Numerical analysis of the post-seismic effects on groundwater flow after the Amatrice-Visso-Norcia 2016 seismic sequence.

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The hydrogeological setting of the Sibillini Mts. is mainly characterized by the coexistence of a shallow and a basal regional aquifer (Viaroli *et al*., 2021) whose spatial distribution, recharge area and groundwater dynamics are strongly controlled by a complex regional tectonic framework.
The 2016 seismic sequence that struck Central Italy altered the hydrodynamic response of the carbonate fractured aquifer, causing sustained variations in the groundwater flow. In particular, after the M_w 6.5, 30 October main shock (called Norcia earthquake), caused by the dislocation of the Vettore Mt. normal fault, a surplus of groundwater discharge was observed at the springs bordering the western side of the Sibillini Mts. and in the Nera River basin. Furthermore, the Torbidone spring in the Norcia plain, exhausted since 1979, reappeared after the seismic event. The observed post-seismic groundwater surplus was attributed to a variation of the hydraulic gradient and an increase in bulk permeability probably caused by the fracture cleaning effect, which caused a shift of the groundwater divide after the fault rupture (Mastrorillo *et al.*, 2020). Such phenomenon induced an eastward shift of the piezometric divide so that the springs located on the eastern side of the Sibillini Mts. strongly reduced their flow, thus causing several problems in the groundwater supply system.

In this work, we aim at assessing the effect of the coseismic dislocation of the Vettore fault on the crustal stress and strain field, the consequent modification of the hydraulic properties of the shallow and basal regional aquifers of the Sibillini Mts. and the related groundwater flow variations. For this purpose, we collected geological and hydrogeological data from the available literature and used them to analyse the area affected by the 30 October earthquake with 2D and 3D numerical models. We first created a simplified 2D geometric model at surface scale (up to 2 km deep), including the spatial relationship between the main tectonic elements and the boundaries of the main hydrogeological complexes, to model the groundwater flow before and after the seismic event. Then a regional-scale 3D model is developed, whose hydraulic parameters are calibrated as a function of the stress and strain changes caused by Vettore fault rupture to obtain two different hydrological scenarios: pre- and post-faulting.

Mastrorillo L., Saroli M., Viaroli S., Banzato F., Valigi D. & Petitta M. 2020. Sustained post-seismic effects on groundwater flow in fractured carbonate aquifers in Central Italy. Hydrological Processes, 34(5), 1167–1181.

Viaroli S., Mirabella F., Mastrorillo L., Angelini S. & Valigi D. 2021. Fractured carbonate aquifers of Sibillini Mts. (Central Italy). Journal of Maps, 17:2, 140-149.