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An example of application of stochastic model to forecasting karst springs discharge

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The groundwater resources in karst are one of the most significant sources of drinking water supply worldwide. The importance of karst is reflected in the ability of karst massifs to accumulate a certain quantity of water and subsequently release it through karst springs. Therefore, well developed karst could amortize the effects of huge and intensive rainfalls, i.e. these regions could largely reduce the impact of floods and preserve stored water for certain period of time.

The extensive use of karst groundwater in water supply systems throughout many countries in SE Europe is due to the wide distribution of karstic areas, the abundant reserves, and its excellent quality. However, because of an unstable flow regime when only natural springflow is tapped, numerous problems arise during the recession period (summer-autumn).

A mathematical model that simulates daily discharges of karst springs in the multiannual period was developed at the Department of Hydrogeology of the Faculty of Mining & Geology, Serbia. This model contains several independent levels. Each level performs a specific function, different by their mathematical structure and period of time discretization, with the same final goal to define daily discharge over a certain period.

The model was conceived at 5 levels (modules) of different computing functions and purposes (Ristić, 2007):
•level 1. - completing the series of available mean monthly discharge by MNC model
•level 2. - determining the duration of an appropriate period for evaluation of elements of multiannual water balance of the karst aquifer - INTKR
•level 3. - water budget of the karst aquifer - BILANS
•level 4. - identifying parameters of transformation functions module - TRANSFUNK
•level 5. - simulation of daily discharges for a multi annual period - SIMIST

The model is applied on the Mlava Spring, at the northern margin of Beljanica Mt. which is the largest spring of Carpathian Arch in Eastern Serbia. The coefficient of correlation of the calculated and observed /realistic values of quantities of discharged waters from the Mlava Spring is 0.72.

Passing through 5 mentioned levels determined parameters for the period of observation 1966-2008 have been adopted as meritorious ones for the forecast period until 2100. The average multiannual value of the discharges for the last 3 decades of this century is lower by 10% than in the initial actual period. Analysis of the seasonal mean monthly values shows a strong decrease in discharges of the Mlava Spring in summer (around 40%). In contrast to the summer months, an opposite situation during the winter period is expected; an increase of about 25% of average discharge is expected.