Risk Analysis of Drinking Water Systems by aggregation of Fuzzy Fault Tree Analysis with Bayesian networks and Dempster-Shafer theory

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Abstract

Safekeeping of drinking water supply makes efficient risk management necessary for urban water systems as an important infrastructure. Before decision making about possible risk reduction measures, an effective risk assessment model should be applied to analyze different hazard events that water utilities may face them. In other hand, the World Health Organization emphasizes the use of an integrated approach where the entire drinking water systems, from source to tap (i.e. Water sources, treatment plants & distribution networks), is considered when assessing and managing the different risks. Fault Tree method is a powerful approach for quantitative risk assessment of complicated networks such as water supply systems, but it has some limitations such as inability to consider dependencies between events and subsystems, uncertainties in incomplete data, hazards' natures and experts' knowledge. So in this paper to overcome to these limitations, this method has been aggregated by Bayesian network model and Dempster-Shafer theory of evidence. The former method is one of the data mining techniques, which can assist it to consider both of available data and experts' beliefs in each level of the Fault Tree. Also it makes it possible to update the failure probabilities when the new data and evidences are available. The latter method is used to aggregate different judgments, which are elicited from experts. Finally, Fuzzy set theory has been applied to decrease the ambiguities and uncertainties of unknown basic events which cannot handled by traditional Fault Tree analysis. Applicability of the proposed method has been examined in a case study in Iran and achieved results have been explained. The results show that this method can provide sufficient risk decision support tool for urban water systems under different water quality and quantity crises.

Keywords: Drinking Water Systems, Water supply, Fuzzy Fault Tree, Bayesian networks, Dempster-Shafer theory, Risk Assessment.