CREGIS-Q: a GIS tool to support decision making in case of aquifer contamination emergency

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INTRODUCTION
The GIS capability to store, query and analyze data is a known important resource in environmental framework and can be very useful in risk analysis. The present work focuses on hazardous liquid transport, which is an issue well suited to being analyzed in a GIS environment (Lovel et al. 1997). When an emergency occurs, as an accidental spill, due to example to the overturning of a tank lorry, a bottleneck is often due not only to the scarce information available, but also to the ability to retrieve it and manage optimally to obtain quick responses, hence support decision making.

A customized GIS tool (CREGIS-Q) has been developed to automate data processing and analysis operations (De Smith et al. 2007) in order to obtain firstly an immediate answer to alert the authorities for which they could be affected by the accidental event and, secondly, to support further analysis. The latter task is performed by loading the informative layers available for the site (hydrogeology, map of water abstraction points, etc.) and selecting from larger databases previously implemented, and providing the relevant information to be used in further analysis such as transport modeling.

The tool has been conceived as a part of a “Best Practices” protocol on the management of groundwater contamination in case of accidental events, as required by the National Civil Protection Department. The tool is aimed at both national and local authorities in order to improve response capabilities in emergency situations.

WHAT CREGIS-Q DOES (emergency phase)

In the first step the user places the event on the map by its coordinates and then fills a form with the main information regarding to the event (name, description, date, operator, location, contaminant, notes, etc.). Other relevant information (e.g. administrative data, lithology and hydrogeological complex in which the event falls) is obtained automatically by means of the GIS overlay techniques (spatial queries) and stored in database. The information provided is of course dependent on the available layers for that site.

The second step is a proximity analysis aimed to narrow the area that could be potentially interested by contamination. The analysis is done considering a “buffer” area around the event, whose radius increases with the permeability of the hydrogeological complex (Pried et al., 1983) in which the event falls (generally 1-3 km, up to 15 km for karstified limestones).

In the third step the drinking water resources that fall within the buffer area are individuated and possibly the water managers are warned for an eventual interruption of the water supply.

Analysis

The last step facilitates the characterization of the event based on the available layers. In particular the parameters to be used in transport models should be gained in this phase. For this reason the available databases (target archiviers) storing various types of data at local and national scale collected from different sources in different time and with different scale and extent should be already linked to the GIS tool. The “target archiviers” have the purpose of storing maps in such a way that it is immediately usable in case of emergency. For each event, the thematic raster and vector layers that insist on the event area are automatically loaded into a specific GIS project. This operation is based on a comparison of extents between each layers available to be loaded in the GIS and the event area defined by the extent of the buffer polygon: if this intersection is not null, the layer is loaded, otherwise not.

In conclusion, risk and decision analysis are often faced with problems having spatial characteristics. As a part of a best possible support for the decision makers, a decision support tool has been implemented in a GIS environment. In the emergency management of groundwater pollution events, the aim of this tool is to facilitate the pre-event phase and support the commission of the available means to prevent or contain the event.

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References

Figure 1. Proximity analysis between drinking water abstraction points and road/rail

Figure 2. CREGIS-Q scheme

Figure 3. Phases of the procedure: preparedness, emergency, post emergency

Analysis of the existing maps to be taken as a reference
Collecting maps (vector and raster), georeferencing and archiving properly (to be retrieved by CREGIS-Q in emergency)
Database design, management and updating

Analysis of the available data and cartography (loaded by CREGIS-Q) for the area involved in the further analysis

Analysis

Preparedness

Emergency

Post emergency