THE USE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN UPGRADING WATER DISTRIBUTION AND SEWERAGE SYSTEMS

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***Abstract**: The creation and use of spatial databases for the management of public water/sewer utilities in order to be in alignment with the EC standards represent nowadays an important tool in making both their quantitative and qualitative exploitation as efficient as possible. Starting from this aspect, this paper presents the stages in the achievement of spatial databases compiled in a GIs application and an example of converting the specific data on IT support, the building of a relational database, the way the connection between the spatial data and the descriptive ones is achieved within the model. Once these connections are established, the information can be used in various types of analyses and optimization modalities in the water/sewer systems. The large volume of graphic information that can be acquired today imposes its use simultaneously with the necessity of ensuring centralized data control in the database management system.*
***Keywords:** GIS, Water Supply, database management system.*

1. Introduction

The use of a spatial database in the management of public utilities systems represents an important aspect in the activity of designing, using and exploiting water/sewer networks, bringing about major benefits in ensuring quality to these services.

Within an information system the link in this activity is represented by the digital map of the area under consideration.

In recent years, although serious efforts have been made with a view to getting a cadastral database, the achievement and continuous upgrading of the geographic information systems specific to diverse fields of activity has become a must.

The aim of this paper is to highlight possible applications of GIS technology in the utilities field, particularizing the strong functions of spatial analysis these contain.

2. The problems of achieving a database for the water/sewer utilities

On the whole, a GIS system represents an administration system of a database that introduces the data to the user in an interactive graphic way that can be interpreted and questioned. This system is an ensemble consisting of computer equipment, programmes, sources of topographic data meant to develop an application specific to the field.

The main distinctive element for a GIS is the fact that information is approached taking into consideration its spatial location established by coordinates (x, y, z).

A GIS is a software that connects geographic (spatial) information with descriptive (alphanumeric) information. Regarding this aspect, it is important to differentiate between the

applications for the utilities networks and the cadastral ones that depend on certain legal requirements and high geometrical accuracy.
The development of some models of data specific to water/sewer systems imposes an overall view of the geo-spatial database that is to be structured according to the amount of information necessary for the complete identification of the utilities networks and the initiation of a procedure to achieve these in a series of stages.

The achievement of the digital plan of the urban agglomeration under consideration

This stage can be accomplished in different ways nowadays, depending on the available data, using:

- the digitisation of the existent plans and maps; in this case there is the advantage of using a minimum of resources when it comes to software and computers . If possible, a spatial database to vectorize the plan at different scales can be created.
- the scanning and vectorization of the existent plans and orthophotoplans brought to the plan scale.
- measurements on the area using modern devices (total station, GPS navigation systems, equipment based on satellites destined for the determination of locations on the land surface, etc.)
- aerial photogrammetry; nowadays there are digital aerial cameras, the photogrammetric process turning thoroughly digital to get orthophotograms.
- satellite digital images; the problems of utilities can make use of several satellite sources that offer images with acceptable resolutions, such as ikonos satellites, digitalglobe, google maps, etc.

Collecting information specific to the water/sewer systems (data about the pipes, reservoirs, pump-stations, valves, branchings, etc.)

At this stage existent data in the utility companies (paper or computer based) will be acquired. This refers to the length and the trajectory of the pipes, the material they are made from, the position of the street manholes, hydrants, etc.

Thus, the component elements of the water/sewer system will be positioned on the digital support of the already existent paper by the geographic coordinates (x. y. z.) of the respective objects. The association of the alphanumeric elements that represent administrative information (the material of the pipes, diameters, speeds, pressures, etc.) is targeted as well.

At this stage information from the utility companies is gathered resulting in a relational database.

The GIS application will have to allow the increase of the degree of detailing the data by the introduction of all the information sources (isometric schemes of the hydraulic plumbing in the street manholes, images of the system objects, etc.)

Case Study

The introduction of a GIS in a company of utilities asks for the establishment of some specific requirements to each and every company and specialised sections. For each field (water/sewer) models of data will be issued by means of a database on each particular object.

After the topographic land measurements, a cadastral utilities map will be edited. Further on, each object within the water/sewer system will have a descriptive database attached to, similar to the geographic database, according to a unique ID of the respective element. When this connection has been established, the descriptive information can be used in diverse types of analyses or can be simply posted.

GIS techniques allow for the combination of information of different types (figures, images, maps, etc.), both hardware and software components, all of them under the direct coordination and determination of the human component.

The possibility of interconnecting these types of data and the management of the spatial relations worth considering for the area under study can be achieved by means of an ARCIS platform.

There follows an exemplification of the way descriptive data can be organised within the GIS for utilities.

For example, for a pipe attributes such as: address, name of material, length, diametres, depth of placement, events (damage), type of faults, dates of identification of fault and its remedy, number of branchments, etc. can be associated for each ID (Fig.1)

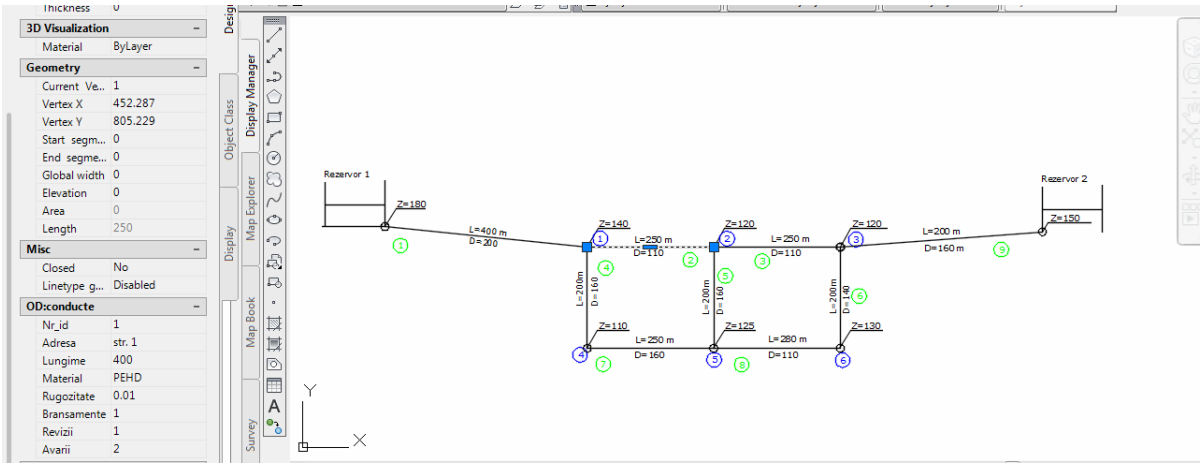

Fig.1. Descriptive data pipeline

In the case of a street manhole attributes such as type of manhole (visitng, airing, emptying), types of section, material, events (damage), types of fault, dates of identification and remedy, equipping – (a hydraulic scheme can be attached) can be associated for each ID (Fig.2; Fig.3).

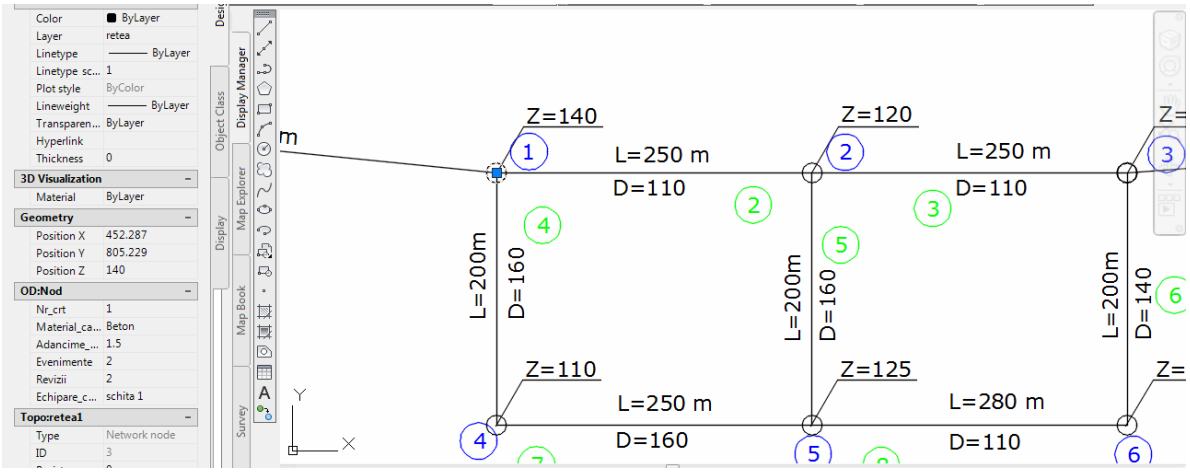

Fig.2. Descriptive data nodes

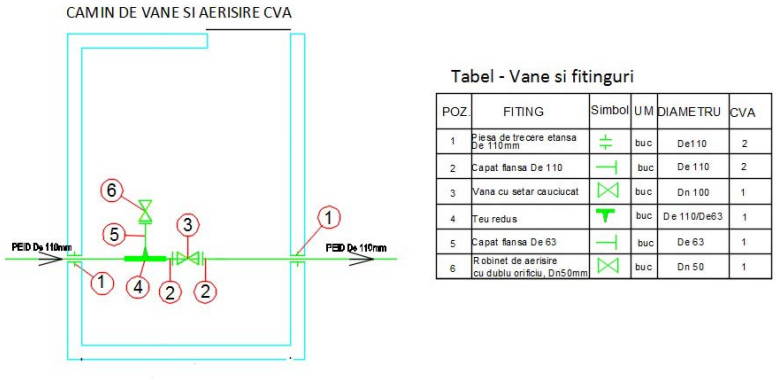

Fig.3. The hydraulic scheme

For each element the attributes are stored in a file named Table of Attributes (Table 1, Table 2).

Table 1 - Table of Attributes for pipes

Table

Retea

Nr_id	Adresa	L (m)	D (mm)	Material	Rugozitate	Bransament	Revizii	Avarii
1	str. 1	400	200	PEHD	0.01	1	1	2
2	str. 2	250	110	PEHD	0.01	1	1	5.04.2014
3	str. 3	250	110	PEHD	0.01	1	1	8.07.2014
4	str. 4	200	160	PEHD	0.01	0	0	0
5	str. 5	200	160	PEHD	0.01	0	0	0
6	str. 6	200	140	PEHD	0.01	0	0	0
7	str.7	250	160	PEHD	0.01	1	1	10.05.2014
8	str.8	250	110	PEHD	0.01	1	0	0
9	str.9	200	160	PEHD	0.01	0	0	0

2 (0 out of 50 Selected)

Retea

Table 2 - Table of Attributes for nods

Table

Nod

Nr_crt	Material	Adancime	Evenimente	Revizii	Echipare
1	beton	1.5	2	2	schita 1
2	beton	1.5	1	0	schita 2
3	beton	1.5	2	0	schita 3
4	beton	1.5	1	0	schita 4
5	beton	1.5	2	0	schita 5
6	beton	1.5	0	0	schita 5

0 (0 out of 50 Selected)

Nod

An important criterion for the implementation of a GIS within the utilities of water/sewer is the establishment of a connection between the spatial and the descriptive data and the creation of a central database by means of which different plans and analyses can be performed according to the companies' demands.

Environmental System Research Institute (ESRI), headquartered in California, USA, develops GIS technologies offering a series of professional services and GIS solutions of high quality through ESRI Romania [4].

In a company of utilities the pursued objectives are:

- to get the cadastral plan of the utilities network which can be overlaid upon the street texture, buildings, etc.
- to associate the descriptive elements with the objects belonging to the networks;
- to interconnect spatial data with descriptive ones;
- to ensure an efficient management -repair damage, clients' services, power saving;
- to create the appropriate framework for the improvement and control over the functioning of the distribution systems using diverse specialised programs.

4. Conclusions

The implementation of a GIS system in the management and exploitation of water/sewer systems aims at an overall approach of the computerization of this activity.Besides the specific activities of a GIS (providing a cartographic database), there will be included other databases that represent management information (the pipe materials, diameters, speeds, pressures, etc.). Some of the advantages of the approach based on management systems of the databases are:

- central control; easier achievement of some new applications related to the databases;
- accurate and continuously upgraded information;
- rapid access to information;
- an increase in the quality and rapidity of performing analyses;
- accomplishing the management of the recorded events;
- making statistical situations and thematic maps;
- creating the necessary conditions for the hydraulic modelling
- the improvement of the activity of exploitation and of controlling the systems.

The GIS application will have to allow for the increase of the data detailing degree by the introduction of all sources of information (isometric schemes of the hydraulic plumbing in the street manhole, images of the objects in the system, etc.) as well as the possibility of permanent upgrading of the system data.

This way there will be removed the existent drawbacks generated at present by the insufficiently accurate knowledge of the location on the territory and of the descriptive data of the networks as well as by the lack of systematic actualization.

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