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STUDIES ON THE IMPLEMENTATION OF GIS MODEL IN WATER SUPPLY SYSTEMS

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Abstract. The paper presents research conducted on the optimization of urban water supply networks. One direction of optimization follows the use of GIS models for digitization on components system. The use of water supply system operation depends on the proper functioning of the structural and functional components.
In the analysis it was found that the main components of the system are the following: capture, headrace, puming stations, reservoirs, distribution networks.
Each component is made up of a multitude of sub-components with specific structural and functional character. Using GIS program it follows to specify custom properties using layers of structural and functional domains. Autocad Civil 3D,GisNet Set, ArcGis Server and Autocad Toolbase programs allowed to obtain thematic maps on specific areas of the system. The model of the study can vary from simple to complex and can be generalized to any water supply system for a specific use (urban area, villages, tourist resorts, shopping complexes etc.).

Introduction

At the moment, developing countries are facing with various problems related to water management where the cause is population growth, water scarcity, water contaminatinon and the effects of the ecomomic crisis. At a country level, there is an extreme variability in the distribution of water resources: from a minimum of $10m^3$/inhabitant in Kuwait to more than 100 000 m^3/inhabitant in Canada, Iceland, Gabon and Suriname so we can see that the water distribution is linked with population (Domitille et al.,2003).

Water supply networks are challenged to relate to water quality and quantity, although it attempt to develop different strategies to save water losses it is required

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a well-developed quality management system if we also consider global warming the cause of increasingly strange phenomena.

Water distribution systems are faced with problems related to water management, rehabilitation and repair. That problems occur because of the fact that the network information are minimal, we don't know the diameters of pipes, length of networks, materials, pressure, flow of the network. The lack of such information had brought into the spotlight the need of a databases for optimal exploitation and development on the water supply systems.

Water supply system is a complex of buildings, installations and measures which have the primary aim to ensure the quality and the quantity of water required by the consumers. The main components of a water supply system: capture, treatment station, pumping stations, headrace, reservoir, distribution network (fig. 1). Each component have a set of subcomponents with structural and specific functions.

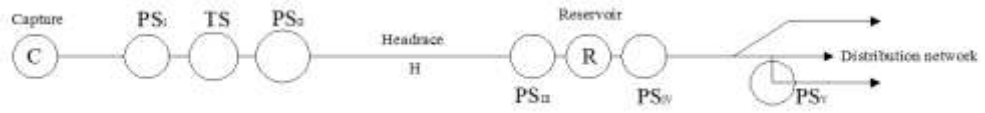

Fig. 1 The general scheme of water supply

Implementation of GIS models in water supply systems helps the understanding of the data, analysis and query them using advanced technologies that can significantly improve the work in the field of urban planning. Using GIS models, viewing, editing, updating, localization and data processing can be done both at the office and in the field, so it reduce cost and time. GIS models are able to plan and analyze investments for the rehabilitation and modernisation of the urban system in order to improve customer satisfaction. GIS model also may schedule, send and manage effective intervention of personnel in the various calls regarding the network crashes.

Water distribution system is an important part in the underground utility sector for which there should be effective plans, including repair, maintenance and rehabilitation of this system that will prevent contamination of the water and reducing water loss (Dehghan, 2009).

The development of water supply depends on the positioning of water supply pipes and the need for a database with various useful information in the case of their evaluation. There are two options in the process of maintenance: replacing the pipe and repairing the pipeline.

Most researchers have developed different models of analysis based on the age of the pipeline as the main factor for the deterioration. However the old pipes have high strength and are still working in satisfactorily mode.

Skipworth et al (2002) said that "the best long term solution may be to identify and analyse the pipeline age based on the level of disruption and the operational costs of the continuing operations as well as maintenance costs in relation to rehabilitation and replacement". Since the pipes are underground is difficult, as they can be seen, diagnosed and rehabilitated.

1. GIS models in the exploitation of water supply systems in Romania

In most countries, the population has developed at the rate of 100 % access to water supply systems and sanitation in Romania in 2013, only 57% of the population had access to water supply network, and 45% to the mains sewer this distribution is uneven with a high deficit in the countryside against urban area what makes the year 2016 that service extending coverage of water supply and sanitation to be still a challenge for our country. It is necessary to modernise the infrastructure of water supply network, expanding, rehabilitation and water network system integration through information systems control in an urban form of a cadastre GIS system.

The GIS system of Iasi, managed by the S.C. Apavital Company, uses GIS NetSet application and targets the completition of suggestive analyses and complex space by linking textual data with high degree of detail with charts and transposed through the queries in digital thematic maps. Through this model of GIS, utility systems aims to adjust with the EU standards.

Fig. 2 – GIS interface of Turda city (Water Company of Arieș)

Implementing a GIS system of water supply network for Turda region managed by the Water Company of Arieș was achieved in 2011 with the expansion and the rehabilitation of the network. The software used is composed of AutoCAD

Civil 3D, Topobase and Autodesk so topographic measurements assigned were combined: pipelines, tank routes, pumping stations as well as dormitories with tactical data: material, diameter, flow rate, year and were placed in a centralized system.

With this database facilities, the design and management of water networks and with the function of analisis for GIS models, it facilitates the process of inspection, monitoring and mainteining of water supply systems.

The network of water supply and sewerage of Buchaeres is administrated by ApaNova Bucharest. The implementation of GIS system has started since 2005 and has been tested by the end of 2012, this system was created in cooperation with Esri Romania using ArcGIS Server and runs on Oracle database. The GIS portal ApaNova Bucharest integrates components of software, hardware and data sets, it is seen that an integral part of the company's enterprise system and is used as a support in decision-making processes, information on the activities of management, operational, structural and functional.

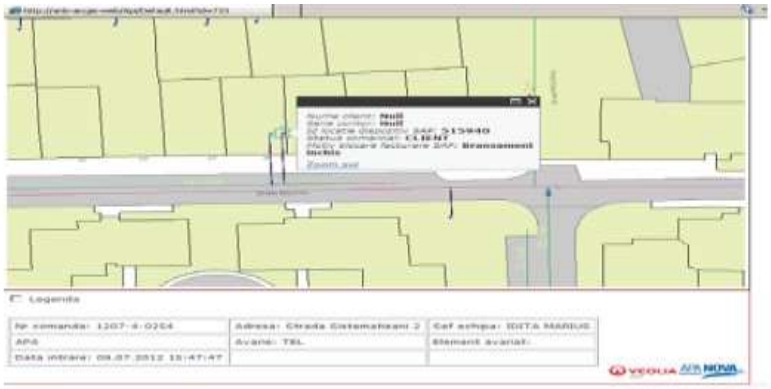

Fig. 3 – The interface of ApaNova Bucharest (ApaNova)

GIS portal of the town benefits from many applications with different features on the structure and functional areas such as applications for viewing sewerager network and water of Bucharest city, drains cleaning scheduling, sewer pipes programming, water network.

The interface of GIS platform has a database containing chart information type and grouped as layers that have location information system with textual address, damaged items, customer name, number, order number, status, number of commercial billing lock (fig. 3) with the help of the application abnormalities can be detected and action plans acomplished.

The water network system of Timișoara city is under the control of the Aquatium Company. The process of implementation of the GIS system has been

stretched out in several stages. The first step has aimed to collect topographic measurements of 218509 points completed in 2013. A second step involves the processing of data with the help of evolved software, and the third stage is represented by the use of data collected through various types of statistics. The fourth phase consists to realize mathematical modeling of urban networks. Timișoara has not yet completed the GIS system and by now it can only create local models.

As a development direction of the urban system using GIS models, aims to involve investment departments, public departments, customers, by interconnecting these systems with applications used by mobile phones that are more and more advanced.

Nationally every city manages it's own GIS models of water feeding systems after their own liking by using different softwares, platforms and application as: GIS NetSet, AutoCAD Civil 3D, Autodesk Topobase, ArcGIS Server (tab.1). Not all the cities benefit of advanced GIS systems, many of the romanian cities had still remained at the analogic map stage and old databases that do not meet our days requirements.

Tab.1-The programs of water network system for GIS models

City	Water Company	Program
Iași	SC ApaVital Iasi SA	GIS NetSet
Turda	Company of water Aries	Autocad Civil 3D, Autodesk Topobase
Timișoara	Aquatium	Work in progress
Bucharest	ApaNova Bucharest	ArcGIS Server

In the context of the commencement of the work for the elaboration of Romania's general cadastre I consider that, apart from the creation of a real-estate cadastre, a series of projects need to be put in motion, projects that are necessary for the execution of the utility cadastre in a unitary system.

2. Aplications of GIS models in water supply systems on international plan

The situation of GIS models of water supply systems is evolved on an international plan in countries as: Turkey, Netherlands, France, Unitet State of America although they have well developed systems they are still in search of modalities of improvement and development of these. But not all countries in the world are well at this chapter, as in the national plan the GIS models are implemented in the main cities of the countries, a similar situation is in Kosovo where the system is still in the project step.

In Kosovo the urban cadastre is defined by the cadastre law and it will be drafted in conformity with it, included in the KCLIS registers (Kosovo Cadastre

Land Information System) maps and text. Until now, just Pristina city has a GIS water supply system implemented, in the rest of the country the situation is still at the project step.

In Netherlands the concern for the protection of the underground utility system has began from the 80's through the establishment of KLIC (Kataster Line Infrastructure and Cable), in 2008 this center was transfered under the national service system of cadaster from Netherlands. Through interconection of the two systems, the operators were forced to take part on the development of the digital system. It is desired that in the near future a new cadastre sistem to be introduced.

In Serbia, the first urban cadastre law was published in 1974 and in 2005 the manual for database creation and urban cadastre mentenance show up. By the year of 1998, 7819 kilometers were digitalised and implemented in digital systems and in year 2011 the number has rised to 11000. The programs Serbia used are ArcGIS for Desktop (Arc Map).

In the United States of America, Florida, there is a GIS system implemented in ArcGIS with its interface as a control panel structured on a group of layers with base maps from which the type of maps can be selected, the water supply system infrastructure; a group of operational layers with functions as working panel, customer calls, SCADA, losses and network reports. This advanced system works in real time, for example, in the moment when a team is sent on the field, the team sends information to the system and this registers them. Also, every pipeline from the distribution network has information attatched about its material, diameter, installation date (fig.4). The system memorises all the informations received from the customers, investors, intervention teams and are kept as a istoric of the network that can be accessed in any moment depending on the operators neccessity.

Fig.4- The parameters of the distribution system of the system of water supply

Turkey has a model of the water supply system where each operator has it's own GIS model, this it is not organised at national level. The figure presents the

city's GIS system in Istanbul which is observed working on layers: the color blue are suitable for water distribution network with attributes such as ID, length, diameter, type and pressure.

Fig. 5- GIS model of water supply in Istanbul (Fatih Doner)

Internationally the GIS models of water supply systems have evolved to in comparation with Romania, although some countries have implemented advanced models; they are in a continuous process of editing and improvement. Both nationally and internationally it can be observed that the access to this type of data is "often restriction due to the fear in a terrorist attach" (Brumbelow si al., 2007).

Conclusions

The modeling of the water supply systems by GIS facilitate the interrogation process, shortens the working time, reduces the maintenance costs, modernizes and rehabilitation through textual data improvement with graphs.

The GIS models are using queries that create digital maps and reports that facilitate the communication between authorities and customers.

Given the ongoing evolution of large urban sprawl it is necessary the implementation of GIS water supply system with a detailed database that can simulate different mathematical models needed for different types of calculation

Today technology keeps evolving so there is a need to continue improving GIS models by interconnections of different databases and through working programs updating to rise the customer’s needs.

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