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MONITORING WATER SUPPLY SYSTEMS FROM ROMANIA THROUGH THE GIS MODES

BY

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Abstract. The exploitation of water supply systems depends on the good functioning of the structural and functional components for long periods of time. The system operation must be monitored on a permanent basis. The implementation of GIS models in monitoring water supply systems contributes to the creation of an ordered data base and its query using advanced analytical and graphical technologies. The GIS programs aim at specifying the properties of water system components on customized layers on structural and functional domains. The Autocad and ArcMap programs allow you to get themed maps on specific operating areas of the water supply system.

Keywords: exploitation; custom layers; data banks; digital plans.

1. Introduction

The GIS models used to monitor and operate the water supply system optimize management and reduce operating costs. Using GIS models allows viewing, editing, updating, locating and processing data from a water supply system.

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The activity of completing the monitoring model is made both in the office and in the field, so that the cost and the working time are reduced. GIS models are linked to information from different sources, stored in different forms depending on the institution that supplies them. Spatial databases are used and maintained in specialized departments within public companies and public administrations and should not be limited to mere cadastral applications. This information attached to the GIS application can provide information on public or private property, building permits, legislative restrictions, disaster and emergency management tools, urban network plans, systematization and land management (Badea & Badea, 2013) .

The situation of GIS models implemented in water supply systems is internationally evolved in countries such as Turkey, the Netherlands, France, the United States of America. Although they have well-developed monitoring systems, they are still looking for ways to improve and develop them. But not all countries of the world are doing well in this area, as national GIS models are implemented in the main cities of the country (a similar situation is in Kosovo where the system is still in the project phase).

Internationally, various hydraulic models are used for the analysis of water supply systems, and some of these are related to GIS modeling. All GIS users can benefit from the value of their data by quickly building up study patterns. To provide highly accurate results, the study model needs additional functionality to manage GIS import and export data.

2. Material and Research Methodology

The research material consists of the structural, constructive and functional parameters of the water supply systems existing in Romania. The construction parameters are made up of capture constructions, pipes, reservoirs, pumping stations, distribution networks, special constructions, etc. Data attached to graphical entities forms GIS models.

The analysis data for pipelines is as follows: cadastral data (sector, parcel), geometrical data (length, diameter), hydraulic data (pressure, flow).

The research methodology is carried out in several stages:

1º Identification of the cadastral elements of each component on the cadastral, topographic, orthophotomap, etc. Thus, each component is assigned a number of plot and plot.

2º Identification of building characteristics by analyzing the technical documentation of design, construction and operation. For example, in the case of a reservoir, constructive elements such as reservoir type, construction material, volume, wall thickness, seismic area, thermal system are identified. From a hydraulic point of view, the hydraulic system is analyzed with geometric and functional data (flows, pressures).

3º Data processing and digitization in order to achieve the working layers.

4º Making the main and additional layers necessary for the GIS model.

5º Making the text database for each component.

6º Linking layers by attaching textual data.

7º Implementation of the GIS model in the water supply systems exploitation programs.

8º Maintenance and upgrading according to the evolution of the water system as a result of the extension of localities and the technical-scientific evolution of the research methodology.

Modeling data with the GIS environment involves translating reality into linear information. Each type of information is determined in a local coordinate system or Stereo-70. Their main features are polygon surface, length for line type and *x*, *y*, *z* coordinates for point type.

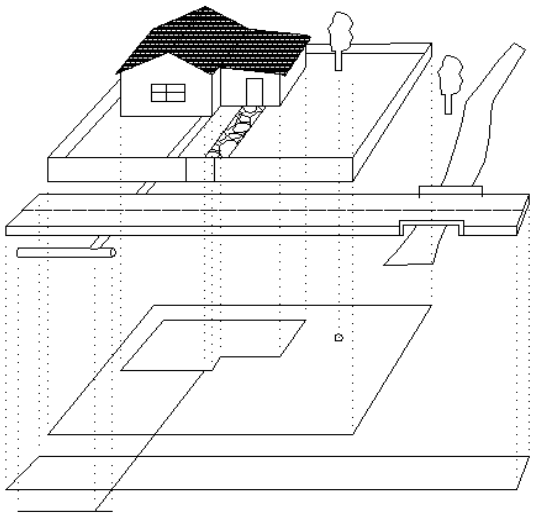


Fig. 1 – Modeling of data field in graphical representation plans.

3. Monitoring Models in Romania

On a national level, each city manages GIS models for water supply systems based on their own criteria, using different programs, platforms and applications such as: GIS NetSet, AutoCAD Civil 3-D, Autodesk Topobase, ArcGIS Server etc.

Following the analysis of water supply systems in Romania, that are monitored using GIS models, we can achieve a classification in three categories (Lateş, 2017):

a) Incipient GIS models where they use the water distribution network geometries to which base data (location, year of commissioning, geometric parameters, etc.) are attached. These models can be applied to rural areas, and programs that can make such a model are Autocad Map or ArcMap.

b) Medium GIS models – these models have attached graphic elements, textual data with additional information to the basic ones (pipeline material, length, related flows, information on water system characteristic constructions). Such a model can be considered as one in the city of Turda. It merged the topographic measurements with the water mains information. The software used to make the model is composed of AutoCAD Civil 3-D and Autodesk Topobase.

c) Advanced GIS models that contain information about the location of fireplaces, water fireplaces, hydrants, owners names that are connected to the network, counter series, damage, damaged items, commercial status, billing blocking number. The city of Bucharest, Iasi, Cluj-Napoca, Ramnicu-Valcea benefit from such models. They use advanced programs such as ArcGIS Server running on Oracle, Arc Map or Geomedia.

The monitoring system must be continuously completed and upgraded to be at the technical level of the exploitation moment. Each water recipe has a different structure, but they have to work together with the GIS-specific models of each watercourse for their better development.

Also, the GIS model can be complemented by a series of analysis and calculation programs, which consider the change in time of the hydraulic parameters of the pipeline network (exemple: change of roughness and increase of load losses). At the same time, the new additional analysis programs can check the structural and strength parameters of pipelines or structures on the network.

At national level in several doctoral theses various GIS models for water supply systems have been developed. As Marian, (2013), mentions, using GIS models, analysis models have been developed to allow: "to simulate the water leakage in the damaged network, to determine the areas and potential customers affected by the damage, to develop a methodology calculation of the volume of evacuated water in case of a network failure, map of the floodable areas in the event of major damage, assessment of the water impact of the damaged water networks ".

Also, Lăpădatu, (2014), used additional GIS modeling tools for modeling water supply networks, these purposes were used to "study the current flows of the network, to verify operational safety, to analyze modeling network behavior, simulation of failures ".

Not all the water supply and sewerage systems serving the cities benefit from advanced GIS systems and many of the towns in Romania have still remained in the analogue format of old maps and old databases that no longer meet the requirements of modern exploitation, immediate and continually complementing the information.

In view of the continuous expansion of large cities in Romania, it is necessary to implement the GIS water supply system with a detailed database that can simulate different mathematical models needed for different types of calculations.

4. Theoretical and Experimental Results

The realization of an experimental GIS model was done in the commune of Româneşti, for Avantu village, Iaşi county.

Text data is attached to the graphics entities. For example, the main data attached to pipelines is: code, location, structural parameters, functional parameters, mounting parameters, location features, etc. Similarly, each structural component of the system (capture, adduction, reservoirs, pumping station, network construction, treatment plant) have attached the informational data base specific to the working field.

An example of a structured data table is the table attributed to pipelines in the water supply network. They have information such as length, material, diameter, year of commissioning, pipeline code, pressure. All this contributes to the creation of a database that provides, through a simple query, information about the GIS model (Lateş, 2016).

Table 1
Structure of Data Attached to Pipelines

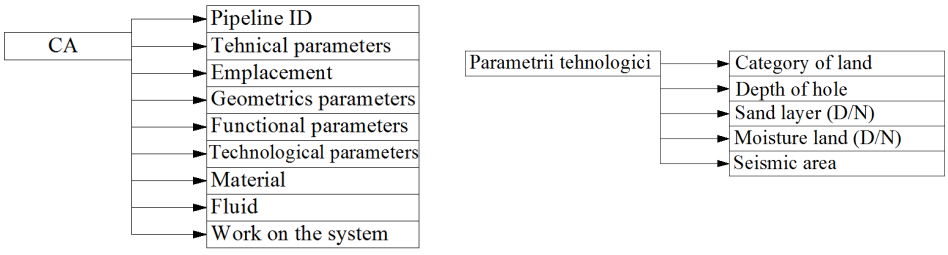
Nr. crt	Length	Material	Diameter	Installation year	Pipe cod	Pressure
1	27.667	PEHD	110	2008	CD 1-1	6
2	152.083	PEHD	110	2008	CD 1-2	6
3	92.447	PEHD	40	2008	CD 1-4	6

The data used is structured and organized into tables that are then attached to the model in the GIS environment. Field data collected through measurements, plans, and feasibility studies are processed, digitized and confronted with cadastral plans and orthophotomaps.

The data table is attached to the graphics entities, so they can be easily viewed within the GIS model. The text data that can be viewed directly in the program interface is chosen by the operator.

Fig. 2 – Viewing the pipeline network in the GIS environment.

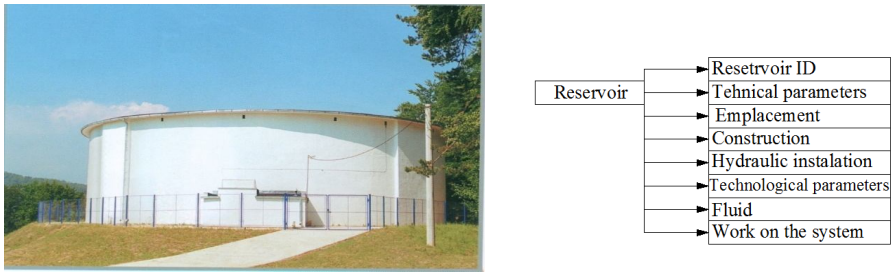
The pipes of water supply networks generally have attached information about their location, technical parameters, functional parameters, material. By completing, new data can be entered regarding the technological characteristics of the system (seismic area, ground humidity), fluid data (density, temperature) etc.



a *b*

Fig. 3 – Structure of data attached to pipelines: *a* – basic data; *b* – details of technological data.

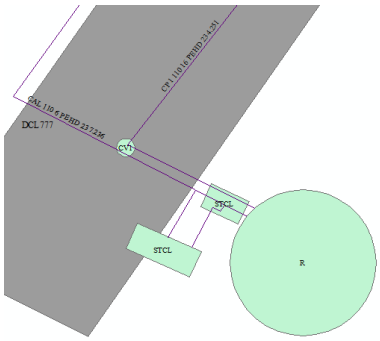
The collected data is attached to both line and polygon entities as the reservoir example. The reservoir may have attached the code that contains its identification in the field, the technical parameters (designer, executor), its location (location, street, plot, plot, coordinates and photographs), construction (shape, dimensions, material) type, material), fluid (density, chemical conductivity), works performed (year rehabilitation, type of rehabilitation).



a *b*

Fig. 4 – *a* – Reinforced concrete reservoir; *b* – data structure attached to a reservoir.

The textual data are combined with graphic data in specialized programs that easily make digital cadastral plans, thematic maps, etc. The tank is represented in the program with the R symbol, but all the data attached to it can be viewed by a simple query. This makes it possible to distinguish its surface, the year of its construction, photographs related to it, the type of the polygon etc.



a

FID	7
Shape	Polygon
OBJECTID	8
Entity	Circle
Layer	Rezervor
Color	253
Linetype	Continuous
Elevation	0
LineWt	18
RefName	
Shape_Leng	33.938444
Shape_Area	91.658762
Id_constru	R
An_instala	2014
Tip_constr	Rezervor
OBJECTID	<null>
Fotografii	<null>
SHAPE_Length	<null>

b

Fig. 5 – *a* – Viewing the reservoir in the GIS environment; *b* – View the text data attached to the model.

GIS modeling contributes to optimizing and assessing the structural state. GIS models predict certain problems of water supply systems.

5. Conclusions

Control models using GIS have become monitoring tools present within water-canal registers, but their co-operation with some areas, such as the land cadastre, is in a relatively early stage.

GIS monitoring models use queries that create digital maps and reports to facilitate communication between water retailers and local or regional authorities and customers.

The modeling of water supply systems using GIS models, combining textual and graphical data, facilitates the process of querying data, shortens working time, reduces maintenance, upgrading, and rehabilitation.

Given the continuing development of cities' expansion, it is necessary to implement the GIS model for monitoring water supply systems, which has a detailed database on the specific areas of interference of water distribution networks with other urban networks and property limits of the beneficiaries.

REFERENCES

Badea Ghe., Badea A.C., *Cadastru, bănci de date şi aplicaţii GIS în zone urbane*, Edit. Conspress, Bucureşti, 2013.

Budea F.I., Alecu D.E., *Necesitatea realizării sistemelor teritoriale/geografice integrate ale sistemelor de irigaţii*, Bul. Ştiinţific al Universităţii Tehnice de Construcţii Bucureşti, Nr. *2*, Bucureşti, 2009

Lateş I., *Contribuţii la îmbunătăţirea monitorizării sistemelor de alimentare cu apă*, Proiect de cercetare, Universitatea Tehnică „Gheorghe Asachi" din Iaşi, 2016.

Lateş I, *Studiu documentar privind monitorizarea prin metode moderne a procesului de exploatare a sistemelor de alimentare cu apă*, Raport de cercetare 1, Universitatea Tehnică „Gheorghe Asachi" din Iaşi, 2017.

Lateş I., Luca M., Ilie G, Iurist N., *Studies on the Implementation of GIS Model in Water Supply Systems*, PESD, Vol. **10**, no. *2*, Edit. Al. I. Cuza University of Iaşi (2016).

Lateş I., Luca M., *Studies for the Management of Water Supply Systems*, Bul. Inst. Politehnic, Iaşi, **62 (66)**, *1-2*, s. Hidrotehnica (2016).

Lăpădatu F.D., *Contribuții privind îmbunătățirea rețelelor de alimentare cu apă*, Ph. D. Diss., Universitatea Tehnică de Construcții Bucureşti, Facultatea de Hidrotehnică, Bucureşti, 2014.

Luca, M., Tămăşanu, F., Luca, Al., L., 2010, *Proiectarea sistemelor de alimentare cu apă în condițiile Podişului Moldovenesc*, Conferința Tehnico-Ştiințifică ARA „Dezvoltarea sistemelor de alimentare cu apă şi canalizare în comunități rurale", Bucureşti, 15-16 iunie 2010, p. 15...20.

Marian R.A., *Studiu geoinformatic privind impactul hidric al avariilor rețelelor de alimentare cu apă din mediul rural. Aplicație la Depresiunea Baia Mare*, Ph. D. Diss., Univ. "Babeş Bolyai", Cluj-Napoca, Fac. de Geografie, 2013.

Mănescu Al., Sandu M., Ianculescu O., *Alimentari cu apă*, Editura Didactică şi Pedagogică, Bucureşti, 1994.

Tămăioagă Ghe., Tămăioagă D., *Cadastru general şi cadastre de specialitate*, Edit. Matrix Rom, Bucureşti, 2005.

MONITORIZAREA SISTEMELOR DE ALIMENTARE CU APĂ DIN ROMÂNIA CU AJUTORUL MODELELOR GIS

(Rezumat)

Exploatarea sistemelor de alimentare cu apă depinde de buna funcționare a componentelor structurale şi funcționale pe perioade mari de timp. Funcționarea sistemului trebuie monitorizată în mod permanent. Implementarea modelelor GIS în monitorizarea sistemele de alimentare cu apă contribuie la realizarea unei baze ordonate de date şi interogarea acesteia folosind tehnologii avansate de tip analitic şi grafic. Cu ajutorul programelor GIS se urmăreşte specificarea proprietăților componentelor sistemului de alimentare cu apă pe layere particularizate pe domenii structurale şi funcționale. Prin programele Autocad şi ArcMap se permite obținerea unor hărți tematice pe domenii specifice de funcționare ale sistemului de alimentare cu apă.