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IMPLEMENTATION OF A SUBSIDENCE RISK MANAGEMENT SYSTEM

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ABSTRACT

The RISKMASS project has allowed defining and evaluating a method to calculate the hazard soil movements (mass movements or subsidence phenomena) on urban areas. This methodology is based on the implementation of an IT system using a Geographic Information System to help on risk management, integrating both whole colleted data and analytical tools.

INTRODUCTION

This paper has the aim to present the GIS application developed inside the RISCMASS Project "Méthodologies pour la gestion des Risques d'Éboulement et des Mouvements du sol avec Scénarios de Politique d'Assurance", financed by the INTERREG III B –2003 MEDOCC program (http://www.riscmass.eu). This project has the objective to determine hazard terrain movements and develop risk management methodologies to support insurance policies. During the project subsidence phenomena has been studied and measured in the Potassic Salt Basin (Conca Potàssica Catalana) in which there are mining activities (see rectangle in Figure 1). One of the areas of most interest in the study region is the *Estació* quarter of Sallent town which is affected by subsidence phenomena related with and old mine. During the 90s heavy damages appeared in building structures. As a response the Catalan Administration started an investigation program to identify, quantify and model the phenomena subsidence in this area (ICC, 2003). In this project an exhaustive satellite image analysis has been carried out, by means of DInSAR techniques, high topographic levelling and geological and geophysics prospection, amongst others (see Figure 2).

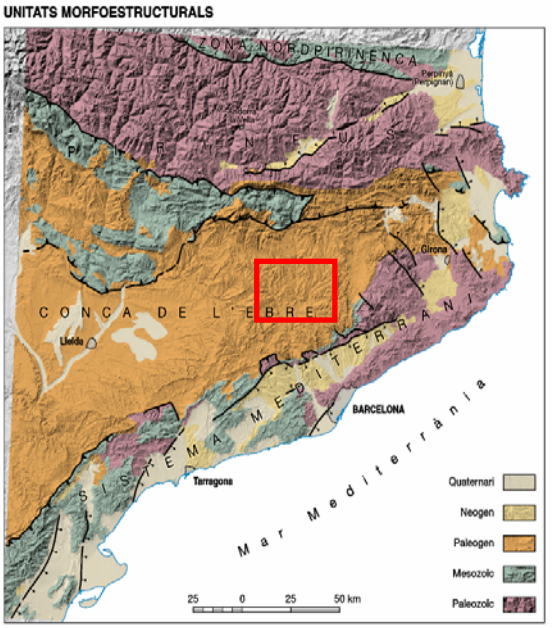

Figure 1 - Geological situation of the study area.

OBJETIVE

One of the aims of the Project is to design, build up, and implement an IT system based on GIS technologies for subsidence risk management in urban areas. This system has to be able to incorporate and manage the great volume of data gathered from diverse sources, such as DInSAR techniques, topographic levelling, geophysical data, urban cadastre, building data, damages and population data (ICC, 2005). For risk management it is necessary to develop and incorporate tools for spatial analysis.

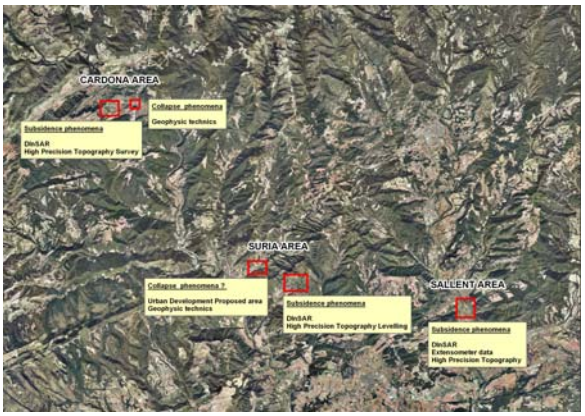

Figure 2 - Distribution of different studies developed in the Conca Potassica area.

SYSTEM ARCHITECTURE

Bearing in mind the exposed goals, the system architecture (see Figure 3) has been defined (ICC, 2006) taking into account the following requirements:

Concerning data storage:

The system allows the storage and consultation of information with spatial components and great complexity.

The information has to be introduced and retrieved from the system in standard formats or well documented ASCII formats.

The data model allows SQL queries, including spatial ones, to the maximum possible parameters.

The information storage has to fulfil the Open Geospatial Consortium (OGC) standards, so that it can be accessed from multiple interfaces.

Concerning analysis tools: Data analysis is done from a SIG application; specifically ArcGIS software version 9 is used.

Data analysis, and fundamentally that regarding deformation or deformation speed, has to allow the access to different functionalities, some of which worth mentioning:

Interpolation

Longitudinal Profile Generation

Graphic Generation

Measure selection using spatial and/or temporal criteria

Spatial Data Exportation:

The system permits locating and downloading the geophysical data.

The final system should allow the access to the ICC corporative data, which is stored in an Oracle Data repository with ArcSDE.

Following the above requirements, the system architecture is defined, decomposed into the subsystems that follow:

Data Base:

The proposed architecture is based in an Oracle managing system (Version 9.0.2 or 10g), on top of which an ArcSDE is installed, acting as spatial motor for the ArcGIS customers.

The format of the spatial data storage is SDO_GEOMETRY and it can be read and edited by ArcGIS through ArcSDE. On the other hand, this format is independent from the GIS graphic interface, which will permit the independence of this module (Data Loading Subsystem) in respect to the GIS platform which is used.

Data Loading Interface:

The data loading interface subsystem is used to feed the data base. This subsystem offers the customer an interface which allows entering the data access libraries in their loading options. As it has been mentioned in the above point, this subsystem is independent from the GIS software and it does not incorporate any kind of graphic interface.

This interface manages the relations and rules between the different objects of the data model, including reports, information related to the different methods and the data itself.

Data Access Libraries:

These libraries are used to load/export the different elements (geophysical, extensometric, radar interferometry, and levelling network). Each one of the methods has been codified in an independent library.

The separation of these libraries from the different interfaces would allow its easy incorporation in another type of interface, either if they are other GIS software or own developments, either in Web application, consulting and data downloading.

Access to the corporative data:

This module allows the access to the whole ICC corporative data, unifying the way this information is visualised by the users. The tools for accessing and/or selecting are based on spatial criteria and they permit a fast access to the different study areas.

Analysis Tools:

This subsystem is developed as a personalisation (Tool Bar) in the ArcGIS environment. The available tools in this subsystem are:

- Raster Layer Contouring
- Profile Generation
- Temporal Data Selection
- Temporal Graphic Generation
- Excel Format Data Exportation
- Exportation Assistance for Geophysical Data
- Scenario Selection of Active Levelling
- Zoom Selection

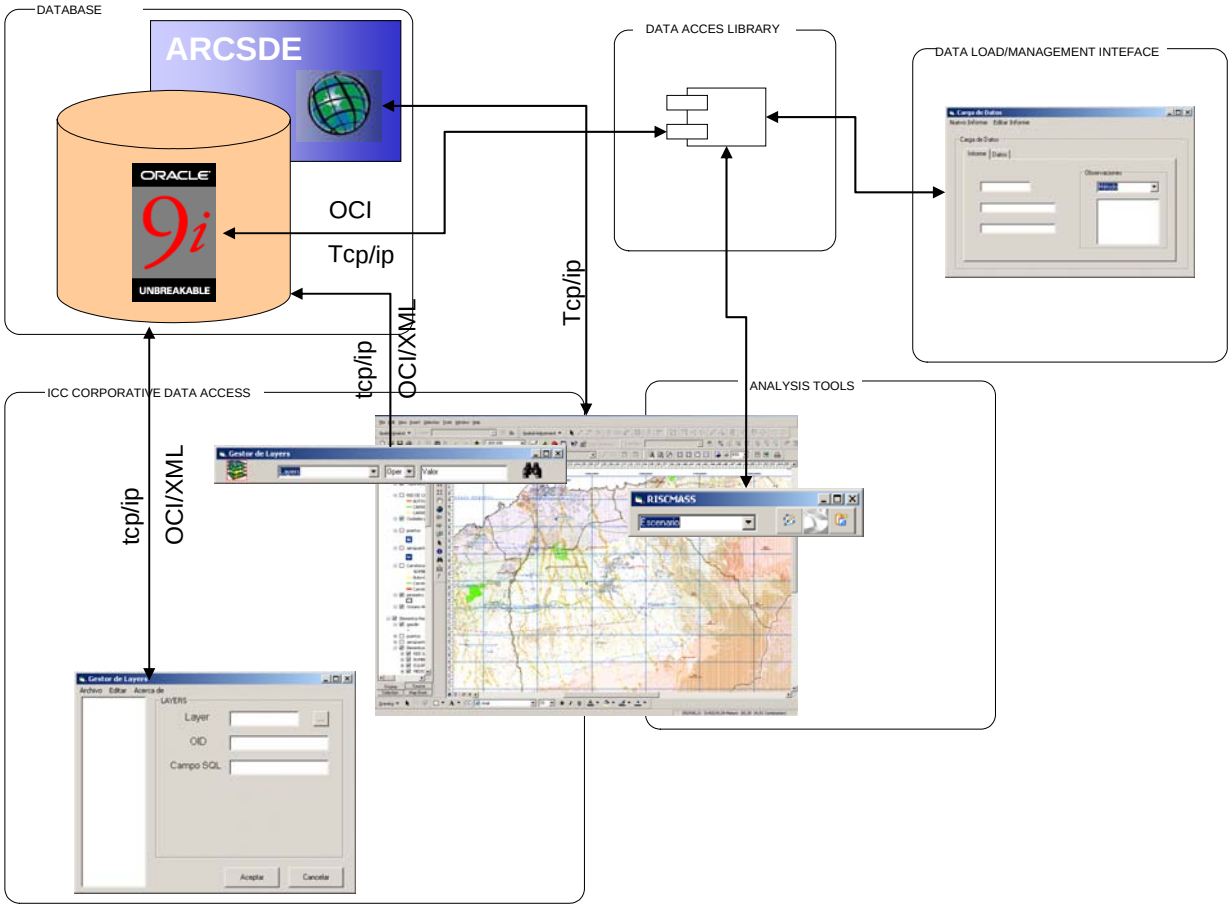

Figure 3 - This draw shows the system architecture implemented.

CONCLUSIONS

The implemented system allows the management of different data sources with spatial component in the risk analysis.

Apart form the data analysis regarding the subsidence hazard, coming fundamentally from DInSAR, precision topography and deformation measurements on boreholes (extensometry), the implemented system allows the user the consultation of geophysical data as well as the whole corporative data: geology, geotechnics, cadastre, etc… managed by ICC.

The storage and access of the obtained spatial data fulfils the OGC standards. The access to this information is consequently independent from the GIS platform used and it could even be accessed from other environments such as CAD, or specially made applications. As a consequence the analysis possibilities remain open.

The data storage in a Relational Database Management System allows a corporative access, without the need to generate and keep data copies, safeguarding the data integrity.

Finally, a set of GIS tools has been developed which will allow an easy data access and analysis.

ACKNOWLEDGEMENTS

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