller than the error value of the test (0.05), then the difference between radar precipitation data and ground observations is significant. In other words, it can be concluded that the rainfall

values recorded in the ground and radar stations do not provide a single result, and none of statistical populations have a uniform distribution, and finally satellite data cannot replace the data. The rainfall data of the stations in area should be used for the study.

Keywords: Statistical Test, Heavy Precipitation, Hydrology, Doppler Radar, Urmia Lake Catchment Area.