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Changes in hydrological behaviour: case studies of the Unica and Rižana karst springs, Slovenia

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Environmental changes, such as alterations in precipitation and evapotranspiration regimes, changes in vegetation type, etc. are triggering direct impact on hydrological cycle through modified amounts and patterns of recharge conditions, as well as occurrence of more frequent and severe hydrometeorological events. Karst aquifers are particularly vulnerable to these effects due to highly dynamic hydrological processes. In this study, we were interested in studying the possibilities to observe changed hydrological behaviour of karst springs on a human timescale. Therefore, we focused on two examples in Slovenia, both regionally important for freshwater supply, agriculture and hydropower. The Unica spring mostly drains areas under moderate continental climate. Its catchment has been repeatedly and severely hit by natural disasters (e.g., ice break, bark beetle attack, windthrow) after 2014 causing large-scale forest disturbances. The catchment of Rižana spring, on the other hand, belongs to the moderate Submediterranean climate. There these types of disturbance did not occur in recent years (excluding some wildfires), but the catchment has been liable to substantial land use changes in the past six decades. For assessment of vegetation cover changes and large-scale disturbances in forests, historical digital orthophotos of the Surveying and Mapping Authority of the Republic of Slovenia since 1957 have been compared with the recent land use data provided by Ministry of Agriculture, Economy and Food and forest state database of Slovenian Forest Service. At the same time, hydrological data of the Unica (Hasberg gauging station) in the period 1962-2018 and Rižana springs (Kubed gauging station) in the period 1966-2018 and precipitation data from Postojna (period 1962-2018) and Podgrad (period 1966-2018) meteorological stations have been processed. Individual flood pulse events over the 57 years for Unica and 53 years for Rižana have been separated. For each flood pulse various information about precipitation amount and intensity, duration of discharge increase, its intensity and amplitude have been specified. We compared these findings with the calculated trends of meteorological and hydrological variables and also changes in land use. The impact of particular environmental change on discharge values of both springs has been evaluated, showing that both, climate and land-use changes, have considerable impact on hydrological regime of studied karst springs. In particular, altered duration of flood pulses increase, their amplitude and intensity have been observed, meaning that the most important issues of water availability that are crucial for water-dependant economic sectors are under threat.