

The Geological/Geotechnical GIS of the Friuli Venezia Giulia Region, Italy

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Abstract

The Geological and Geotechnical Map of the Friuli Venezia Giulia Region (Italy) is a project aimed at creating a geological database with maps at a scale of 1:5,000. The database has approximately 34,000 information points and the map is presently completed for 1,100 km² (approximately 1,500 km² will be added soon). This Map will allow to underline the geolithological, geostructural, geomorphological, geotechnical, geomechanics and hydrogeological characteristics of this region. The SIT-CGT (GIS of CGT) has been designed in an ORACLE-ArcSDE platform and it operates using ArcGIS, which has been specially customized for this project. The system has been created using a customized ESRI environment and has been thought as the main GEO-GIS system of our Region. This system will be used by technical and private users thanks to its user-friendly interface (VB made) and will provide fast and easy-to-handle data on the geological and geotechnical features of the region.

List of Abbreviations

CGT Geological and Geotechnical map
FVG Friuli Venezia Giulia Region
GIS Geographical Information System
GS Geological service of Friuli Venezia Giulia Region

Background

The Friuli Venezia Giulia Region is situated at the North-eastern border of the Italian peninsula. Since 1997, the Geological Service of the Region has commissioned to the Universities of the Region the “CGT project”- a Geotechnical and Geological map of FVG at a scale of 1:5000. This project involves more than 30 people operating in different roles, such as Technical coordinators, scientific coordinators, scientific chiefs, technical staff and surveyors.

The goal of this project is to draw 6 thematic maps using 1:5000-scale field surveying: a geolithological, a geostructural, an applied geomorphological, a geotechnical, a geomechanics and a hydrogeological map and, last but not least, to localize and map all punctual surveying data using bibliographic sources.

The cartographic service of FVG subdivides the region using 1:50000 IGM (Geographic Military Service of Italy) subdivisions. At a lower level we have the “sections” at a 1:10000 scale (16 sections on 1 sheet) and the “elements” at a 1:5000 scale (64 elements on 1 sheet). All elements are approximately 3200 X 2800 m, for an area of approximately 900 hectares each. The element is the minimum surveying area into this project (fig.1).

In 10 years the survey work team has successfully completed 240 elements (X 6 maps) and catalogued more than 29000 surveying points and they are still working on new sheets.

The cartographic data was stored on AutoCAD Files and the alphanumeric data on Microsoft Access or paper.

In 2005, the GS decided to reorganize this large amount of data and entrusted our University with the task of creating the GIS.

The goal of this GIS is to create a highly customized and user-friendly system to harmonize and manage the data that has been collected since 1997 and the data that is still being collected and will be collected in the next few years.

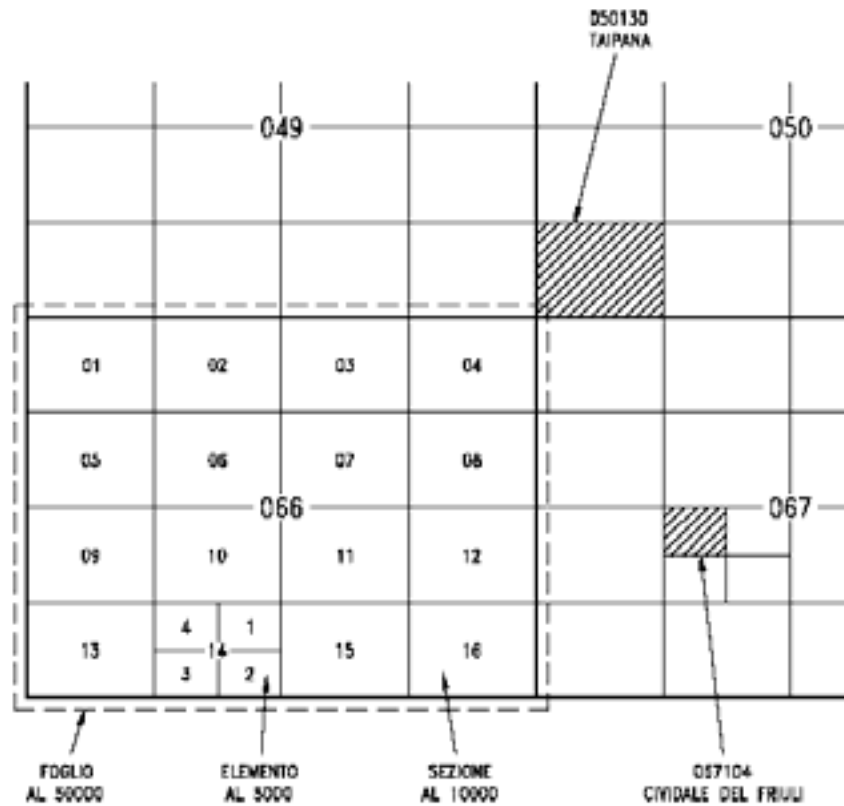


Fig 1: geographical subdivision

The challenge

When we started, we had to solve many problems concerning the GS and the work team expectation:

- Harmonizing heterogeneous data formats caused by many years of protocols changes
- Creating a system that did not make many changes in field team digitalization process
- Translating the “how to digitalize” protocol into informatics procedures
- Creating a read-only Interoperable system
- Creating a user-friendly “field to GIS” import process
- Creating a user-friendly but secure application for accessing, reporting and managing GIS data
- Automating the map production process (viewing and printing)
- Implementing some features to improve the security concerning the whole data flow between import to validation, print or delete phase.

These expectations have been studied by the work team composed of GS members and researchers of the University of Trieste.

Given the complexity of this project, we decided to involve Globo s.r.l in the project, an ESRI Business partner that had worked for the National Geological Service before.

Material and methods

System Architecture

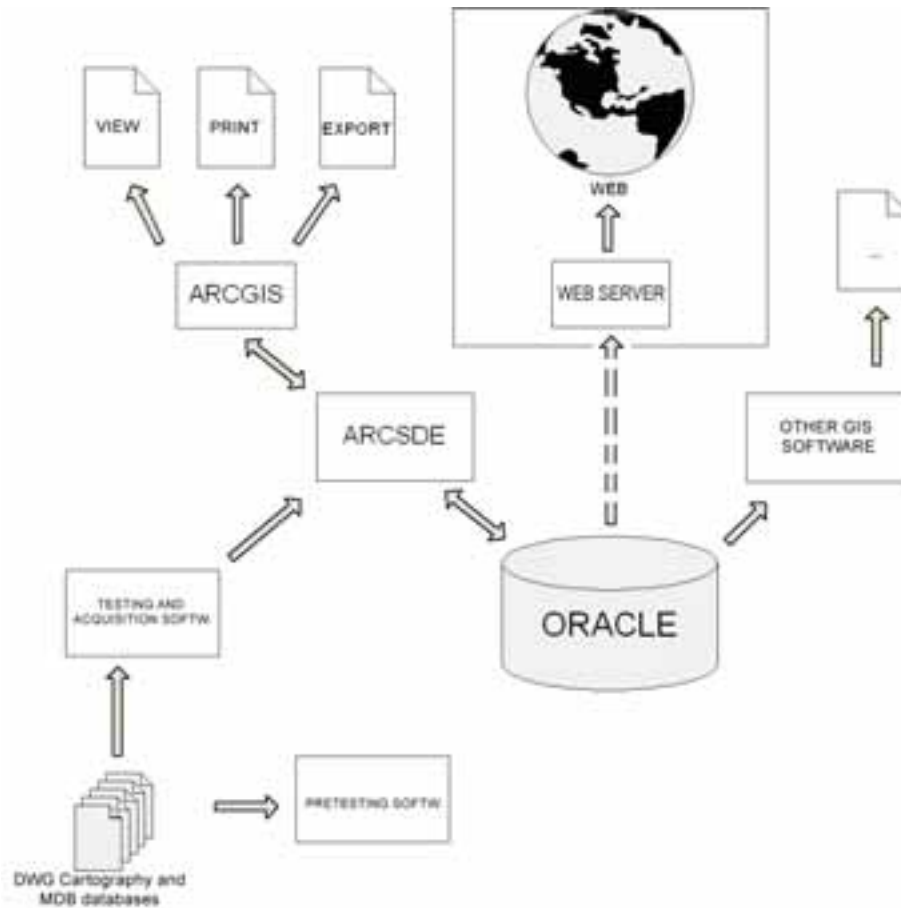


Fig. 1: System Architecture

DWG Cartography and MDB databases

The workflow starting point is the DWG cartography and the databases. The geographical data (dwg file format) are divided on 6 files that describe the components of CGT:

- the geolithological, geostructural and geotechnical surface map
- the geolithological, geostructural and geotechnical underground map
- applied geomorphological map
- hydrogeological map
- geohazard map
- punctual surveying data map

Every feature type (every lithology, rock mass subdivision etc.) is identified by a specific CAD layer (311 layers) codified by name, typology, symbology and legend description.

The alphanumeric database contains information about punctual surveying data. This database specifically contains data and attachments (stratygraphy, pictures, and analytical data) about the 34 punctual typologies of the CGT project. The MDB files are divided into 9 classes:

- geology
- hydrogeology
- plain
- sea and coast
- direct surveying
- geophysical surveying
- hydraulic hazard
- hydrogeological hazard
- observation point

Pretesting, Testing and acquisition software.

We had satisfied 3.5 out of 8 work team expectations creating 2 software applications. The main role of both software applications is to control the topological congruence of CAD and MDB data.

The Pretesting software called “Precollaudo CGT” is a standalone software and it uses freeware libraries (MapObjects LT). This feature permits to distribute the application without any fees to all field surveyors. This application is used by the field surveyors to test the conformity between the informatization protocols and the DWG and MBD files made by the surveyors. The testing and acquisition software called “CGT manager” is used by the surveyors and by the technical team to test once again the DWG and MBD that have already been tested. This test is made using the ArcObjects libraries more efficient than the LT libraries. The installation of "CGT manager" requires the installation of an Oracle client provider and a license of ArcEditor or ArcInfo.

ArcInfo also permits to import all data to the Oracle Geodatabase, to manage users, to view the access log and other administrative tasks.

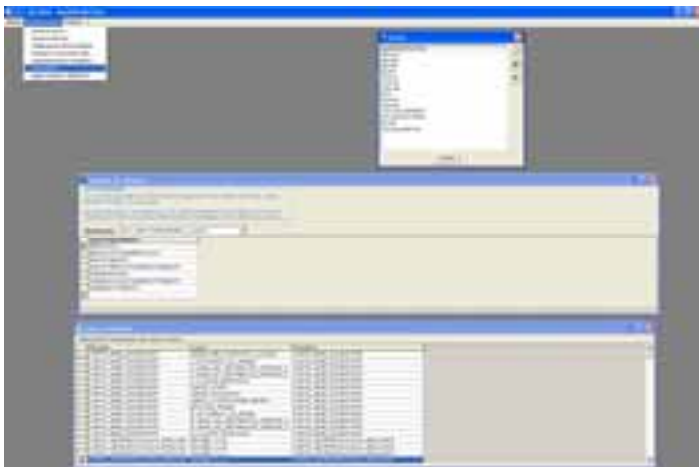


Fig. 2: Testing and acquisition software

Oracle DB

All CGT data are stored in Oracle Geodatabase Enterprise Edition 10g R1 with Spatial option. The geometries are stored in an Oracle Spatial format “SDO geometry” and not “SDE geometry”. This choice was made by the geological service to assure complete interoperability between our geodatabase and other GIS software like Intergraph and Autodesk GIS.

ArcGIS - ArcSDE

We have created a customized ArcGIS 9.1-ArcMap MXD document in order to view and manage the CGT data. The read-write possibility is granted by using ESRI ArcSDE 9.1.

Using this MXD you can:

- Load and view geographical and alphanumerical data
- Validate or invalidate data
- Make layouts and print the thematic maps
- Export data
- Edit the all features and the surveying point data.

Every feature class can be edited using ArcMap capability. The other specific CGT functions are made available through new toolbars, appropriate interfaces and wizards that “drive” the user in specific tasks.

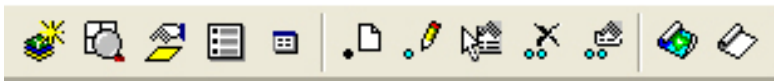


Fig. 3: CGT toolbar

We have made new .style file and we have created 65 fill symbols, 59 line symbols and 67 marker symbols and a TTF font file to view and print all thematic maps.

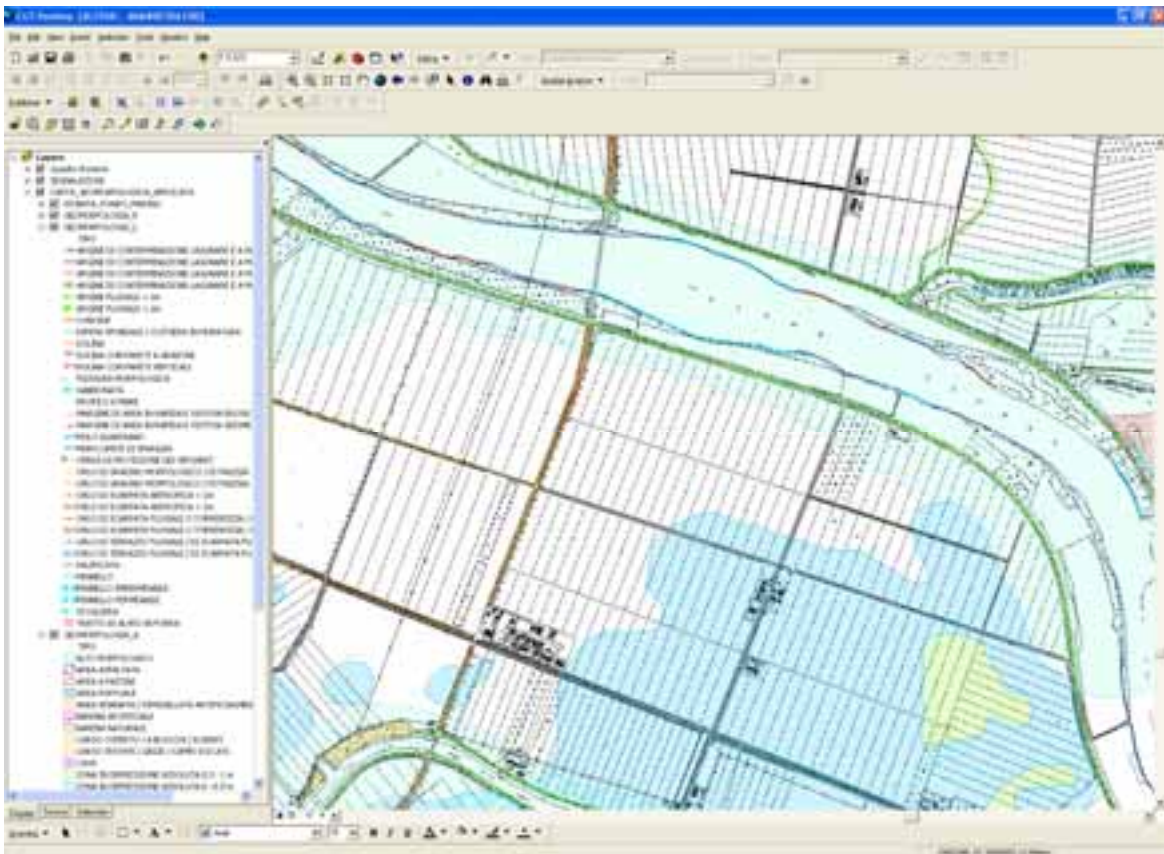


Fig. 4: An example of thematic map (Applied geomorphological map)

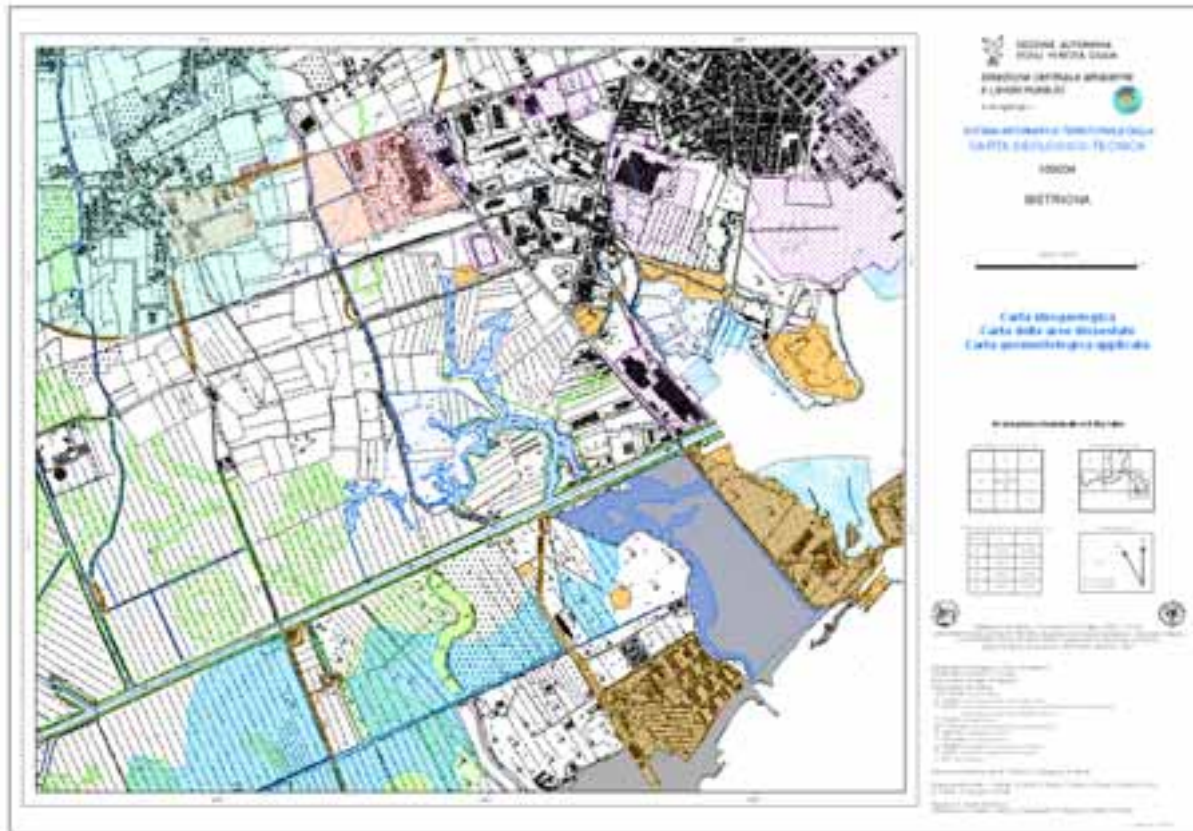


Fig. 5: An example of layout map (Applied geomorphological and Hydrogeological map)

Third part - GIS application

Using the Oracle Spatial format (SDO geometry), we enabled other applications to access the geodatabase.

System security and validation process

The access to “CGT manager” and “CGT desktop” is protected by a User-password login system. This feature has become necessary in order to guarantee the safety and integrity of the data and the respect of the CGT workflow from the survey to the publication (survey – insert on geodb - technical verification - scientific endorsement- publication). The possible tasks are:

- Reading
- Loading data on the Geodatabase
- Editing data
- Validating / Invalidating features
- Publication
- Administering the SIT-CGT system

It is possible to define the relative privilege for each user on every theme of every element. For example, creating a user and granting them “responsibility for Hydrogeology thematic” of sheet 088 means giving this user the privilege to insert, to validate and to invalidate the layer of the thematic Hydrogeology for

all the elements of the cited sheet. In order to simplify the management of the users we have created eight user profiles and we have attributed to each of them the specific operations described on the following table:

Profile	Ins	Edi	Val	Inv	Pub
Reader					
Surveyor	X				
Univ. Technical Staff	X	X			
FVG Staff	X	X			
Thematic map Manager	X	X	X	X	
Sheet Manager	X	X	X	X	
FVG Validating team	X	X	X	X	
Project manager	X	X	X	X	X

We would like to focus on two privileges that are the reading and the validation/invalidation feature:

- reading is an operation granted to all users on whole feature classes if a single data is marked by a “published” state.

- validation is an operation that is carried out with the aim to define as “controlled and scientifically correct” the data inserted on the geodatabase. This operation can be made both for an entire thematic feature of an element and for every single surveying point.

Every thematic element is subjected to this workflow: surveying – loading – validation – publication.

Current project status and future perspectives

The SIT-CGT project architecture has been completed and we have successfully conducted several heavy load test.

The standard size of each element is 3200 m x 2800 m and we have loaded into the geodatabase more than 1200 thematic maps at a 1:5000 scale (200 elements, more than 1140 square kilometers) maintaining good system performances.

We are still making field surveys, and we are working on new MXD features like new customized query functions on geographic and alphanumeric data, new reporting functions and other few things in order to make the project more efficient and “well done”.

Our project is appreciated by other regional services (Central Directorate for Environment) so we have now been requested to add new themes in a SIT-CGT environment.

Conclusion

The SIT-CGT project has been designed to create the best instrument possible to manage and store all geological-geotechnical and hydraulic data of the Friuli Venezia Giulia Region.

This project can be defined as D.S.S. - Decision Support Systems. This means that it is an investigation instrument that can be readily used by the public administration to use and manage the territory.

The system architecture is also a good starting point to create a Web GIS using ESRI ArcIMS.

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