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Water management in the Mucille area (NE Italy) through hydrologic balance estimation

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After abundant rainfalls, the Mucille area (Ronchi dei Legionari, Northeastern Italy) is subject to frequent flooding. Although this area has always been exposed to such hazard, these inundations become problematic since 2001 as they more frequently affect housing and recreational areas, leading the population to believe that the swallow holes draining the area stopped functioning. The increased frequency of intense rainfall events led the municipal technicians to involve the Department of Mathematics and Geosciences of the University of Trieste to assess the situation. The Mucille karstic depression is fed by a spring area and drained by two swallow holes one of which is permanently active while the other operates only during floods. The Mucille springs represent the westernmost drain of the Classical Karst aquifer. During floods, as in-situ discharge measurements are impossible, only a hydrologic balance model may assess the inflow or outflow discharges. The extension of the flooded areas has been mapped. The obtained flooded surface together with high resolution DEM coverage allows to calculate the volume of surface water. Combined with water table levels recorded in an adjacent piezometer, this volume can be computed over time. Thus, the hydrologic balance (inflow minus outflow) can be estimated. This model has been applied to several flood events among which, two were the most important in terms of flooded areas: one in December 2017 and the other in November 2019. During the event of December 2017, the water level reached 7,5 m a.s.l. and the difference between the inflow and the outflow was 880 l/s. The day following the peak, the discharge difference decreased to 273 l/sand the 5 subsequent days the water balance was close to equilibrium. From the eighth day on, the outflow became predominant resulting in a negative budget between -233 and -78 l/s. The flood event of November 2019 reached the maximum inundated area at a water level of 7,8 m a.s.l. with a difference between the inflow and the outflow of 750 l/s . Two days after the peak a negative balance of -200 l/s was recorded and remained negative for the next 5 days. A period of intermittent precipitations increased again the inflow up to 600 l/s. Following a period of ten days with a negative balance the water level returned to the initial values of 5 m a.s.l. This study provides evidences fundamental for the design of measures to mitigate the risk. It estimates the discharge of the swallow holes, confirming their efficiency. Nonetheless it also emphasises the need to improve their draining capacity, especially considering the unsuspected high outflow of the springs at the onset of the flood.