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Propagation of uncertainties in water distribution systems modeling

Subhankar Karmakar

Centre for Environmental Science and Engineering (CESE), Indian Institute of Technology Bombay, Powai, Mumbai 400 076, India
Tel. +91 22 2576 7857; Fax +91 22 2576 4650; email: skarmakar@iitb.ac.in

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ABSTRACT

Optimal design and systematic uncertainty modeling of a municipal Water Distribution System (WDS) aim to minimize operational & construction costs, while meeting demands with required pressure levels and water quality. Study about the propagation of uncertainty through the hydraulic model provides a basis for general model improvement in an efficient and economic way. The present study introduces a novel technique for uncertainty analysis of a WDS, which synchronizes the hydraulic network and water quality solving capabilities of EPANET with an interface to MATLAB. It treats the pipe friction factors and the nodal demands as input fuzzy variables whereas the output fuzzy parameters include pipe discharges, nodal heads and chlorine concentrations. The methodology involves decomposition of the given uncertainties into a set of all possible combinations of input parameter values, numerical analysis of the hydraulic network, calculation of extremities of each unknown variable at each alpha cut level and the final construction of the respective fuzzy membership functions. Four distinct types of uncertainties associated with a hydraulic network are identified. Besides these, a sample hydraulic network is conceptualized to investigate the responses of different head-loss formulae to the variations in uncertainty.

Keywords: Water quality; Uncertainty analysis; α-cut level; Water distribution system; Roughness; Fuzzy set; Demand uncertainty