Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 453 (E-14), 2025, pp. 65–67
DOI: 10.25171/InstGeoph_PAS_Publs-2025-043
XLII International School of Hydraulics, Radocza, Poland, 20–23 May 2025

Assessment of Trends in the Polish Annual Peak Flow Data

Geetika CHAUHAN and Iwona KUPTEL-MARKIEWICZ

Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland

✉ gchauhan@igf.edu.pl; iwonamar@igf.edu.pl

A b s t r a c t

The present study investigates the stationarity of annual peak flow data from 140 gauging stations in Poland. The primary criterion for selecting these stations was the availability of continuous 70-year peak flow records. The modified Mann–Kendall test is employed to identify the trend in the data series.

1. INTRODUCTION

The stationarity of the annual peak flow records has been a cornerstone of flood frequency analysis and more generally, the flood risk analysis (Villarini et al. 2009). A fundamental assumption in classical flood frequency analysis is the stationarity of annual peak flow data, i.e. the data under consideration is free of trend, shifts, or periodicity. However, anthropogenic changes in land use or land cover and the regulation of rivers through dams and reservoirs question the assumption of stationarity of annual peak flow data. The recent devastating flood in September 2024 in southwestern Poland raises the need to study the assumption of stationarity of the annual peak flows in the country. The most common way to check for the existence of non-stationarity in the annual peak time series is to check for the presence of slowly varying changes through trend analysis. Analysing the trend of the historical and present data is an important tool for obtaining a clearer understanding of what the future will hold for us (Villarini et al. 2011). Because when a trend is detected, it is likely to continue into the future (Villarini et al. 2009). In this study, we investigate the stationarity of annual peak flow data from 140 gauging stations in Poland, using the modified Mann–Kendall test at the significance level of 0.05.

© 2025 The Author(s). Published by the Institute of Geophysics, Polish Academy of Sciences.
This is an open access publication under the CC BY license 4.0.

2. METHOD

2.1 Data

A total of 140 gauging stations were selected for this study, based on the criterion of having continuous annual peak flow time series of 70 years. The data was provided by the Institute of Meteorology and Water Management – National Research Institute (IMGW–PIB). The selected gauging stations are evenly spread out across Poland. The rivers monitored by these stations are affected mostly by hydrotechnical structures like dams, reservoirs, weirs, run-of-river hydropower plants, and urbanization.

2.2 Trend analysis

The most commonly used tool for trend detection in hydrological time series is the Mann–Kendall (MK) test. The null hypothesis for the MK test states that the data are independent and randomly ordered, i.e., there is no trend or serial correlation among the observations. However, annual peak flow data is often related to a previous observation. The existence of positive or negative autocorrelation in a time series will interfere with the proper identification of a significant trend. Therefore, we used the modified MK test to detect the trend in the selected time series. The modification of the MK test is based on the assumption that data are autocorrelated, and therefore the autocorrelation is estimated from the data in the test procedure.

3. RESULTS

Our analysis reveals that out of the 140 selected gauging stations, only 16 stations exhibit a positive trend in the annual peak flow data. However, a statistically significant trend at the 0.05 significance level is observed only in three stations. Conversely, 124 stations demonstrate a negative trend, with 76 stations exhibiting statistical significance at the 0.05 level, as illustrated in Fig. 1. The majority of rivers in Poland show a negative trend in the annual peak flow data, which is reported by as many as 89% of the gauging stations examined, with just 11% of the stations reporting a positive trend. The type I error of incorrect rejection of the null hypothesis when there is no trend, was detected at two gauging stations. The type II error of incorrect acceptance of the null hypothesis when a trend exists, was detected at eight gauging stations due to the presence of autocorrelation in the time series.

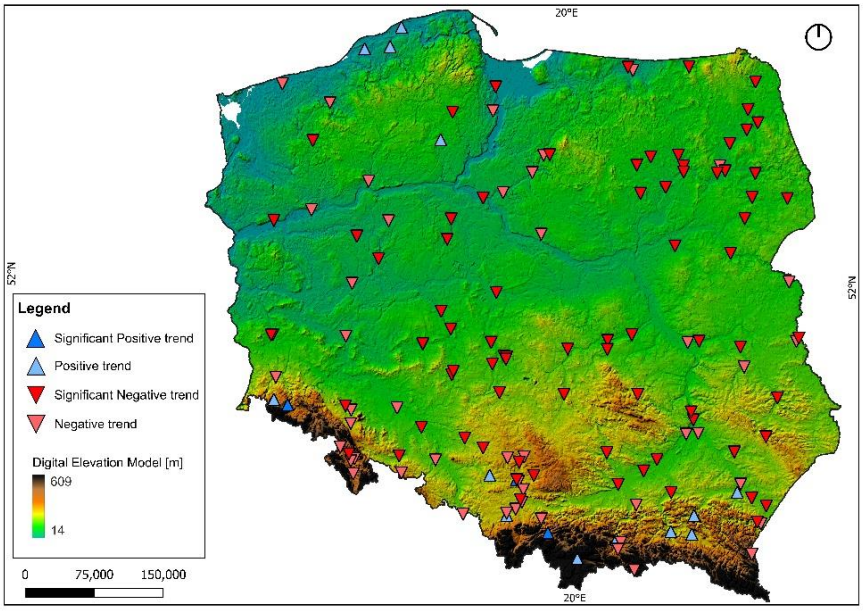

Fig. 1. Results of modified MK test analysis for 140 gauging stations in Poland.

References

Villarini, G., J.A. Smith, F. Serinaldi**,** J. Bales, P.D. Bates, and W.F. Krajewski (2009), Flood frequency analysis for nonstationary annual peak records in an urban drainage basin, *Adv. Water Resour*. **32**, 8, 1255 –1266, DOI: 10.1016/j.advwatres.2009.05.003.

Villarini, G., J.A. Smith, F. Serinaldi, and A.A. Ntelekos (2011), Analyses of seasonal and annual maximum daily discharge records for central Europe, *J. Hydrol*. **399**, 3–4, 299–312, DOI: 10.1016/j.jhydrol.2011.01.007.