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Recession analysis of karst spring discharge: example of the springs of rivers Cetina, Krka and Krcic

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The springs of the karst rivers Krčić, Krka and Cetina are located in the bare Dinaric karst in Croatia. The Krčić catchment is composed of Upper Triassic dolomites, Jurassic dolomites and limestone and Quaternary alluvial deposits. The river Krčić flows partly through Upper Triassic dolomites and partly through the limestone overlying the dolomites. The Krka and Cetina springs catchments are mainly formed of Jurassic limestone. The Dinaric karst is deep and well developed. It is practically without soil cover, with scarce vegetation and with numerous surface and subsurface micro and macro karst phenomena.
The Krčić springs zone is situated near the base of the Dinara mountain at altitude of 370 m a.s.l. After approximately 10 km, the river Krčić ends with a waterfall in the river Krka. The most important spring of the Krka springs zone (Main Spring) is located in the cave directly under the waterfall at altitude of 225 m a.s.l. The Krka springs zone contains also two small springs: Small Spring and Third Spring. The contribution of the two small springs in the total discharge from the Krka springs is approximately 10-20%. The total discharge is estimated by subtracting the discharge of the river Krčić from the discharge observed at the station Krka-Topolje located downstream from the Krka springs zone. The Cetina springs zone consists of four springs: Milaševo vrelo, Vukovića vrelo, Nele and Kotluša. They are located about 23 km away from the Krka springs zone. The discharge from the Cetina springs is measured daily at the station Cetina-Vinalić located downstream from the Cetina springs zone. The Cetina and Krka springs are perennial with the minimum discharges greater than 1.0 and 2.0 m3s-1, respectively, while the Krčić springs dry up every year. The average annual discharges for the Krčić, Krka and Cetina springs are 3.93, 6.54 and 10.40 m3s-1, respectively.
The time series of discharges from the Cetina, Krka and Krčić springs were subjected to the recession analysis, in order to obtain better understanding of outflow processes. A family of depletion curves is constructed for each spring by using graphical techniques introduced by Petras (1986), as well as regression analysis by segments. The envelope of depletion curves and master depletion curves are estimated. The values of depletion coefficients are calculated and their variability is investigated. The characteristics of low flow segments of the recession curve are essential for establishing the threshold values for any water resources management activities. However, this work shows that the classical recession analysis including evaluation of form and behavior of recession curves provide also additional information on functioning of complex and highly vulnerable karst system, which can be useful in preliminary studies.