

## THE MANAGEMENT OF WATER RESOURCES BETWEEN TRADITIONS AND SUSTAINABILITY: THE QANATS OF SHAHROOD PROVINCE (NORTH-EASTERN IRAN)

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Many towns and villages in Iran are nowadays supplied by qanats, a hydraulic and mining technology dating back thousands of years, probably native of Middle East area and widespread in Asia and North Africa. As part of a scientific cooperation agreement between the University of L’Aquila, the Institute of Chemical Methodologies of the Italian Research Council (IMC-CNR) and the Shahrood University of Technology, some qanats of the Province of Shahrood were selected and studied according to the intended use of their waters.

This multidisciplinary study involved: the qanat of the town of Shahrood (150,000 inhabitants), whose water resources cover about a third of the water demand; the qanat of Beyarjomand, used to meet the agricultural water needs of the area; the qanat of Torud, which is the traditional water resource for agricultural and sanitary purposes of this village (1000 inhabitants) located within the Kavir Desert.

Surveys of qanat branches were carried out, identifying the areas and points (mother wells) of recharge. Discharge flow measurements were performed at hydraulic work outlets to evaluate water availability. Physical-chemical parameters data of the collected waters (e.g. temperature, electrical conductivity and pH) have been acquired. In order to complete, as far as possible, the information framework of the three studied areas, three weather stations were installed (recording temperature, relative humidity and rainfall data). Moreover, the presence of radon in qanat waters and inside the maintenance wells has been evaluated. Interviews with technical and maintenance personnel of the qanats were conducted to better understand management processes and their issues. Contextually, investigations were conducted on the historical artifacts related to the studied hydraulic works (such as mills and checkpoints located along the track of the qanats).

The acquired information was georeferenced to implement the 3D reconstructions of the water systems in GIS environments and to facilitate the definition of preliminary hydrogeological conceptual models. Measured water availability of the studied qanats ranges between several tens and hundreds of liters per second. The collected interviews indicate a gradual decrease of such flow rates over time due to climatic and anthropic causes. Water

temperatures of qanats are quite variable, but can reach 20-25 °C. Water electrical conductivity varies between 450 and 5800 uS/cm. The assessed values can be related to the locations of the sites ranging from the southern foothills of the Alborz Range (Shahrood) and the northern part of the desert (Torud). Radon concentrations in water are very low.

Despite the increasingly widespread recourse to drilled wells to tap groundwater, qanats are still important and valuable resources for water supply in areas located near deserts. Wells withdrawals are depressing groundwater level, decreasing (or, at worst, preventing) the sub-horizontal gravity drainage of these traditional water works. The observed water availabilities of the qanats and their temperatures suggest the implementation of low enthalpy projects (heating and/or greenhouses). This would allow a more rational use of qanat water and a better exploitation, especially in winter, when water demand is lower and traditional agricultural activities stop.

