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Hydrogeological model of the central-eastern sector of Sicily

A. Pisciotta (1), F. Nigro (1), Favara (1), P. Renda (2)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, via U. La Malfa n. 153, 90146, Palermo, Italy

(2) Dipartimento di Geologia e Geodesia dell'Università, C.so Tukory n. 131, 90134, Palermo, Italy

(pisciotta@pa.ingv.it / fax: + 390916809449)

Abstract

The expansion of irrigation activities, industrialization, urbanization are changing the natural dynamic of groundwater resources.

The largest available source of fresh water lying below the ground it has become crucial not only for object of groundwater potential zones, but also monitoring and conserving this important resource.

To preserve from the deterioration of the aquifer system in this area, an efficient integrated and sustainable management tool for groundwater resources is needed.

The aim of this research was to develop an efficient GIS system with a complete database that represents the characteristics of the aquifer system and modelling tools to achieve the impacts of decision alternatives.

The GIS application and visualization technology significantly contributes to the efficiency and success of developing ground-water models

We analyzed a sector of the Central Sicily, where the Upper Neogene-Quaternary sediments form the youngest successions within a region known as the Caltanissetta basin, a broad area of syn-tectonic deposition developed above and adjacent to evolving thrust and folds of the so called Gela Nappe. In particular, in the analysed region, widely outcrops Pleistocene carbonate sands body overlying U. Pliocene clays.

A set of geophysical data (about 250 Vertical Electrical Soundings) allow to contoured the bottom of the Pleistocene sand body. The high resistivity contrast among the two layers has allowed to reconstruct the geometry of their separation surface.

To construct the 3D geology, drillhole cross-sections were constructed also using ArcGIS 9.0, and custom extensions.

These tools can help to formulate the conceptual model by quickly revealing the basin wide geohydrologic characteristics and changes of a ground-water flow system, and by identifying the most influential components of system dynamics.

Moreover the GIS functions allow the overlaying and cross-correlating of the different thematic maps (hydrological, geological, geophysical, and geochemical maps) to quickly identify the major geohydrologic characteristics controlling the natural variation of hydraulic head in space, such as faults, basin-bottom altitude, and aquifer stratigraphies, and also to identify the temporal changes induced by human activities, such as pumping.

The GIS representation of the groundwater systems is utilized to develop interfaces between the ArcGIS environment and groundwater models (e.g. MODFLOW).

The vulnerability Map of the aquifers is an indispensable tool for the effective management of water resources and to support environmental protection planning policies.

One of the most used Vulnerability parametric mapping methods is “SINTACS R5” (Civita and De Maio, 2000), which is a point count system model for the assessment of groundwater pollution hazards.

This method values the Mediterranean conditions in a better way respect the well-known DRASTIC model. The model takes into account seven environmental parameters: depth to

groundwater (S), recharge action (I), attenuation potential of the vadose zone (N), attenuation potential of the soil (T), hydrogeologic characteristics of the aquifer (A), hydraulic conductivity (C) and topographic slope (S).

The spatial knowledge of all these factors and their mutual relationships is needed in order to properly model aquifer vulnerability using this model.

The data necessary for vulnerability assessment was collected and exported to a Geographic Information System, it was also used to express each of SINTACS parameters as a spatial thematic layer with a specific weight and score. The final SINTACS thematic layer (intrinsic vulnerability index) was produced by taking the summation of each score parameter multiplied by its specific weight and the layout of the potential

pollution centres.