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Hydraulics of Reka-Timavo system, Classical Karst (Carso), Slovenia-Italy

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In tectonically active areas, karst systems continuously adapt to the relatively rapid changes of the structural and boundary conditions. The flow pathways in such systems are characterised by high variability of channel cross-sections and breakdowns, which restrict the flow and cause high fluctuations of groundwater level, particularly if the recharge variations are high. One of the world's most prominent karst systems with such characteristics is the Kras/Carso plateau (Classical Karst), which extends between SW Slovenia and NE Italy. The ground water dynamics is mainly influenced by the allogenic input of Reka river which sinks at the Škocjanske jame (Škocjan caves) and emerges about 40 km north-west at the coast of Adria near Duino in springs of Timavo. The ratio between highest and lowest flow of Reka reaches 1700 with the maximum measured discharge 305 m3/s, and minimum 0.18 m3/s. This work is based on the long-term continuous monitoring of basic physical parameters of underground flow within six active caves of the Reka-Timavo system. Using stage, temperature and specific electric conductivity hydrographs, following questions were addressed: How do different signals (flood pulse, temperature, SEP) propagate through the system? How does the known geometry relate to the recorded hydrographs in caves? Can we infer on the structure of unknown parts of the system from the recorded hydrographs ? Where are the restrictions causing floods in different parts of the system? The data analysis includes heuristic and statistical analysis of the hydrographs and optimisation based hydraulic modelling.
The response to recharge events is vigorous; high flow variability causes extreme stage variations along the whole observed system, with more than 100 m difference between the base and highest water levels at rising and recession rates reaching almost 10 m/h. By analysing large recharge events, we show that high floods in the two most upstream caves (Škocjanske jame and Kačna jama) are controlled by the same restriction downwards from the second one (Kačna jama). We furthermore relate stage observation in Kačna jama to its known geometry and relate stage and temperature signal in the lower part of the system to storage in the mostly unknown overflow galleries between the Kačna jama and the cave that follows it (Jama 1 v Kanjaducah). Temperature and conductivity data were used to calculate transit times between different points of the system at various hydrological conditions. Finally, we parametrise the system and apply the US EPA SWMM model to simulate the response to recorded flood events. The best fit was achieved by addition of overflow channels in the lower part of the system.