The subsoil cadastre of Mazara del Vallo

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Key words: Engineering survey, GIS, GNSS/GPS, Land management

SUMMARY

One of the major problems among institutions or companies that manage technological networks is the certain and rapid identification of networks, often buried underground, in order to quickly carry out the necessary interventions.
In most cases, technical departments have only a vague knowledge of the development of the networks, based on partial and often imprecise profiles, information gathered in thousand of cards and paper files, or information available on their personal computers or even entrusted to the memories of employees.
In 2006, The College of Surveyors of the Province of Trapani, thanks to the active collaboration between the National Council of Surveyors, the Italian Social Security and Assistance Fund of Freelance Surveyors and the City of Mazara del Vallo, organised a course/topographical training project for the profiling and graphical depiction of the belowground of the City of Mazara Del Vallo.
Eight surveyors registered as practitioners and four surveyors registered as professionals revealed, with hand-held GPS devices, GIS data on the territory and contributed to the creation of a complete and exhaustive Geographic Database of the subterranean technological networks present.
The project was perfectly integrated with the realisation of its own GIS by the City Administration of Mazara del Vallo, and is perfectly in line with the directive (Micheli 1999) issued by the Ministry of Public Works "for the rational organisation of subterranean services", and had, among its other goals, that of providing an important tool for technicians operating in the territory and the local administration managing it.
The project, besides, sought to create professional development opportunities for Surveyors and an important service to the community.

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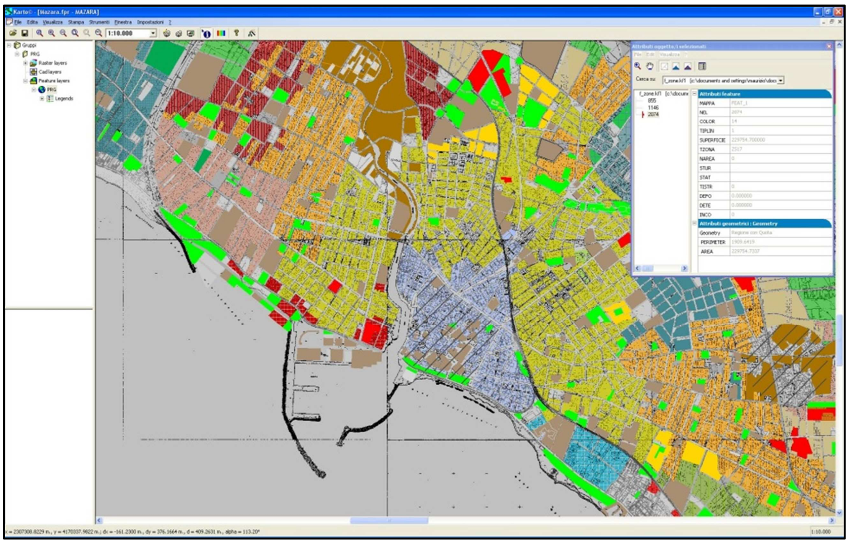
1. The project

"The subsoil cadastre" is a pilot project aimed at mapping the networks of infrastructure found in the subsoil of the town of Mazara del Vallo in Sicily.
The project came about from an idea of the province of Trapani's Board of Surveyors and from a coordinated effort between the Mazara del Vallo local administration, the National Board of Surveyors and the Italian Social Security Fund for Surveyors. It involved several young surveyors from the Trapani College of Surveyors and the involvement of a team of young trainee surveyors, who were coordinated by expert surveyors/topographers with proven experience. The presence of young surveyors played a fundamental role in carrying out the work.
The work, which was carried out over the course of approximately a year, was characterised by the use of advanced technology and equipment, which were useful in conducting the analysis necessary to completely understanding the land. This was in line with the directive (Micheli 1999) issued by the Italian Minister of Public Works on the "rationalisation of subsoil infrastructure". Article 1 of the directive states that "*the main objective is to rationalise subsoil use in order to facilitate the coordination of intervention works*" and the provisions set out by the directive "*will have a direct effect on making it easier to access the different types of infrastructure and to carry out maintenance work on them"*.
Therefore, there is a sense that we are becoming more aware that an area's subsoil can no longer be seen as an endless resource and that we need to focus on maintenance work and of reducing the impact that this has on people's everyday lives and on the environment.
The most important and innovative aspect of the directive is the *General Urban Subsoil Infrastructure Plan*, which is to form an integral part of the General Land Use Plan and which the directive states must be drawn up by the main city in each province, as well as by municipalities with over 30,000 inhabitants or municipalities with significant tourist numbers. The *General Urban Subsoil Infrastructure Plan* must lay emphasis on resolving – especially during the planning phase – any disruptions caused by work being carried out and on making maintenance work more efficient when the infrastructure is in operation. Therefore, what should be suggested is the use of non-damaging techniques when retrieving information about the subsoil and identifying a location for the infrastructure as well as when it comes to installing it.
The initial concrete actions that the municipalities must take in order to adhere to what is prescribed by the directive and in order to draw up the *General Urban Subsoil Infrastructure*

Plan are the following:

- set up a survey to monitor the existing multipurpose infrastructure in the local area;
- obtain satisfactory information systems that are compatible and interoperable for collection and storing cartographic data concerning the use of the area’s subsoil;
- ensure that the cartographic data concerning local subsoil infrastructure is constantly updated and make this information public;
- record any new intervention works in the new system;
- a Territorial/Geographic Information System (SIT/GIS) must thus be created, which should be a useful resource in terms of responding to any design, planning or documentation needs, serving as a single information point containing data from different organisations and companies for reference and use.



In January 2005 the municipality of Mazara del Vallo started to create a GIS. It began to digitalise its aerial photogrammetric map, its General Land Use Plan and its cadastral map of Mazara onto the **KARTO**® GIS made by Miduell Informatika in Belluno, and then it began to publish these data on the municipality’s website.

The survey that was undertaken for this project has made it possible to obtain a cadastre of the local subsoil in order to properly monitor the area’s underground infrastructure and to design more proficiently routes for new networks and alterations to the existing ones. It was undoubtedly a useful exercise, which will go a long way to helping to identify the municipality’s priorities in allocating its resources.

2. The team of surveyors

Four teams were created to undertake the survey of the underground systems. The teams were made up of four surveyors and a municipality employee. Two of the surveyors were young trainees, while one was a young surveyor who was on the Italian surveyor’s register and the other was an experienced surveyor who worked as the team coordinator.

Before carrying out the survey, the surveyors took part in a training course that lasted for two weeks.

The course was designed for anyone who was going to be working with GPS or GIS tools for the first time and aimed to provide the young surveyors with a basis in theory and practice, which would help them initially as they began their fieldwork. In addition, it was also aimed at creating professionals who were trained in a specific area, and so the surveyors were taught the basic elements of geodesy throughout the duration of the course, which served as an introduction to general theory on how GPS works. On top of this, they were also taught the basics of GIS, and practical training in using GIS software was scheduled to take place during the digitalisation and data processing phase later on.

3. Tools used

Each team was supplied with:

- a GPS GS20 handheld device with external to obtain and update the GIS data
- a metric tape measure
- a notebook.

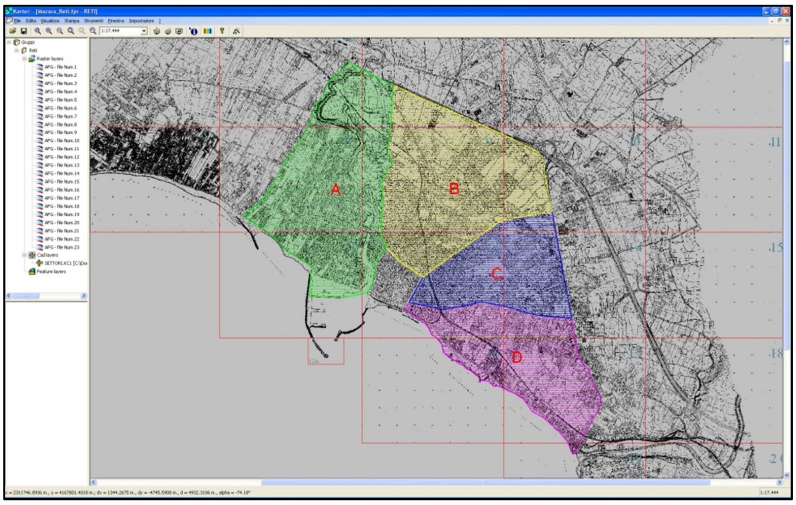
Each team was left to organise its surveying work independently.

The GIS software the surveyors used was **KARTO**® by Miduell Informatika in Belluno. This GIS platform had already been used by the municipality of Mazara del Vallo in its land management.

GISDatapro software was used for the post processing of the data obtained using the Leica GS20 handheld device. This software has an import/export function, as well as allowing the obtained GPS/GIS data to be visualised and processed.

4. How the survey was carried out

The area where the survey was carried out, mainly urban land in Mazara del Vallo, was divided into four sections that covered a surface area of approximately 828 ha out 27,000 ha, which is the total surface area of the municipality of Mazara del Vallo. Each section was assigned to a team.



The underground infrastructure networks surveyed were:

- *The local water network;*
- *The local drainage network (waste and storm water);*
- *The local methane gas network;*
- *The local public lighting network;*
- *The local electricity network (ENEL).*

For each network, the exact position at road level was identified, how far down the networks were as well as the diameter of the pipelines.
Everything surveyed was reproduced onto the municipality of Mazara's GIS digital map using a "*layer*" system with every single street in the four sections identified being represented.

The points used to outline the networks (manholes, lighting points, etc.) were obtained using Leica Geosystems GS20 handheld devices with external antennae to improve reception. This was carried out by standing at the point being surveyed for 10 to 20 seconds. However, on several occasions the signal was lost due to problems caused by a lack of "visibility" of the satellites, which were either obstructed by tall buildings or due to the fact that the point was not accessible for direct GPS signals. On these occasions, the surveyors had to obtain the data of a single point using the offset method. In this case, the distances were inserted manually after they had been measured using a metric tape measure.

As the GPS data were being collected – i.e. as the geometric positions of the points were being identified – the area's GIS data were also collected since the GS20 device is also designed to create and update this type of data. The main features of each network were thus linked up with each point (e.g. Identity Number, Street, Type of Drain, Manhole Cover Material, Manhole Material, Manhole Position, Manhole Section, Manhole Size, etc.).

5. How the acquired data were transferred

The data acquired using GPS were downloaded daily onto the central system of the municipality of Mazara's GIS office.
The first step that needed to be taken once the data had been downloaded was to find the data for each reference station in order to carry out the post processing.
The data that were collected using GPS were immediately processed in relation to their reference station using the office software GISDatatpro. In other words, the calculated coordinates, again in WGS84 format, were converted for use in the Gauss-Boaga map system. The Gauss-Boaga system is the reference

system for digital mapping for the municipality GIS.
This made it possible to immediately overlay the data acquired using GPS onto the digital map in the office in order to carry out an initial check of the quality of the acquired data.

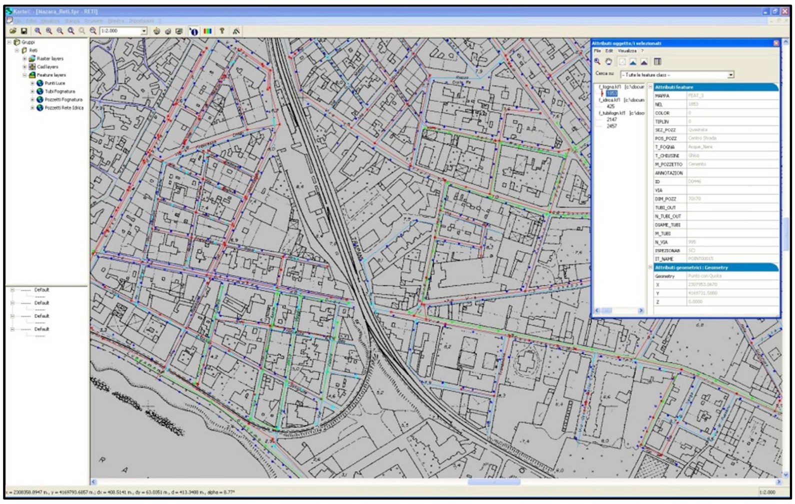
6. The foundation map

The data from the surveyed networks were imported and edited on the raster base of the aerial photo map provided by the municipality of Mazara del Vallo, a geo-referenced foundation map that was created when the vectorization of the new General Land Use Plan was carried out.

This was made up of 22 tables of aerial photo map on a scale of 1:2.000 mapped in 1987. At the time of the project, it was the only map of this scale that the municipality of Mazara had in its possession. The map, which is in paper form, was imported using a scanner. It was transferred in black and white at a resolution of 400 DPI, and was later georeferenced in the Gauss-Boaga system.

7. Sketch of the networks

A sketch of the infrastructure networks was created in the municipality of Mazara del Vallo's GIS department. The networks were sketched and outlined using a graph made of lines (the network pipelines) and points (where the lines intersect), onto which the manholes were inserted.
The decision was made to create a map for each network that was surveyed. This was partly for reasons of flexibility in managing the maps of the networks, but also because each map could later be intended for different departments, given that the networks of infrastructure are managed by different municipality departments. In any case, it is possible to overlay the maps on top of each other and consult them together, given that a single map reference system is in use. This helps to create a complete picture of the underground infrastructure and their intersections, which is essential to planning new developments and maintenance work efficiently.



KARTO® is equipped with an easy-to-use CAD function, which has made it possible to create a graphic-numerical cadastre, in which the geometric features of the networks can be entered, stored and updated.

In each individual map, the graphic data were organised according to their information layers, so that they can be overlain or used individually.

8. Publication of the project

The data obtained in this project were recorded onto magnetic media and distributed to all the professionals in Mazara del Vallo to give them a comprehensive picture of the available underground infrastructure.

The project presented in this paper was aimed at making an initial contribution towards a new, innovative way of managing the local networks of infrastructure. This approach involves using a system that does not just make it possible to retrieve data about the infrastructure, but also to visualise the maps on the ground. Through creating databases, the system also makes it possible to manage statistics, plan any necessary maintenance work and update the survey.

Using a handheld GPS device on the ground helps to speed up, or sometimes even do away with, many stages of the process considered fundamental in traditional surveying carried out on paper (photocopy of the sheet map; surveying by hand on the site; creating a fair copy in the office; manual archiving carried out by memory by the surveyor). These stages are replaced by computerised surveying. When viewing the map, it is possible to position graphic and textual data onto it by drawing them directly on the screen, and to link all alphanumerical data into the map.

The young surveyors who carried out the work were relatively inexperienced in using PCs– or in some cases, had no experience. They required several training sessions to ensure they could use a handheld GPS device independently to create, update and use the GIS in their work. This shows that municipal engineers, surveyors, team leaders, water and drainage network workers can use GIS with the same level of ease, as well as updating it by using a handheld device and using it interactively to produce moulds for maintenance work. On top of this result, it should be added that with the use of GIS the amount we know about networks will continue to grow, due to the ease with which the database can be updated, rather than deteriorating every time an experienced plumber retires.

If we know more about the subsoil of a certain area, this allows us to *manage the subsoil as a resource that supports the development of sustainable cities.*

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