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Applications of hydroinformatics in municipal water systems

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Abstract: The application of hydroinformatics in municipal water systems has become an important part of the water utilities industry operations. The general characteristics of such systems are examined. A short review of the current status of available tools is presented first, including the main areas of application. Next, information is given on the general status of such applications in Greece today, along with references in currently active projects. Two case studies are examined and presented.

Key words: municipal, water networks, hydroinformatics, Greece, GIS.

1. HYDROINFORMATICS AND TOOLS FOR MUNICIPAL WATER SYSTEMS

1.1 Available Technology

The application of hydroinformatics tools in water networks is currently a standard approach worldwide. The application of such tools can effectively assist water network owners and operators to be efficient in the management of their infrastructure, ensuring proper service levels at reasonable prices.

The evolution of technology in the field of hydroinformatics has been following the general tendency in computer science for rapid advance. The theoretical basis of modelling and calculation methodologies have remained roughly the same for decades, however, the advances in the tools have been significant. Some of the major forces that have driven the progress in the water network and utilities tools are:

Advances in GIS technology. GIS has been a revolutionary approach during the last decades. By nature, the handling of utility network data is very well adapted to the GIS philosophy, since location of each of the network's component, is as important as its descriptive data. The rapid progress of GIS has immensely helped the water network tools to become significantly more powerful and comprehensive, and has resulted in a great benefit for the water industry [1]. The data is now available across the water company departments in maps, without even requiring the understanding of the technology involved. Finally, GIS technology over the internet has further facilitated cartographic data dissemination.

Advances in data collection and transmission. Modern telecommunication facilities allow for the easy setup of data transmission all around the world. This has allowed for the efficient and centralized data collection and handling for water network installations. Alarm notifications can be used to instantly inform interested parties, as well as to manually or automatically execute control commands, making real-time operation possible.

Advances in the modelling techniques, especially in what concerns extended modelling tools, such as optimization, calibration, unsteady hydraulic conditions. Strong mathematical algorithms developed by academic institutions and other researchers in the past decades have been efficiently embedded in commercially available software, allowing for fast and accurate solutions. This has greatly improved the ability to build and tune accurate models with less effort.

Mobile computers and location devices. The availability of "spatially aware" mobile devices, has radically affected the way municipal water systems are managed. Affordable GPS devices coupled with proper infrastructure information and mobile data connectivity, has lead to radical progress in terms of operations and field work.

1.2 Areas of Application of Hydroinformatics Tools

The hydroinformatics tools in public water networks can be grouped in three main areas of application, depending on the objectives of their use. However, it must be noted that there is a clear overlap of these tools, and applications in one area can be greatly beneficial in another. A properly organized information system should focus on effectively integrating all areas of application. A conceptual model of processes, analyses and objectives for water networks is shown in Figure 1.

Asset information. The necessity for information of the assets owned and operated is of crucial importance. Even in the pre-computer days, network owners kept hardcopy data of their assets and the details of their installations. This requirement has not changed over the years, but the technological advances have made the whole process a lot more efficient. Transferring from paper to computer and early CAD representations, current GIS technologies allow for the accurate and rich network and devices representation. GIS allows the information to be distributed throughout the operator's departments and even to the public, allowing interaction and feedback.

Hydraulic modelling. The derivation of a proper mathematical background of equations and respective solutions that are fit for a computer based analysis was achieved several decades ago. The availability of easy to use, public domain drinking water modelling and storm water modelling software starting from the 70s, did not just provide a solution to modelling requirements worldwide, but also allowed for the development of impressive software packages, integrating a wealth of design and analysis tools. The role of sound and detailed hydraulic models is now firmly established within the water industry. Modern hydraulic modelling software is capable of simulating extended flow periods, simulating quality characteristics, while advanced models can also include multiple contaminants, temperatures, particle transport and unsteady flow calculations [2]. One of the most important evolutions of models is their integration with GIS technology, used not only for geometry description, but also for powerful analysis and efficient modelling. The GIS capacities in water network modelling allow for the more accurate calculation of the spatial distribution of demand, assist in asset assessments, and may be used to provide an efficient platform of sharing meaningful data, graphically represented. Models also include additional optimization tools that assist design and sizing optimization, model calibration, zoning management, leakage detection assistance. Modern modelling solutions, commercially available, can provide for a basic SCADA one-way communication, where real-time data is used to instantly assess the model quality [2, 3].

Asset management (mid and long term operation). The idea of an optimized approach towards asset management is again quite old. It embraces the basic idea that tangible assets such as water networks can be analysed in terms of risk of failure, using both their characteristics and the history of their operation. Such an analysis, when properly performed, can lead to effective prioritization in maintenance and operation, so as to maintain the desired level of services, while minimizing the required investment. The demand for total cost recovery of water services, officially introduced with the WFD 60/2000, actually renders the asset management process as a major requirement [4]. Modern asset management tools for water networks are tightly linked with other hydroinformatics tools, since the basic information required is common. However, asset management techniques do not necessarily require hydraulic calculations or modelling. Although information about hydraulic performance can be quite helpful in an asset management analysis, the latter can be employed independently, using its own statistical and mathematical techniques. Latest evolution in asset management includes the application of GIS in the analysis. GIS in asset management introduces a capacity for spatial criteria, answering to criticality queries, or defining the impact of failure, based on location.

Real Time (short term) operation. The rapid evolution of technology in terms of data transfer and communication allows the implementation of operation decisions even in real time. In the past few years, modelling software has been successfully coupled to data acquisition systems in a manner that predicts problems, based on real time information. Deviation from expected patterns can be acknowledged and this allows for the proactive analysis of possible responses. Such systems are heavily based on fast modelling along with abundant data availability. They can also provide a continuous optimization of operation processes, under which all operation decisions are every time taken based on the most current data available, rather than older measurements or average values.

The integration of all the above areas of interest can be regarded as able to provide a full hydroinformatics system for complete network operation and ownership cycle.

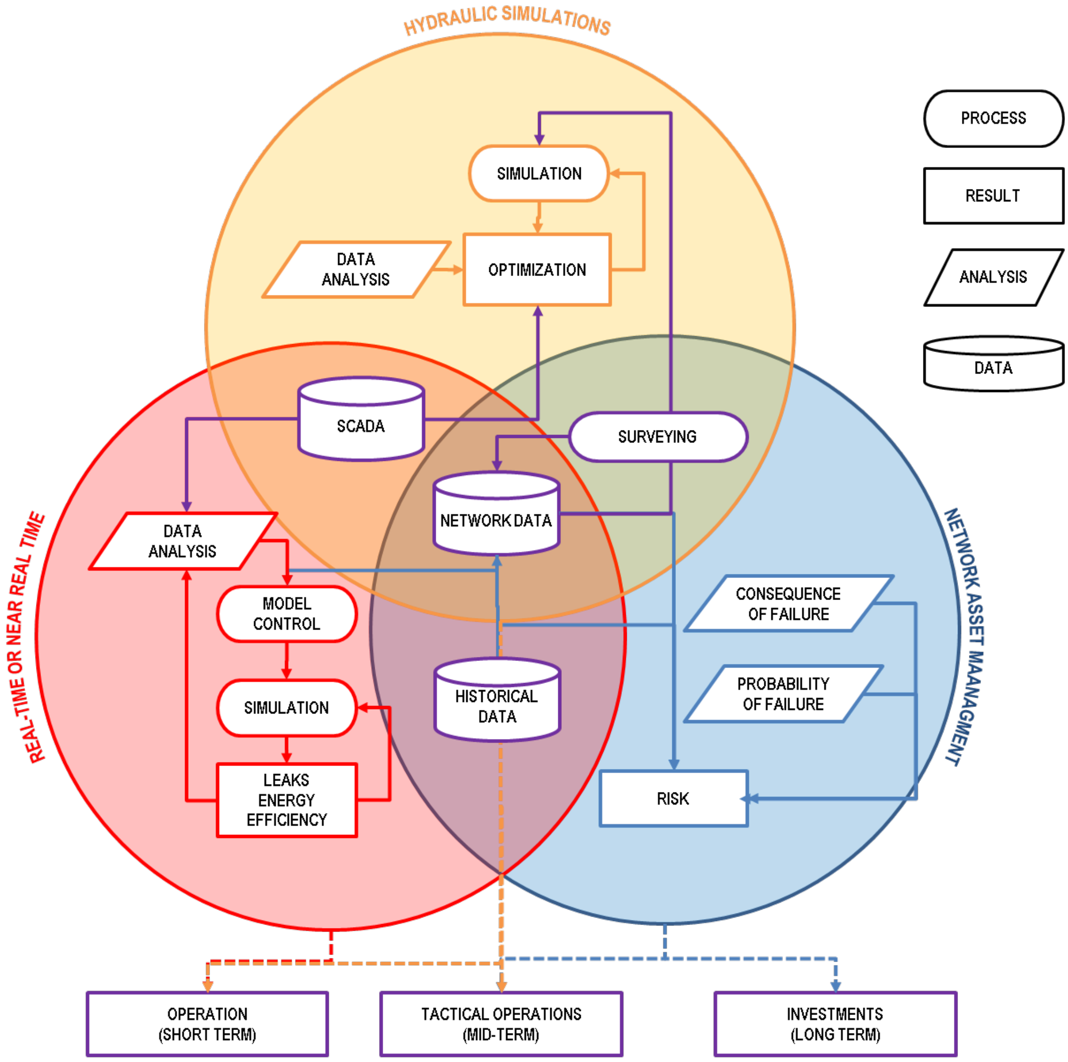

Figure 1. Hydroinformatics conceptual model of processes, analyses and objectives for water networks

2. HYDROINFORMATICS FOR MUNICIPALITIES IN GREECE TODAY

2.1 Current Status

The adaptation of modern hydroinformatics tools in the municipal water systems in Greece has been relatively slow. The reasons for this are lack of proper asset management culture, lack of funding, focus on operations on a daily per-incident basis, lack of incentives aimed at introducing and using technology, lack of technology understanding and proper administration commitment to such approaches. The reluctance to assign financial resources and invest in technology under the above circumstances is generally quite persistent. In some exceptional cases, however, SCADA systems have been in use since 2000s [5]. In almost all cases, hydroinformatics systems currently in use have been implemented along with SCADA systems and measurement sensors.

Currently, Greece is implementing projects co-financed by the European Regional Development Fund, focused on the design, installation and operation of advanced SCADA systems in drinking water networks, with a general objective of leak reduction and better water management. Under the EPPERAA 2007-2013 framework and Action 2 - "Protection and Management of Water Resources", several municipal water companies have applied and are receiving funding for the installation of such systems. Currently, several projects have been completed or are in progress, while a lot more are to be announced [6].

For every project among the approved under Action 2, the authorities have set their own specifications. The objectives of the project are always common, setting as their main goal the effort to reduce water losses, enhance level of services and optimize energy requirements. Their main point in common in the project scope is the requirement for purchase, installation and configuration of measurement devices, linked under a SCADA central unit.

Almost all of the biddings published up to date, have a requirement for setting up a hydroinformatics system. This system in most cases is based on a hydraulic modeling platform; however, it is often the case that extra requirements are explicitly required. In general, the specifications include provisions for:

- A hydraulic model to be developed from whatever available material (usually paper or CAD drawings).
- Calibration of models, either based on measurements to be performed by the new sensors, or in some cases on older available data.
- Verification of models, including scheduling and organizing target flow and pressure measurements.
- Water balance calculations, aiming at determining the unaccounted water.
- Power consumption optimization tools.
- Asset management (in very few cases and inadequately described).
- Customer portals.

The specifications set out for these projects, despite some vulnerabilities and vague references, are a positive step toward an initial implementation of a hydroinformatics system for municipal water companies. In the following two case studies, experience from the implementation of such projects is conveyed.

2.2 Case 1. Installation of a SCADA System in Nigrita, Macedonia

The project's scope was the installation of a SCADA system for the external mains of five separate communities. The total length of the pipes is 49 km, and includes a series of pumping stations and tanks. No distribution network is included. This is a case where no use of hydroinformatics had ever been performed in the municipal water company. The project included provisions for development and calibration of water modelling software, including connection interfaces with the SCADA and pump optimization capabilities. Such a model was developed and delivered. The major issue during the model development was the complete lack of data regarding the existing installations. The project did not provide for services concerning surveying and installation mapping. Furthermore, only rough information was available for the pipes and devices. Finally, the model calibration was only based on a small sample of measurements, since the project schedule did not provide adequate time for the collection of more data. This means that the delivered model will have to be extensively recalibrated, when more data is available. The municipality staff was well adapted to the SCADA operation, and is now scheduling and operating from the SCADA room. They feel a lot more reluctant about the model, since the technologies involved were quite foreign to their current practices. Therefore, it would be greatly beneficial for the staff to seriously invest in learning more and using the tools provided, that will help them optimize their infrastructure operation and management.

2.3 Case 2. Upgrade and Installation of a SCADA System for the Water Distribution Network of Karditsa, Thessaly

The Karditsa municipal company had a large set of flow and pressure sensors installed several years ago. At the same time, significant network upgrade and pipe renewal work was carried out. This new project provided the maintenance and upgrade of the installed sensors, along with the installation of new ones, under a central SCADA system. It also provided for the development of a hydraulic model, water balance calculations, water portal and asset management. The municipal water company of Karditsa was quite familiar with modelling technology, since they had issued consulting contracts of modelling of their networks, and had had experience with measurements and data handling. They also kept CAD data for their assets. The project is approaching completion (7/2014). The preparation of the model was quite simple in this case, since digital data was available, along with properly trained personnel. The calibration was also a lot more confident, but no verification was included. The analyses demonstrated, on one hand, weaknesses concerning the accuracy of the network data, and on the other hand, identified areas that seem to be accounted for the majority of water losses. The water company staff is familiar with hydroinformatics technologies, however, they will need to further develop their skills by working with new tools.

3. CONCLUSIONS

The application of modern hydroinformatics in the water sector has proven to be a major benefit to those who have chosen to invest in such technology. The investment involved can be significant, especially in cases where measurement sensors and SCADA are installed; however, the expected return is major improvement in operation, maintenance and long-term planning, while achieving the expected level of service requirements.

The progress in several areas of computer and communication technology has transformed the tools available to the water industry over the past decades, especially in what concerns GIS. It is, nowadays, possible to implement integrated hydroinformatics systems for water utilities, including all aspects of operation, such as real-time control, design and optimization, along with asset management and long-term investment scheduling.

In Greece, significant EU funding has been allocated to SCADA projects over the past years. Projects have focused on drinking water networks, while there is much room for wastewater as well. The adoption of technology from municipalities has shown signs of improvement; however, the commitment of management and staff remains low. Therefore, the most important aspect of the process should be the conveyance of knowledge and understanding of why this technology is important and how it can help them improve their workflows and achieve better results in a manner that is beneficial for owners, operators and clients.

REFERENCES

[1] National Research Council, 2006. Drinking water distribution systems - assessing and reducing risks. The National Academies Press.
[2] Innovyze, 2014. Innovyze product list 2014., www.innovyze.com
[3] Data from http://www.bentley.com/ (major software developer and vendor)
[4] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy, Official Journal L 327 , 22/12/2000
[5] Municipal water company of Kozani, leaflet, 2014, http://www.deyakozanis.gr
[6] EPPERAA 2007-2013 European funding framework for the environment, data from www.epperaa.gr