



## **Resource vulnerability mapping in carbonate aquifers by COP method. Application to Alta Cadena site, Southern Spain**

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Carbonate terrains cover 35% of land-surface in Europe, and in some countries karst groundwater contributes up to 50% to the total drinking water supply; in many regions it is the only available fresh water resource. Karst aquifers are particularly sensitive to contamination due to their characteristics such as concentrate recharge via swallow holes, rapid flow and short transit times, scarce protection cover and normally high karst network development. Consequently, contaminants may easily reach the groundwater and be rapidly transported in karst conduits over large distances. Vulnerability mapping is commonly used for land use management over aquifers and groundwater protection zones in the catchments area of springs and well. Several methodologies for karst groundwater vulnerability mapping has been proposed, such as EPIK, PI and COP. The COP method was developed in the frame of European COST Action 620 taking into account specific properties of karst aquifers. The method considers the characteristics of Overlying layers above the water table (O factor), the Concentration of flow through swallow holes (C factor) and/or karstic landforms development and Precipitation (P factor), both quantity and intensity, over the aquifer. The method has been successfully applied to carbonate aquifers in several countries (Spain, Slovenia, Germany, Ethiopia). In present case the method has been applied to Alta Cadena pilot site, which shows climatic, geological and hydrogeological characteristics representative of Mediterranean carbonate aquifers moderately karstified. The Alta Cadena aquifer extends over 70 km<sup>2</sup> and its topography is abrupt like of most carbonate

aquifers in southern Spain. This aquifer is formed by Jurassic limestone and dolomites and is mainly drained by springs located on the northern edge of aquifer. In Alta Cadena, the average resources come exclusively from rainfall infiltration onto the surface of the aquifer and they are used for water supply to population around. The aquifer results moderate to highly vulnerable to the contamination, according to COP method, in the areas where bare Jurassic limestones outcrop and karst features exist. In the catchment area of a swallow hole the vulnerability is of Very High degree. However, Low vulnerability exists over the marly rocks. The distribution of vulnerability degrees is relatively congruent with the hydrogeological knowledge of the study area.