Abstract

Ongoing climate change is still accelerating and significantly changing climatic conditions in all regions of the planet. The effects of changing climatic conditions are manifested not only by an increase in the mean global temperature but also by a significant extremization of the weather events. (IPCC 2021) Extreme precipitation events associated with the occurrence of maximum sums of multi-day atmospheric precipitation totals have the potential, even without a changing climate, to bring about such high precipitation totals that are destructive to infrastructure and endanger the lives and property of the population. The presented dissertation focuses on a comprehensive seasonal regional frequency analysis (RFA) of maximum 2-day (Rx2D) and 5-day precipitation totals (Rx5D) in Slovakia using the L-moment approach (Hosking and Wallis, 1997). The aim is to estimate regional distribution functions for the full year, warm half-year, and cold half-year, and to calculate design values of Rx2D and Rx5D for individual stations within these seasons at specified exceedance probabilities [%]: 99, 98, 95, 90, 80, 70, 60, 50, 40, 30, 25, 20, 10, 5, 2, 1, and 0.5. Additionally, maximum seasonal Rx2D and Rx5D values are analyzed for trends in historical and model time series. For the statistical analysis of historical data, precipitation records from 419 stations in Slovakia with daily data from 1951 to 2020 were utilized. Regional climate model outputs from five EURO-CORDEX models, covering 66 stations, were used to analyze future trends. While most stations did not show statistically significant trends via Mann-Kendall test and Sen's slope estimate, certain regions exhibited significant increases in Rx2D and Rx5D values.

Homogeneous regions were identified via cluster analysis using the Index-flood procedure and Ward's hierarchical clustering algorithm. The suitability of stations within these regions was assessed using the discordancy measure (D_i) and homogeneity tests (Hosking and Wallis, 1997). Regional distribution functions were determined using L-moment ratio diagrams, Z^{Dist} measure (Hosking and Wallis, 1997), and Anderson-Darling test (Viglione et al., 2006), indicating a generalized extreme value distribution (GEV) for Rx2D and generalized logistic distribution (GLO) for Rx5D as the best theoretical fits.

Results from the frequency analysis suggest, that Rx5D values expected once every 100 years in lowland regions could occur every 25 years in mountainous areas. Future climate model projections (2020-2099) show a statistically significant increase in all seasonal Rx2D and Rx5D values during the cold half-year.

This dissertation significantly contributes to understanding of current and future extremes of multi-day precipitation in Slovakia. The statistical methods demonstrated here can guide similar studies in regions with complex climatic and topographical conditions, highlighting the potential of regional analysis in hydrological and climatological research.

Keywords: maximum sums of multi-day precipitation totals, trend analysis, climate regionalization, regional frequency analysis, regional climate models.