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Flood forecasting using sensor network and Support Vector Machine model

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Machine learning has shown great promise for hydrological modeling because, unlike conventional approaches, it allows efficient processing of big data provided by the recent automatic monitoring networks. This research presents the Support Vector Machine (SVM) model designed for modeling floods in a montane environment based on data from a distributed automated sensor network. The study aimed to test the reliability of the SVM model to predict the different types of flood events occurring in the environment of a mid-latitude headwater basin, experiencing the effects of climate and land use change.

The sensor network uses four hydrological and two meteorological stations, located in headwaters of the montane basin of Vydra, experiencing intense forest disturbance, a rise in air temperatures, and frequent occurrence of flood events. Automated hydrological stations are operating in the study area for ten years, recording the water levels in a 10-minute interval with online access to data. Meteorological stations monitor air temperatures, precipitation, and snow cover depth at the same time step.

The model network was built using the Support Vector Machines (SVM), particularly the nu-SVR algorithm, employing the LibSVM library. The network was trained and validated on a complex sample of hydrological observations and tested on the scenarios covering different types of extreme events. The simulation scenarios included the floods from a single summer storm, recurrent storms, prolonged regional rain, snowmelt, and a rain-on-snow event.

The model proved the robustness and good performance of the data-driven SVM model to simulate hydrological time series. The RMSE model performance ranged from 0,91-0,97 for individual scenarios, without substantial errors in the fit of the trend, timing of the events, peak values, and flood volumes. The model reliably reconstructed even the complex flood events, such as rain on snow episodes and flooding from recurrent precipitation.

The research proved that the data-driven SVM model provides a reliable and robust tool for simulating flood events from sensor network data. The model proved reliability in a montane environment featuring rapid runoff generation, transient environmental conditions, and variability of flood event types. The SVM model proved to efficiently handle big data volumes from sensor networks and, under such conditions, is a promising approach for operational flood forecasting

and hydrological research.