



Characterization of a small-scale drainage basin in Central Portugal – a multidisciplinary approach

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This study presents a multidisciplinary characterization of a small-scale watershed encompassing its topography, geology, local and regional tectonics, morphometry of the drainage system, soil type, land use and climatology. All these parameters are important controllers of the groundwater circulation and storage, as well as the localization of the recharge areas.

It also identifies the piezometric changes, the upper (or phreatic) aquifer flow and the major recharge areas. Simultaneously, it includes the hydrochemical classification and the active hydrogeochemical processes occurring on the local aquifers.

The combined analysis of these data is necessary for interpreting the hydrodynamics of the local aquifer units.

The research focused on the surrounding domains of Olhos da Ferveça spring, particularly in the Ferveça watershed, a small-scale drainage basin close to Cantanhede city (Coimbra District, Portugal). This watershed is located on a rural area within the Vouga hydrographic basin.

The methodology included: (1) delimitation of the watershed; (2) geometric (or physiographic) characterization of the basin; (3) analysis of the digital elevation model to quantify the slopes and to detect structural alignments that influence the surface and groundwater flow; (4) geologic characterization of the basin; (5) description of the soil type and the land use; (6) classification of the regional climatic conditions; (7) inventory and regular hydrogeologic characterization of wells (diameter, depth, wellhead and piezometry); (8) elaboration of piezometric maps in order to identify the groundwater flow; (9) groundwater sampling and in situ measurement of physico-chemical parameters (pH, groundwater temperature, specific electrical conductivity, Eh, dissolved oxygen, HCO_3); (10) conducting laboratorial hydrochemical analyzes (Cl, NO_3 , SO_4 , PO_4 , Ca, Na, Mg, K, Fe, Mn, Al); (11) groundwater classification, hydrochemical interpretation and identification of the water-rock interactions; (12) data integration in order to define the groundwater circulation, storage and recharge areas within the Ferveça watershed.

The drainage basin has an area of about 61.2 km², a perimeter of 43.5 km and the ellipsoidal height ranges from 68 m to 198 m. The total length of streams equals 105.9 km and they are characterized by a dendritic drainage pattern. The main watercourse has an extension of about 15.7 km, it has a perennial regime and it exhibits a SE-NW orientation.

The sedimentary formations are dominant in the studied watershed, being the Quaternary deposits the most representative. The Jurassic units are located especially in the eastern side, small outcrops of Cretaceous units are scattered in the area and some Pliocene sandstones are also present.

The piezometric map expresses that the prevailing groundwater flow is similar to the surface drainage and there is a convergence of groundwater flow into the area of Olhos da Ferveça spring. In the western side of the watershed the groundwater flows from S to N and in the eastern side of the watershed it is from ESE to WNW.

Piper's triangular diagram classifies the waters as bicarbonate calcium (associated with carbonated formations) and as sulphate and/or calcium chloride (dominant in Cretaceous or Quaternary formations).