Geophysical Research Abstracts
Vol. 13, EGU2011-8429, 2011
EGU General Assembly 2011

Leakage Management in Water Distribution Networks – An Approach based on Bayesian Networks

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Leakages in urban water distribution networks not only result in loss of water but also present environmental and sustainability issues. Further, they may also result in contamination of water especially under low pressure conditions. In order to address these economic and health related issues posed by leakages, the management of leakages in water distribution networks is of paramount importance. Leakage management consists of assessment, detection/localization and control of leakages. The efforts of practitioners and researchers have resulted in the development of several methodologies, both equipment based and model based. A very few of these methods address all three aspects of leakage management. Towards efficient management of water supply assets, however, it is highly desirable to possess a method that integrates the three aspects of leakage management.

Leakages mainly occur due to pipe bursts and other factors such as cracks and poor joints. Thus, any factor that affects the structural and/or chemical properties of the pipe can affect the burst risk of a pipe. A pipe network being underground, it is difficult to obtain information on its condition and hence on the presence of leakages or factors that would lead to leakages. This makes deterministic modeling difficult and calls for analysis in the probabilistic framework. The present work addresses this issue by employing Bayesian networks to develop risk models as functions of associated characteristics of bursting pipe (age, diameter, material of construction etc.), type of soil in which pipe is laid, climatological factors such as temperature and external factors such as traffic loading etc. Such risk models coupled with available pressure measurements and metering data are shown to aid accurate detection and localization of leaks.

Further, the probabilistic modeling of the distribution network aids in addressing the evolution of risk with the ageing of the network. This helps in planning optimal rehabilitation strategies in advance (i.e. before the leakage actually occurs) thereby considerably reducing the impact of the leakage. This is particularly useful for ageing pipe networks in large cities where preventive maintenance helps cutting down potential water losses. This and other approaches proposed in this work are demonstrated via suitable examples.