

Abstract

Despite the increasing availability of high-resolution time series precipitation data in hydrology, especially in urban hydrology, engineers designing and modeling drainage systems still rely on predefined scenarios of rainfall distributions in time, using standard hyetograms. This creates a need for a reliable statistical workshop for developing and verifying locally used standard hyetograms. The development of a workshop for identifying similar precipitation patterns is also crucial for constructing real-time stormwater management systems, particularly those based on artificial intelligence.

The research conducted during the doctoral project presents a complete workshop for isolating intense rainfall events from the PANDa project database, clustering rainfall data into clusters with similar distributions over time, allowing for targeted identification of local standard hyetograms. This workshop is based on cluster analysis, including hierarchical agglomerative methods and k-means clustering. A novel aspect of the proposed workshop involves: objectifying the determination of the number of clusters based on the analysis of the total within-sum of squares and the Calinski-Harabasz index; verifying the internal cohesion and external isolation of clusters based on the bootmean parameter; and profiling the isolated clusters.

This workshop was created and initially tested on a large urban rainfall field scale—specifically in the city of Kraków—using a dataset of 1,806 intense rainfall events from 25 rain gauges. The results confirmed the utility and reproducibility of the developed methodology for partitioning intense rainfall datasets and identifying standard hyetograms in individual clusters across the entire city. Subsequently, this methodology was applied to analyze a dataset of 31,646 intense rainfall events extracted from the PANDa project database for 100 rain gauges in Poland. The resulting data allowed for the creation of several local precipitation patterns for each of the hundred areas in the country, grouping the most characteristic and frequently occurring rainfall distributions over time for those regions. These sets of local hyetograms were then implemented into the innovative web application WaterFolder Connect, which will facilitate accurate design, modeling, and verification of small urban drainage systems for all interested parties.

Until now, no software manufacturer for modeling urban drainage systems in the Polish market has provided such a unique dataset, enabling easier, faster, and more accurate analyses.