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Energy saving and leakage control in Water Distribution Networks: a joint research project between Italy and China

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Abstract

One of the most challenging problems in the Chinese water sector is to fulfill water requests in urban areas with increasing population density and deteriorate water distribution infrastructures. Effective decision support systems (DSS) are required to manage energy consumption for pumping by simultaneously controlling leakage volumes. A recently approved joint project between Italy and China aims at transferring the latest advancements on water distribution network (WDN) analysis and management to Chinese water engineers to develop effective DSS by using the WDNetXL system (www.hydroinformatics.it). The preliminary DMAs design on a pilot WDN is reported to exemplify the WDNetXL decision support paradigm.

Keywords: Water distribution system modeling; Local water storages; Presssure-driven simulation; Extended period simulation

1. Introduction

Running a WDN requires energy for treating water and pumping it through the pipelines in order to satisfy customers' requests with sufficient pressure. Unfortunately, in highly deteriorated WDN, water leakages associated with the required minimum pressure regimes often result into severe water wastage, customers' dissatisfaction and non-revenue water (NRW). Such a management problem is further exacerbated in the Chinese context due to the

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complex and rapidly changing urban areas where the increasing population density is putting pressure on existing water distribution infrastructures.

In the past decades, Chinese water utilities have attempted to reduce the NRW by implementing several technologies and management strategies. Nonetheless, the cost-effectiveness of such campaigns has always been questioned due to the scarce results achieved.

Actually, there are some major limitations of the Chinese water sector which are recognized to hamper effective WDN management practices and are ascribed to the lack of professional training of the engineers in water utilities and the absence of structured decision making processes.

In January 2013 the project titled "Energy saving and leakage control in water distribution networks: development of a decision support system" has been included among the significant research projects eligible for funding within the framework of the "Agreement on Scientific and Technological Cooperation" between Italian Government and Chinese Government.

The project pursues two main objectives aimed at overcoming the abovementioned major limitations: to train Chinese water technicians in developing decision support systems (DSS) for sustainable management of WDN; to develop and implement a customized DSS for a real Chinese pilot WDNs, which may provide practical guidelines for large scale applications.

The technology transfer and the training of technicians will be achieved by using the WDNetXL system (Giustolisi et al., 2011, www.hydroinformatics.it) which is a recently developed system that integrates the internationally most advanced methodologies in WDN analysis and management into functions working in Microsoft Office Excel (MS-Excel) environment. The ease of use of WDNetXL and the possibility of customizing its functionalities permit to device dedicated DSS by using all information available to water utilities and incorporating peculiar management needs.

2. Project motivations and objectives

In China, the average NRW rate is about 20%; in northern China, the NRW is even higher up to 40% (due to the melting process of ice during the spring which could lead to the uneven settlement of soil and might result in pipe leaks). In addition, the increased water requests in urban areas results into progressively increasing energy consumption for treating and pumping larger and larger water volumes. These circumstances have put great pressure on the managers of water utilities in order to reduce the NRW and implement efficient energy consumption strategies.

Unfortunately, the technologies and management practices implemented in the last years did not result into significant reduction of NRW and water companies appears to be not prepared in coping with optimal energy management problems. Although there are several reasons for this, three main aspects are recognized to entail possible areas of improvement: (a) lack of available data, (b) lack of a structured decision making process and (c) lack of professional training for the engineers in water utilities.

(a) Data availability is a big issue in many water utilities. Although some water utilities have GIS format pipe data, the accuracy is not always satisfied and some data are missing. In addition, the lack of efficient decision support systems, that might exploit detailed information on the WDN, further reduces the motivation for improving the accuracy of data collection.

(b) The decision making process is always "experience oriented" and, only in some cases, attempted to apply international guidelines to the peculiar Chinese context. Nonetheless, most of existing studies have been developed on urban areas (i.e. in Europe or in the U.S.A.) showing very different conditions from China. One example of this is the configuration of DMAs which are aimed at monitoring flow and pressure through the network, mainly for leakage control purposes. Many researchers have indicated that a DMA should cover 3000-5000 households (e.g. Farley and Trow, 2003). However, in the case of China, where skyscrapers are commonly built for resident purpose in recent years due to high population density, 3000-5000 households mean just about 10 buildings. This have confused the decision makers since applying such criterion would result into huge number of DMAs, thus impairing their effectiveness for supporting leakage control.