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Hydrological response to different time scales of meteorological conditions using standardized indicators

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Monitoring and early warning (M&EW) systems are a crucial component of water management. M&EW systems make use of standardized indicators to assess meteorological and hydrological moisture conditions continuously in time and space. The different response of hydrological systems to precipitation can vary noticeably as a function of the time scales. Finding the most adequate time scale of moisture conditions and hydrological ones can be useful for monitoring and prediction of extreme hydrometeorological phenomena with the special emphasis on droughts. The research aims to parameterize hydrological response to meteorological conditions accumulated over different time spans to be operative for water management and M&EW purposes. Parameterization of relationship between the current hydrological conditions and previous meteorological moisture conditions was the basis for proposed monitoring and prediction scheme.

The developed procedure was applied to standardized precipitation index (SPI) and standardized runoff index (SRI) time series calculated for different time aggregations (1, 3, 6, 12, 18, 24, 36 and 48 months). Standardized indicators were developed for period the 1970-2015. The analyzed area covers selected catchments of the Odra river basin of different climatological, hydrological and topographical conditions. In order to find corresponding SPI-SRI pairs of values for each catchment area, SPI results were interpolated with the use of IDW method and mean SPI values were developed.

The analysis of a set of combinations of SPI and SRI values for different aggregation intervals were examined while maintaining one month time interval between SPI and SRI time series. I.e. SPI time series calculated for 1, 3, 6, 12, 18, 24, 36 and 48 months were merged with the SRI 1 month value shifted forward by 1 month. For each of the coupled time series a joint probability distribution function was estimated with the use of kernel density method. The developed set of functions allowed for estimating probability of particular moisture conditions (dry, wet, normal) during next month based on calculated SPI value in the previous 1 month, 3 months, 6 months, etc. This was used for prediction of hydrological moisture conditions expressed in terms of SRI values range with the highest estimated probability.

The obtained parameterization of hydrological response to different time scales of meteorological conditions differed under various environmental conditions and investigated hydrological extremes (drought of different severity). This provides an indication for a rate of hydrological cycle changes pending on these factors.