Assessing the Predictability in Rainfall Time Series—A Case Study in Wisconsin Basin

P. Saravanan and C. Sivapragasam

Abstract Understanding the trend of rainfall series is necessary to manage water resources and to plan future development activities, especially during the construction of large-scale hydraulic structures. In many reported works, trend is estimated using Mann–Kendall test and persistence of the trend in future is estimated using the value of Hurst exponent. But the Hurst exponent only shows the nature of persistence ($H > 0.5$ persistence, $H < 0.5$ anti-persistence and $H = 0.5$ have equal probability), but it doesn't say for sure that the series is predictable even if it is persistent. In this study, a method is proposed to check how predictable a time series is. Annual and seasonal rainfall series for a period of 20 years (2002–2021) for 15 rain gauges located in Wisconsin river basin (Wisconsin State of USA) is used which covers almost 20 counties. It is seen that for annual data, increasing trend is found in all the 15 stations. Further, the Hurst exponent indicates the increasing trend is persistent in future also. In seasonal data, 13 stations have increasing trend with Hurst exponent value more than 0.5 in all the stations. Then, the Hurst exponent values are explored for14 different sizes of the series starting from 7th year to 20th year for all the stations. Finally, the relation between predictability and oscillation (in term of standard deviation) of the 14 Hurst exponents is demonstrated. Prediction is performed using Artificial Neural Network to see how the oscillation in the 14 different Hurst exponents of series influences the prediction. The prediction performance with annual data of Reedsburg station is not good (NRMSE = 0.30) when compared to Lac Vieux Desert (NRMSE = 0.08) as evident from the standard deviation values. The Standard deviation in the 14 Hurst exponents of Reedsburg and Lac Vieux Desert are 0.22 and 0.08. Later, the same analysis is done on seasonal data which also corroborates that there is a relation between the oscillation of 14 different Hurst exponents and predictability.

P. Saravanan (✉)
Department of Civil Engineering, Vedavyasa Institute of Technology (Formerly Kalasalingam Academy of Research and Education, Srivilliputhur), Malappuram, India
e-mail: coeveda@vedavyasa.org

C. Sivapragasam
Department of Civil Engineering, Kalasalingam Academy of Research and Education, Srivilliputhur, India

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