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Temporal and spatial changes of effective precipitation and their key role in climate change impact on groundwater in Central Europe

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Groundwater resources, as well as many other aspects of planetary mass balance, are exposed to the influence of climate change. Estimation of groundwater recharge as a respective part of effective precipitation and its possible change should be an essential part of any hydrogeological study dealing with prognoses of future groundwater resources. In our study, the evaluation of effective precipitation by means of geostatistical analysis of meteorological stations over the territory of Slovakia for the period 1951-1980 is presented. Effective precipitation and resulting groundwater recharge is primarily defined by air temperature and precipitation, both strongly dependent on local geomorphology. For this purpose of spatialization sparse data drawn from meteorological stations, we used a detrended kriging as recommended most favourable method. Its usefulness was proven also on the territory of Slovakia in this study, where the method of residual kriging with removed global trend was used to estimate mean monthly and annual air temperatures and precipitation totals. To identify global trends in the two fundamental climatologic variables – temperature and precipitation, a stepwise regression was applied to detect their trends in the geographic position as well as in the local geomorphology. Two positional and three geomorphological parameters were assessed to be governing the global variation in these variables. Verification of the results proved that the applied method is well capable of reproducing observations.

To calculate mean potential evapotranspiration evaluation, Thornthwaite's method [1], [2], with monthly calculation steps was used. These results served as inputs in calculation of actual (real) monthly evapotranspiration, using soil reservoir evaporation/precipitation balance. Here, the monthly precipitation totals and potential evapotranspiration were compared to make the change in soil water content. In cases where precipitation volume was exceeding sum of potential evapotranspiration and field capacity of soil, the unevaporated water, not stored in soil, represents the recharging volume. Air temperature records from 98 climatic stations and precipitation totals from 211 stations (1 per 232 km^2) gathered in 30 years period were used in this study. Recharging precipitation was then verified on the runoff data from 60 river basins monitored in the same period.

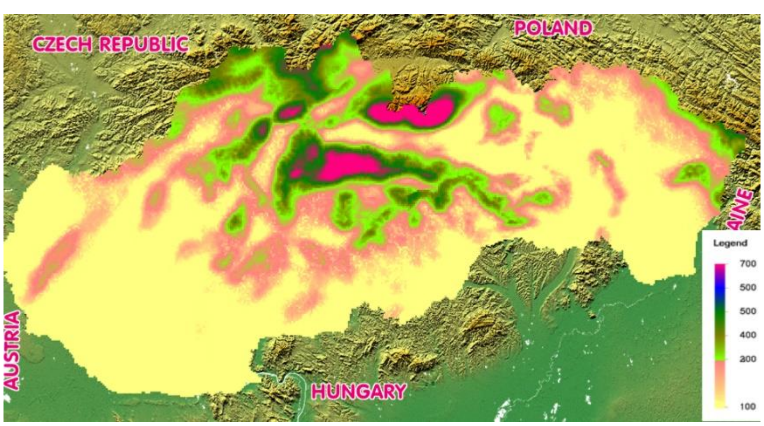

Figure 1: Distribution of mean annual effective precipitation (in mm) over Slovakia (Central Europe).

This simple, but effective and already verified model [3] then enables us to change input data – air temperature and precipitation totals, both in annual or monthly values, and to study the impact of air temperature and precipitation changes. Applied temperature raise forecast up to +5°C and precipitation decrease up to -20% did not substantially affect modelled groundwater recharge. It seems that groundwater resources can play a crucial role in climate change mitigation strategy in Central European water supply balancing.

References:

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