Recession processes in Red Lake, Imotski

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eurokarst
VODIME
VODE IMOTSKE KRAJINE

SCAN ME

SCAN ME

STUDY AREA

Fig. 1. Red Lake

Red Lake, a cryptodepression near the town of Imotski (Croatia), is located in a karst area rich in surface and subsurface karst formations connected by a very complex underground drainage system. Consequently, the well developed karst features have an impact on the water circulation in the karst massif and the hydrological dynamics of the water. Difficult access to the lake and other karst features has led to a lack of scientific research and thus unknowns regarding groundwater movement and catchment boundaries. To this end, the application of recession analysis determined the predominant hydrologic mechanism in the lake and quantified various hydrologic phenomena using water level and precipitation data.

Fig. 2. Study area location map

MATERIALS AND METHODS

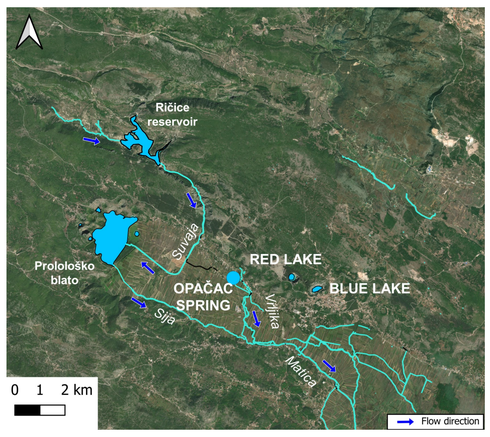


Fig. 3. Map of the study area with the locations of Red Lake, Opačac spring and other water bodies.

- Analysis include hourly data on precipitation and water levels in Red Lake as well as discharges at Opačac spring.
- The use of neural networks has been employed to correct data gaps in the records caused by operational disruptions of the measurement equipment.
- The hydrodynamics of the lake was determined by the morphometric model, the model of coherence between the water level and the corresponding volume of the lake. Consequently, integral volume changes (IVC) were defined and transformed to avoid negative values.
- Recession periods were isolated from the integral volume changes data and the composite curve - Master recession curve (MRC) was obtained using the Adapted matching strip method, Tabulation, and Petraš method. Envelope of individual recession segments (MRC) provides average characteristics of runoff components.

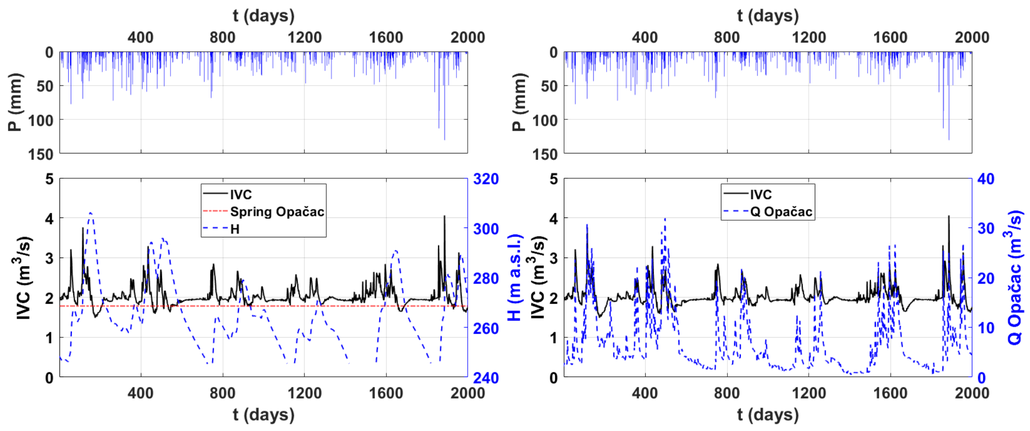
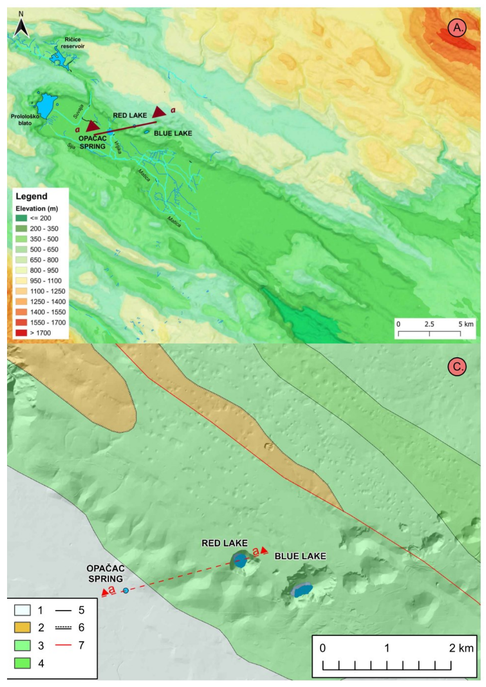
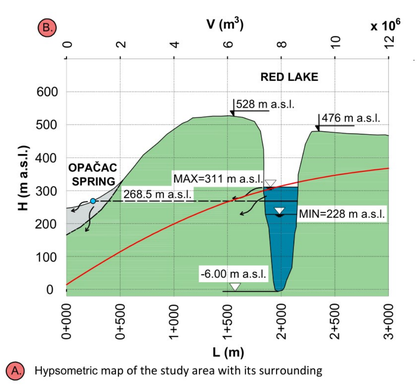


Fig. 4. Comparison of precipitation at the Imotski gauging station with Red Lake integral volume changes (IVC), related water levels (H), and Opačac Spring discharges

RESULTS





A Hypsometric map of the study area with its surrounding

B Cross-section *a-a*
Cross-section of Red Lake with the corresponding water levels of the minimum, maximum and water level of the Opačac spring; Volume curve of Red Lake as a function of water level

C Geological map
1 - Alluvium (Holocene)
2 - Liburnian beds (limestones; Paleogene)
3 - Rudist limestones (Upper Crecateous)
4 - Dolomite and breccia (Upper/Lower Crecateous)
5 - Normal border
6 - Erosional border
7 - Fault

Source: Geološka karta Republike Hrvatske, Hrvatski geološki institut, 2009.

Fig. 5. Hypsometric map (A), the cross-section *a-a* combined with the volume curve of Red Lake as a function of water level (B) and geological map of the study area (C)

- The change in the recession coefficient is also evident in the graph of water level change. A shift in the slope of the water level (H) can be seen at a water level of 268.5 m a.s.l., the height of the Opačac spring.
- The comparison of the Red Lake and Opačac spring showed that the peak values and the recession periods coincide. Due to the extremely rapid runoff at higher water levels, this phenomenon might be explained by the existence of a karst conduit connecting Red Lake and Opačac Spring.
- The ACF showed that Opačac's hydrogeologic system is much more inert than Red Lake's, and the CCF showed that Opačac responds quickly to precipitation, unlike Red Lake, whose system is fed less by precipitation than by groundwater. The periodicity observed with SDF corresponds to one hydrological year.

- Recession curves describing fluctuations in water volume are called quasi-recession curves, while coefficients describing depletion of water supplies are called quasi-recession coefficients.
- The average quasi-recession coefficients obtained with Maillet's exponential function are α_1=0.1103 and α_2=0.082. Fast leakage from karst channels and fissures is denoted by α_1, while slow leakage from subsurface reserves is denoted by α_2.

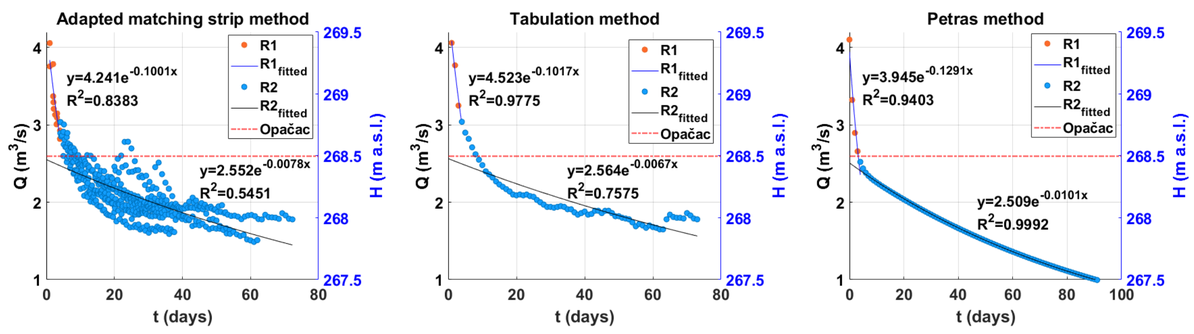


Fig. 6. Results of recession analysis using Adapted matching strip method, Tabulation and Petraš method

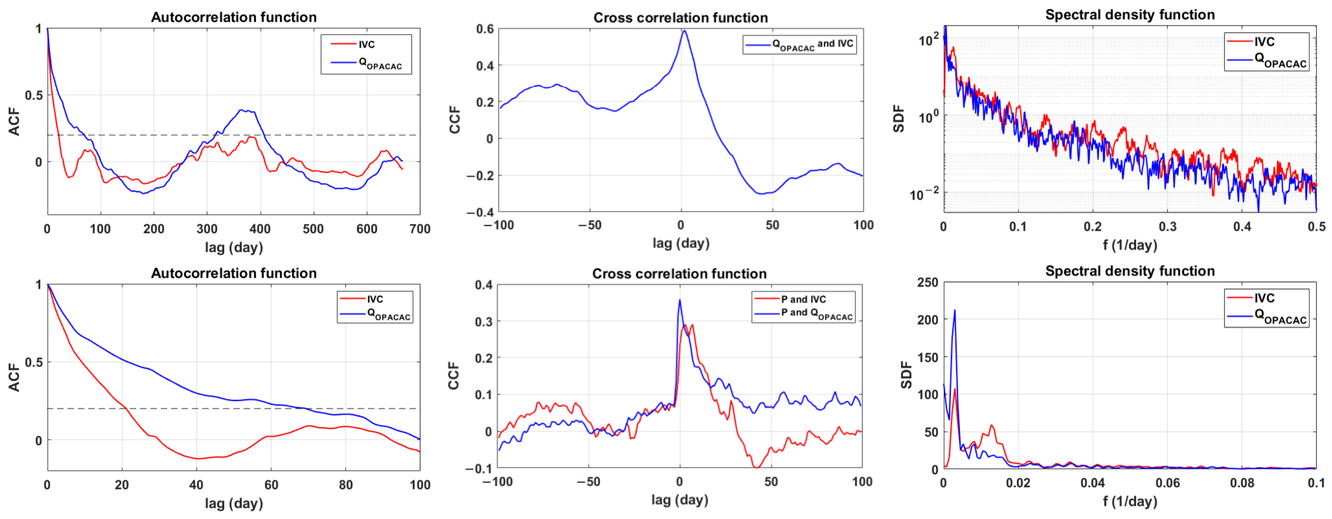


Fig. 7. Autocorrelograms of integral volume changes (IVC) and discharges at Opačac; Cross correlation functions of the same data and their combination with precipitation; SDF of integral volume changes in Red Lake and discharges at Opačac

CONCLUSION

- By isolating quasi-recession curves, different flow regimes were detected. The dominance of base flow indicates an important role of groundwater in the hydrological function of the lake.
- Short-term precipitation has no significant effect on the hydrodynamics of the lake, suggesting that regional flow in the Dinaric Karst dominates water level fluctuations.
- The Opačac spring locally influences the hydrodynamics of Red Lake, indicating the existence of a probable water conduit between them.
- Cryptodepressions in karst and their hydrodynamics disclose essential hydrogeological properties on a field and regional scale.

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