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Decision support tools for sustainable groundwater management

title: **Hydrogeological database, a decision support tool**

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INTRODUCTION

An Hydrological Data Base (HDB) allows to introduce, to store, to order, to manipulate and to manage important volume of diverse information. For this reason a good initial design determines its utilization and validity in the future. It is necessary to know the use that wants to give at HDB, information that is needed for working, necessary fields and the design — relation between different tables. The incorporation of HDB in a Geographic Information System (GIS) environment allows to store information as a collection of thematic layers.

FCIHS HDB is organized in a mother table which contains basic information in order that a point can be geoindexed (Figure 1). Hydrogeological, geological, chemical, etc. data are in different tables with a particular relation between them.

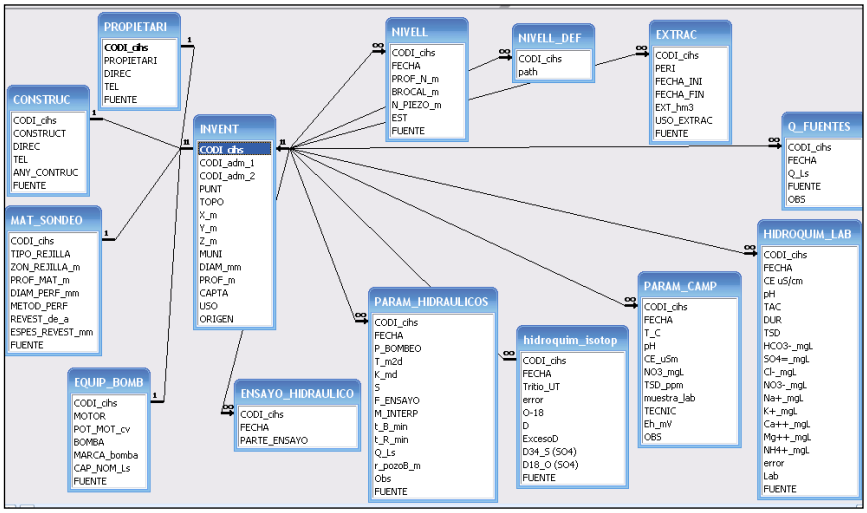

Figure 1. Relations between mother table and hidrogeological tables.

A methodology to validated information entry has been created during implementation and application phases of FCIHS HDB. These methodology of entry information is realized from a set of dichotomy keys. FCIHS HDB have been validated 20–25% of the existing information in the documentary corpus. These numbers represent 55000 hydrological information, corresponding to 6000 water points. FCIHS has elaborated graphical documents to visualize information about a point: its location, piezometric data, chemical record, tests of pumping – recovery, hydraulic parameters, etc.

In the FCIHS it is being used the potential of the BDH in multiple hydrogeological works. One of these are focused to prevent barrier effect of linear infrastructures (tunnels, long parking, etc.) in aquifers.

Barrier effect takes place when a construction work intercepts the lines of flow of one aquifer. The magnitude of its effect relates to the length of orientation and intersection of the lines of flow with regard to construction work. When both lines are orthogonal major variation of level is generated. A simple barrier can generate a relative ascent or decrease of the groundwater level. In both cases, it is very important to determinate and control the modification of the original flow that can generate a change of the quality of underground water.

METODOLOGY

Current condition of exploitation of the aquifer (without considering the consequences of its management under extreme droughts or avenues situations) and only with pre-existing infrastructures is the start point of this methodology. Two determining are defined: general and specific.

General determining is directly generated by the conditions of regional aquifer flow. It is based on the maintenance of the not saturated thickness of the aquifer and the current condition of hydraulic gradient. Humidity map, dryness map and average map are constructed to represent a three piezometric maps of climatic conditions of the aquifer. This climatic factor can express from the evolution of the piezometry historical levels of the zone. By obtained results, area is divided in different zones depending on the value of not saturated thickness zones. In aquifers with piezometers with historical record or with high degree of information, the threshold value will be obtained with the relation between the average value of not saturated zone and the piezometric oscillation (maxim and minim). Aquifers with low quantity of information, will consider that barrier valour will be a maximum threshold that corresponds of 25% effect of the aquifer not saturated local thickness zone.

Specific determining is associated with the presence or absence of urban zones, of humid zones, of landfills with residues, of wells and in the habit of concerning a sector of the study area. In case in which it is not present, general determining will only apply.

Tracing of underground infrastructures under urban zones can flood preexisting spaces that do not have efficient waterproofing. The methodology will be considered to be a threshold of alert the possibility of changing, for effect barrier, a minimum thickness of 3 m measured from the surface of the area. Depending on the value of general determining in the concrete water point it will be alerted.

In the humid zones there is designated a void variation of level in the limit of the humid zone or in the protective area of them.

Landfills with residues represent a risk of pollution if these intercept the local piezometric level. Generally, there is not known the vertical penetration of the same aquifer and only there is a suspect of the location of the landfills. For this reason in that methodology the criteria prevention is the generation protection zone (buffer) of 500 meters from the landfills area.

Wells represent a service of water capture that can be disturbed by the construction work. There is defined a protection radius of 100 meters from the water point.

APPLICATION IN A RIVERDELTA AQUIFER

A practical case took place in the superficial aquifer of Low Valley and Delta of the Llobregat river. Combination of piezometric map and topographic map allows to obtain the layers of thickness not saturated (Figure 1). Piezometry has been obtained of Model of Accumulation Impacts and from the control points of Catalan Water Agency (ACA) in the zone, considering three climatic conditions (humidity, dryness and averages). In this particular case we propose four general zones depending on the not saturated thickness for every climatic frame: zone A of not saturated thickness lower than 1 meters, zone B of not saturated thickness lower than 3 meters, zone C of not saturated thickness lower than 5 meters and zone D of not saturated thickness higher than 5 meters.

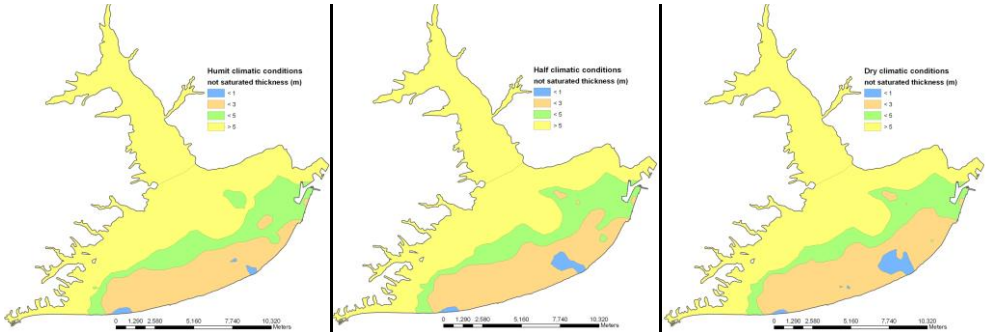

Figure 1. Layers of zoning not saturated thickness in dry, humid and averages climatic conditions.

Specific determining, combines the respective layers of information associated with the proximity to urban zones, to landfills with residues, to humid zones, and to wells.

The layer of urban zones includes different polygons associated with urban and industrial zones (Figure 2a). For this case, in urban areas where not saturated zone already is lower than 3 m, it would not be possible to allow additional ascents provoked by the barrier effect. If a zone has not saturated top thickness, there will be applied a level security of 25% of the difference between the not saturated local level and 3 m previously mentioned.

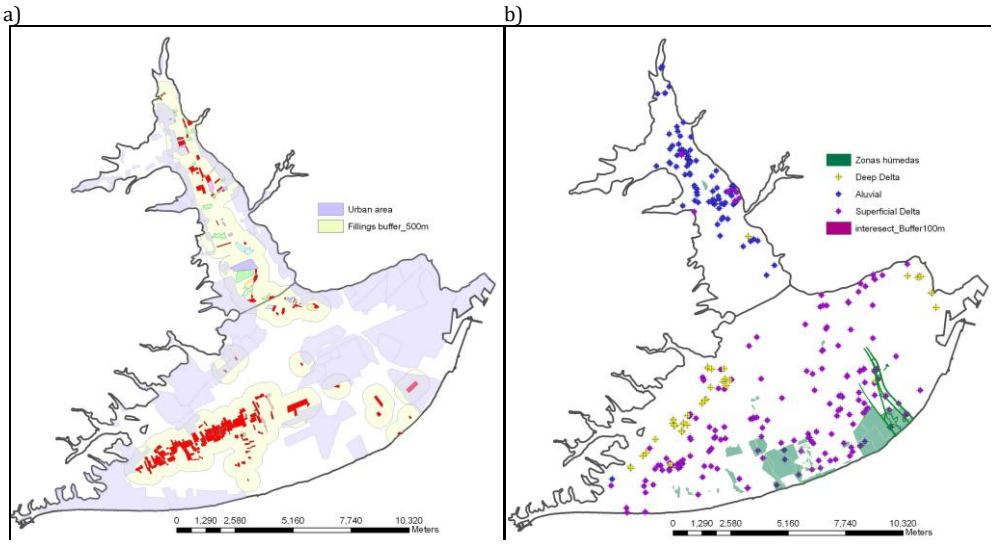

Figure 2. a) Layer of area of influence (500m) of fillings and distribution of urban area; b) Layer of wells and distribution of superficial waters and humid zones.

The layer of extractive activity landfills presents by different polygons associated with different information. From this layer there has been created a buffer of 500 m that corresponds to the area where influence of landfill is considered (Figure 2a).

Wells layer gathers the points inside the study area (Figure 2b). From this layer is created a crown of influence of 100 m that corresponds to a protective area of the wells.

In the layer of humid zones of the study area there are two humid zones: humid areas and reservations. there is defined the absence of variation of the level inside the bounding perimeter of humid zone as it is a humid area as it is a reservation area (Figure 2b).

General determining plus specific determining allows to impose the thresholds of the barrier effect depending on the value of not saturated thickness. With the creation of this new layer and overlapping the infrastructure is determined, the maximum admissible threshold from the zoning of the treated infrastructure (Figure 4).

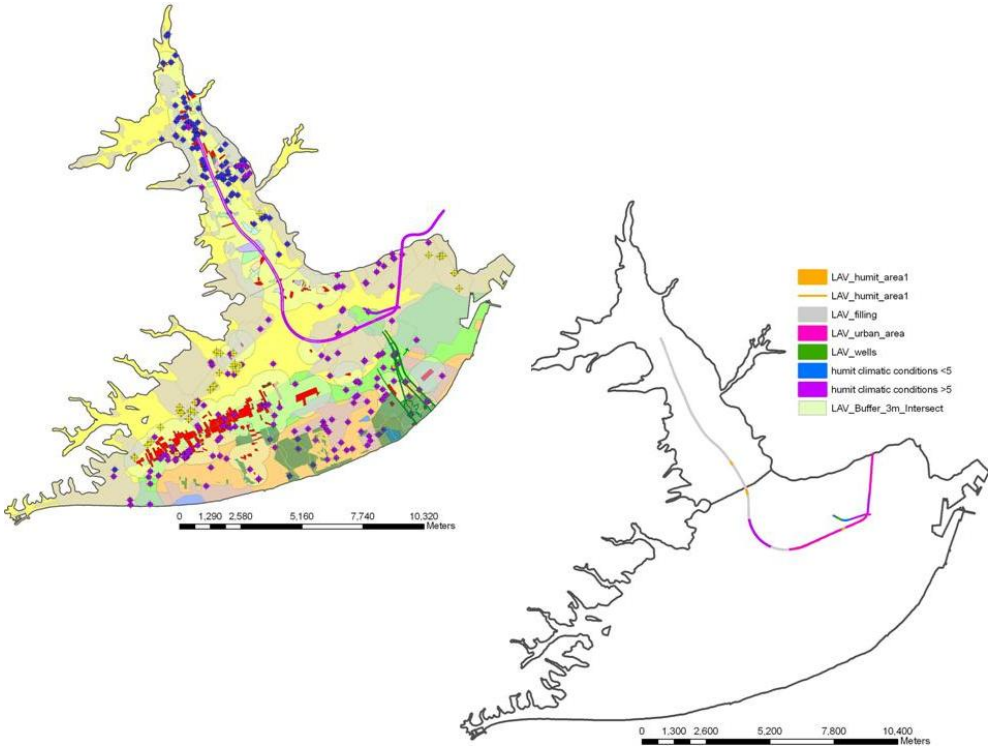

Figure 4. Integration of all layers, general and specific determining, in study area. See the tracing of the LAV divided into zones depending on the intersection with the different determining.

CONCLUSIONS

HDB is a tool to arrange hydrogeological information of a geoindexed form. It is an important management tool because:

(1) it allows to combine punctual and cartographic information in different formats,

(2) obtain different models of visualization and analysis hydrogeological information.

Precision of the results will depend on the degree of knowledge and accuracy of the different kind of data that form a part of the layers of information.

Methodology for determination admissible threshold of barrier effect tries to be a tool of great application and simple use in hydrogeological infrastructures projects.

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