Assessing and improving sustainability of urban water resources and systems

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Abstract: The overall scope of the EC funded AISUWRS project is to assess and improve the sustainability of selected urban water systems with the help of computer tools. This model represents water and contaminant flows through the existing water, wastewater and stormwater systems, from source to groundwater and discharge points and has already been applied successfully in selected areas in Australia and Germany.

Key words: Urban groundwater, water resources, urban water model, sustainability.

Introduction

With over 40 % of the water supply of Western & Eastern Europe and the Mediterranean region coming from urban aquifers, efficient and cost effective management tools for this resource are essential to maintain the quality of life and ensure that they are available for use by future generations. With population densities increasing in urban areas and constraints on funding, it is becoming increasingly evident that the present management of urban water resources and systems will not be suitable models for service provision into the 21st century and that increased emphasis will be placed upon the use of groundwater reserves. Without an adequate knowledge base of the current status of urban water resources, and an understanding of the processes involved, the health and safety of the people who depend on urban groundwater as drinking water cannot be assured. Therefore the EC funded AISUWRS initiative will provide assessment and modelling tools for planning of alternative approaches for sustainable urban water systems and thus minimise the impact of pollution on the underlying urban groundwater resources. The AISUWRS project is member of the cluster CityNet - The network of European research projects on integrated urban water management.

Scientific paper

SCIENTIFIC AND TECHNICAL OBJECTIVES

In spite of strong efforts initiated by the European Union and other international organizations in the past 20 years, groundwater pollution from industry, traffic, sewers and agriculture is still very high. The complex transport processes of groundwater flow are responsible for the wide distribution of recharged water and contaminants. There is evidence that urban downstream aquifers are contaminated by inorganic, organic and microbial pollution. Special attention is therefore given in this project to urban aquifers: They are particularly vulnerable, but very important in many regions of Europe. Indeed, in many regions they are the only natural resources for drinking water supply.
Alternative approaches to the provision of urban water services do exist, but they have not been thoroughly investigated because of a reluctance to experiment with any system that could in any way compromise human health. With population densities increasing particularly in urban areas and the corresponding constraints on funding, it is becoming increasingly evident that present urban water systems will not be suitable models for service provision into the 21st century. The overall objective of the AISUWRS initiative is to develop an innovative system to quantify and manage the problems from unsustainable urban water systems and assess the impact of pollution on the underlying groundwater resources. The major scientific and technical objectives are:

- Assessment of sustainability of existing urban water systems,
- Development of an inovative urban water and contaminant balance model,
- Development of new urban water management tools and innovative decision support systems (DSS).

INNOVATION

The overall scope of the AISUWRS initiative is to assess and **improve the sustainability of urban water systems** with the help of computer tools. Parts of these model tools have been already developed to estimate the water flows and contaminant loads within the urban water system. This model represents water and contaminant flows through the existing water, wastewater and stormwater systems, from source to groundwater and discharge points and has already been applied successfully in selected areas in Australia and Germany. Bulk water supply is considered an input into the urban water system. Aquifers that underlie an urban area are also included in the urban water system since they play a role in the supply and disposal of water within urban areas. In the urban water and contaminant balance model called UVQ (Urban Volume and Quality) the system boundaries for contaminant flows are the same with the exception of contaminant flows to groundwater. Flows of contaminants to the groundwater are not considered in the existing model but will be implemented by integrating unsaturated flow and transport models. The complexity of interactions between contaminants and soils require detailed descriptions of each site (field investigations). The potential loads from different urban contaminant sources (sewer leakages, stormwater overflow etc.) will then be available for further modelling with a geographic information system (GIS) and a groundwater model in order to **simulate contaminant flows to the urban groundwater** (Fig. 1).

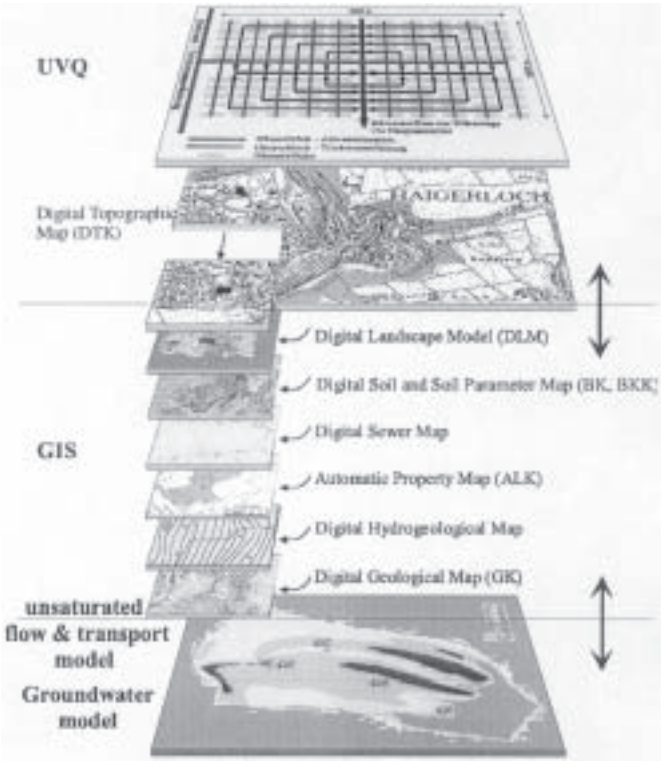

Figure 1. Model concept of the combined urban water model

The objective of the AISUWRS initiative is to build upon and further develop the concepts of Australia's urban water program (UWP) to identify and develop systems and technologies, integrative processes and tools of analysis, which are commercially valuable, scientifically robust and which improve the cost effectiveness of urban water services, in line with the project's vision of ecological sustainability. The existing conceptual urban water and contaminant balance model represents water and contaminant flows through the existing urban water, wastewater and stormwater systems, from source to discharge point.

The actual model includes the leakage of water mains as well as in/exfiltration from the wastewater drainage. The contaminant balance of this model has the advantage of directly representing the way in which alterations in the water delivery and disposal routes affect the movement and distribution of contaminants in the urban environment. Consequently this model will enable **analysis of alternate urban water system scenarios** and view their corresponding effects on surface, soil and groundwater contamination.

A number of procedures can be undertaken to reduce leakage in both sewers and water supply systems. Within the AISUWRS initiative analysis of alternative urban water systems and related costs will be carried out for different scenarios. For water reticulations pipelines, either rehabilitation can be undertaken or pressure management techniques instigated. Pressure management can be a very cost-effective means of reducing losses or controlling demand for many utilities, with a wide diversity of conditions.

If the state of the urban water system is known, e.g. by advanced leakage detection, decisions on how to operate asset management schemes and whether to undertake maintenance, repair or replacement can be made. Existing **decision support systems** (DSS) to evaluate replacement or preventive maintenance priorities for sewers and water mains do not necessarily address the issue of selection of the repair/replacement technology to combat the problem of pipe leakage. It is widely recognised that true asset management requires a balance between risk and planning and it is essential to develop a decision support system for rehabilitation that will support rational and objective comparisons between the engineering, cost and social benefits of each technique. Existing DSS models need to be expanded to allow operational and rehabilitation procedures to be analysed. For this reason, a decision-support system that allows selection of rehabilitation techniques incorporating wholelife-costing methodologies, to assess the viability of each selection decision, will be developed and implemented into the innovative urban water model within the AISUWRS initiative.

There is a growing interest throughout the world in studying the sustainability aspects of water management. It is clear that the social, economic and institutional dimensions of water problems are often the cause of severe deadlocks. Nevertheless, much more attention has been paid so far to the purely technological problems of water management. In fact, comparative studies on the sustainability of the whole urban water system are still not frequent, yet they can provide a good insight into the aspects that are specific for each country and common to all countries. It is clear nowadays that solving water problems requires not only adequate technologies but also an insight in the social, economic, legal and institutional dimensions of the water problems. In the AISUWRS initiative these dimensions will be investigated and analysed comparing the different approaches in various countries. The AISUWRS initiative will be one important step towards identifying and developing systems and technologies that could improve the cost effectiveness of urban water services whilst maintaining ecological sustainability.

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