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A hybrid spatiotemporal drought forecasting model for operational use

L. Vasiliades and A. Loukas
University of Thessaly, Department of Civil Engineering, Volos, Greece (lvassil@uth.gr, +30 2421074169)

Drought forecasting plays an important role in the planning and management of natural resources and water resource systems in a river basin. Early and timelines forecasting of a drought event can help to take proactive measures and set out drought mitigation strategies to alleviate the impacts of drought. Spatiotemporal data mining is the extraction of unknown and implicit knowledge, structures, spatiotemporal relationships, or patterns not explicitly stored in spatiotemporal databases. As one of data mining techniques, forecasting is widely used to predict the unknown future based upon the patterns hidden in the current and past data. This study develops a hybrid spatiotemporal scheme for integrated spatial and temporal forecasting. Temporal forecasting is achieved using feed-forward neural networks and the temporal forecasts are extended to the spatial dimension using a spatial recurrent neural network model. The methodology is demonstrated for an operational meteorological drought index the Standardized Precipitation Index (SPI) calculated at multiple timescales. 48 precipitation stations and 18 independent precipitation stations, located at Pinios river basin in Thessaly region, Greece, were used for the development and spatiotemporal validation of the hybrid spatiotemporal scheme. Several quantitative temporal and spatial statistical indices were considered for the performance evaluation of the models. Furthermore, qualitative statistical criteria based on contingency tables between observed and forecasted drought episodes were calculated. The results show that the lead time of forecasting for operational use depends on the SPI timescale. The hybrid spatiotemporal drought forecasting model could be operationally used for forecasting up to three months ahead for SPI short timescales (e.g. 3-6 months) up to six months ahead for large SPI timescales (e.g. 24 months). The above findings could be useful in developing a drought preparedness plan in the region.