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**Massoud Tabesh, Abbas Roozbahani,
Farhad Hadigol & Elham Ghaemi**

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Risk Assessment of Water Treatment Plants Using Fuzzy Fault Tree Analysis and Monte Carlo Simulation

Massoud Tabesh¹ · Abbas Roozbahani² · Farhad Hadigol¹ · Elham Ghaemi¹

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Abstract

Urban water supply, transmission, and distribution systems are considered as the basic infrastructures of each community. Deficiency of water resources in system leads to lack of some subscribers' access to safe water at any time. The water treatment units have a high potential for massive crisis and importance of sustainable performance in water treatment plants, due to their special role in high quantity and quality water supply even in critical situations, requires a comprehensive approach in assessing and increasing the reliability. A comprehensive approach in assessing the performance of water treatment plants and reducing their vulnerability can lead to cost reduction of inappropriate performance in critical situations and also a focus on the most important vulnerable parts of water treatment plants to decrease their vulnerability, as well as cost-effective budgeting in recovery programs. In this research, due to the uncertainties in the input information, two methods of fuzzy fault tree analysis (FFTA) and fault tree analysis (FTA) based on Monte Carlo simulation were evaluated in Jalaliyeh water treatment plant in Tehran, and results of both approaches were compared in terms of uncertainty analysis. The results indicate the low to moderate failure risk in the treatment plant in both approaches and a small difference between results in both cases. Failure probability of top event for FFTA and Monte Carlo-based FTA methods is 0.194 and 0.27, respectively. In the basic event rating, it was found that threats such as inappropriate reservoir design, power equipment failure, transfer pipe failure, and inappropriate maintenance of the pumps play the major role in treatment plant failure.

Keywords Risk analysis · Water treatment plant · FFTA · Monte Carlo simulation

1 Introduction

Urban infrastructures are responsible for important tasks in a community, and any disruption can affect a wide range of people especially in megacities. The urban water supply systems are considered as basic infrastructures, which play a major role in high quality and quantity water supplying. Any disruption in their function can lead to lack of access of a large part of community to safe water, which creates a situation for public dissatisfaction, in addition to health problems.

The water treatment plants are among the main components of urban water systems, which due to their high capacity in dealing with the risks, can cause huge problems in such systems affect a wide range of people in the community. Threatening events in water treatment plants can have human origins such as terrorist and military attacks, or natural origin such as earthquakes, flood, droughts, or even functional origin such as management, design, and control faults of components. On the other hand, the risk-dealing structures, and lack of transparency of institutional planning associated with these threats as well as non-scientific nature of some of these planning increase the risks of failure. Due to these factors, examining the current situation of water treatment plants as well as predicting the probable critical conditions is significantly important. The aim of this study is to provide a comprehensive approach in assessing and increasing the reliability of water treatment plants. This approach can help the decision makers in assessing the performance of water treatment plants, identification of most important vulnerable parts of water treatment plants and

✉ Massoud Tabesh
mtabesh@ut.ac.ir

✉ Abbas Roozbahani
roozbahani@ut.ac.ir

¹ School of Civil Engineering, College of Engineering,
University of Tehran, Tehran, Iran

² Department of Irrigation Engineering, Aburaihan Campus,
University of Tehran, Tehran, Iran