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Parameter Uncertainty Modelling in Water Distribution Network Models

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Abstract

The use of water distribution network (WDN) models is an extended practice [13]. Confidence on decisions taken upon such models depends highly on their accuracy [11]. The parameters uncertainty has to be defined in order to include it in the model. Some of the parameters in a network (e.g. pipes lengths and diameters) can be easily measured and their uncertainty can be calculated on a statistical basis [4]. Demands cannot be measured directly and they have to be estimated using other measurements [10][8]. The uncertainty in the measurements used for that estimation is propagated to the parameters [1]. Besides, demands have their own stochastic nature that induces uncertainty. This paper describes how the pressure measurements are used to infer the uncertainty model in demands for a real network. The real data are treated in order to avoid the effect of boundary conditions. An uncertainty model for demands is calculated to justify the observed behaviour of the measurements. Montecarlo simulations are used for the validation.

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Keywords: Uncertainty; water networks; demands; pressure measurements.

1. Introduction

A model-based leak localisation method was successfully applied in a pilot test in a District Metered Area (DMA), called Nova Icaria, located within the Barcelona water distribution network (WDN). This study was the result of two different projects (PROFURED [6] and RTNM [7]) proposed and lead by CETAQUA, the technological Center of Barcelona Water Company managing the DMA (AGBAR), and mainly developed by the Advanced Control Systems (SAC) group of Technical University of Catalunya (UPC). This first approach motivated further steps on this work, related with the accuracy that could be achieved by the initial methodology when applied exhaustively to the whole WDN, if the only available information is coming from the measurements of the sensors already installed in the system, and how it improves as new sensors are introduced [6][5]. Furthermore, the accuracy of any model-based

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methodology is highly dependant on the model reliability [12][3]. The uncertainty of a model can have different origins. In this work the uncertainty is observed using measurements gathered from real scenarios. Measurements obtained at the same hour in different days show an uncertain behaviour of the network. Once the expected distribution of measurements is estimated, a hypothesis of the uncertainty source is assumed. This uncertainty source is modelled so that the simulated scenarios are a realistic representation of the system.

1.1. Problem statement

In general a DMA has its inputs monitored, both flows and pressures. This is the actual case in the Barcelona WDN where pressure measurements are used to set the model boundary conditions together with the demand distribution, based on registered water and the total demand provided by flow sensors at the network inputs [6]. The pressure values obtained by sensors installed within the DMA present a relevant dispersion. This dispersion includes uncertainties with different origins. The reproduction of these uncertainties in the simulation model allows the assessment of any methodology that will be applied in real networks beforehand. The questions that this work aims to answer are:

1. How can the uncertainty in pressure measurements be reduced by taking into account available information?
2. Which sources may be chosen to generate this uncertainty in the models?
3. How can this uncertainty be created in the simulation models?

1.2. Case Study

In this work, a DMA located in the Barcelona area is used as a case study. In order to simulate the DMA isolated from the water transport network, the boundary conditions (i.e. pressure and flow measurements from the network) are fixed. Generally, pressure is fixed using a reservoir and the overall demand is obtained as the sum of the inflow distributed through the DMA. The total inflow is distributed using a constant coefficient (base demand) in each consumption node. Hence, all the consumptions are assumed to share the same profile, whilst the billing information is used to determine the base demand of each particular consumption. A good estimation of the demand model is paramount for the real case application.

The DMA considered here (Fig. 1) is called *Canyars* and is located at the pressure level 80 within the Barcelona water transport network. This DMA has $N_n = 694$ nodes and $N_l = 719$ links, and delivers water to the end consumers by means of a single input point.

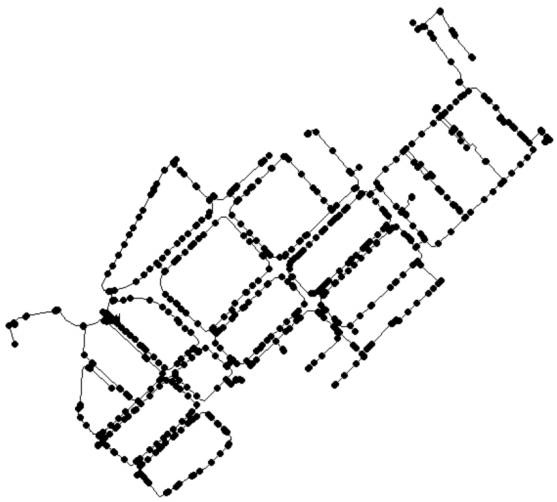

Fig. 1. Canyars DMA

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