Criteria for the realization of a quantitative monitoring network and testing

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ABSTRACT - In groundwater resources' field, the Italian National Geological Survey (APAT) has promoted activities in order to define the groundwater bodies'characteristics and to realize an experimental monitoring network in a sample alluvial plain area of relevant interest: the Low Friuli Plain in Udine district (BPF). In the BPF subsoil, considerable groundwater resources are allocated, whose role is strategic referring both to the drinking use and to the maintenance and development of industrial and agricultural activities. The large amount of exploiting wells (over 30.000) is due to traditions being an integral part of a keen popular culture; in some countries, they are the only source of water supply. Notwithstanding this, such area is completely unprovided with active control networks. The BPF, about 738 km2 wide, extends from the spring zone to N, to the Adriatic coastline to S, being delimited by the Tagliamento River to the W and the Torre-Natisone-Isonzo hydrographic system to the E. As a result of the Upper Pleistocene depositional processes, strictly connected with the climatic events of Quaternary glaciations, the sector is formed by an alternance of pervious sand and gravel lenticular bodies, intercalated with impervious, wide and continuous silty-clay layers. The knowledge of the deep structure of the area prevailingly follows from the geophysical and stratigraphical data of hydrocarbon surveys; the structure of the superimposed alluvial body is pointed out by means of the lithostratigraphical data coming from water wells. In order to define the dynamic characteristics of BPF's groundwater, a purposely arranged quantitative monitoring network referring to single aquifer units has been planned. The survey has been developed according to the geological and hydrogeological characteristics of the sector, to the amount and kind of available data and to various territorial constraints.

In a first stage, the analysis and critical review of both new and already available data, together with the finding of further information during specific *in situ* controls, has allowed to realize a reference knowledge basis. The collected data have been organized in a computer-aided database, supporting all the cartographic elaborations that can be brought up-to-date by a GIS (MapInfo). Successively, the general methodological aspects associated to the monitoring networks' realization have been closely examined. First basing on geometrical and hydrogeological criteria, the network sites' choice has been managed. A set of 83 wells endowed with suitable characteristics for the purpose of the research (possibility of fairly using the measure instruments for both unconfined and confined aquifers; accessibility; well-known depth; exploitation of a sole aquifer; refusing of wells involved in production cycles) has been preliminarily singled out from a sample of 526 wells. Groundwater levels and natural discharges have been measured in a first series of field investigations (January-February 2003); the collected data have allowed to map out a flow field for each aquifer unit, using kriging as geostatistical interpolation method. In a further stage, since the spatial distribution of the 83 wells was not homogeneous and some aquifer levels were not concerned, the integration and stabilization of the measure sites have been managed; in particular, control points have been thickened correspondingly with recharge areas (spring zone), in compatibility with the disposal of suitable wells. The monitoring network has been refined during the field investigations by means of an increase of the measure sites equal to 62%; the procedure has led to the choice of 134 wells provided with geological references and reaching all the recognised aquifers. The measure of groundwater levels and the observation of natural groundwater discharge have been repeated under a different storage condition (September-October 2003) involving the whole identified water-wells. A second set of piezometric maps, compared with the ones firstly drawn, has allowed both to achieve a satisfactory accuracy in the hydrogeological model, and to single out the evolution trends in space and time of the groundwater resources.

KEY WORDS: Friuli, alluvial plain, monitoring network, confined aquifer system, hydraulic head, kriging.