PhD THESIS

BUILDING WATER DISTRIBUTION NETWORK MODELS FROM A GIS AND DEVELOPMENT OF DECISION SUPPORT TOOLS

ABSTRACT

Advances in information technology in the past two decades have seen innovations in the field of domestic and industrial computing that led to a paradigm shift in the management and operation of urban water systems by water utility companies. The traditional public management policy that focused on ensuring a minimum quality of service regardless of the costs associated with the processes of catchment, treatment and distribution of water, in many cases even unknown, have evolved towards more efficient cost sensitive models. These new wholly or partly public funded management systems improve not only the quality of service offered to users, but also optimize resources by reducing the cost and causing the minimum environmental impact.

The new challenges raised by the European Water Framework[1] Directive by imposing cost recovery to improve water efficiency and environmental sustainability have led to a significant change at all levels of water management. Consequently, new priorities have been established in terms of infrastructure management that require the reduction of water losses and the improvement of the water efficiency in urban networks for human consumption. Likewise, in a broader context which includes the water--energy binomial, it is also desirable to improve the energy efficiency and carbon emissions of these systems.

Today, **network sectoring is the most commonly used strategy to improve management and increase network performance**. It basically consists of dividing the network into several smaller hydraulic sectors, where water inlets and outlets are perfectly controlled. This simplifies the task of carrying out periodic water balances in each of the sectors, and allows water loss volume to be assessed for a given period of time.

As configuring network sectors is not a trivial task, it is therefore important to have appropriate tools to perform the task efficiently and effectively. **Mathematical models can play an important role as decision support tools to help water managers assess the performance of water network distribution systems**.

This thesis aims to **address the current problems of managing urban water networks by combining new information-processing technologies with innovative network modelling techniques**. It intends to facilitate the system diagnosis and **extend the use of models on the decision-making process** to provide better solutions to the management of urban water networks.

For this purpose a software extension that works on a **geographic information system (GIS)** has been developed. It integrates: the **hydraulic and water quality simulation program EPANET 2**, innovative tools for model **analysis and diagnostic**, **automatic tools for sectoring** and **computing tools to conduct water balances in the sectors** using actual measurements.

The work demonstrates the **compatibility and complementarity of GIS and hydraulic models** as technologies that can be used to support the assessment and diagnosis of water distribution networks. Considering that the majority of information linked to the network system has some geographic reference, it is not surprising that GIS has become a popular tool for dealing with such information. At the same time, the integration of mathematical modelling and simulation tools, offers the GIS a new dimension in the realm of hydraulic study of water networks. Furthermore, if this specific integration is provided with new features aimed not only to facilitate the model building, but also to assist the user in decision-making using powerful algorithms based on the application of the graph theory, the result is a powerful up-to-date analytical tool, which opens up new possibilities in the field of management and efficient operation of urban water supply systems.

[1] Directive (2000/60/CE) of the European Parliament, 23 October 2000, which establishes a European framework for community action in the water policy (DO L 327 22/12/2000).