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Evaluation of the vulnerability of water supply facilities using the AHP and RAMCAP combined methods

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ABSTRACT: The supply and distribution network for drinking water is one of the key assets and infrastructure of any country and is vulnerable to terrorist attacks. Access to safe drinking water is one of the vital needs of communities. Importance of water supply facilities, sometimes in the enemy's sabotage operation, these facilities are targeted as strategic centers, which may lead to serious damage to society and sometimes security crises. Regarding this issue, in this research, a total of vulnerabilities was investigated by providing a combination of analysis and risk management for vital asset protection (RAMCAP) and Analytical Hierarchy Process (AHP) analysis of the total water infrastructure of Tehran. The present research is an applied research (extension type). In this way, a questionnaire (quantitative) method has been used for collecting and analyzing information and the research method is descriptive-analytic. The results show that the main facilities identified in the city of Tehran's water supply system, according to the criteria for the ability to discover and identify, the ability to reach the target, the weakness index, the index of resilience, the secondary damage index, the combined effects index, the most vulnerability of the Letyan dam is 0.0858, and Amir Kabir Dam with a vulnerability of 0.0779 and Taleghan dam with a vulnerability of 0.0721 are included in the next assessment. The lowest vulnerability was 0.0133 and 0.0063, respectively, based on the defined criteria for storage tanks and distribution network with vulnerability numbers.

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1. INTRODUCTION

Generally, drinking water systems from the point of delivery to the receiving point of water, which are consumed by consumers, have different components and risk [1]. Today, more than two-thirds of the threats are critical to the main infrastructure, and the vital role of them in the comprehensive management of urban crisis and the close linkage of these networks, on the one hand, and their economic value, on the other hand, makes them particularly attention [2]. Therefore, protecting the vital infrastructure of each society is a determinant of the survival of that society.

Urban water supply and distribution systems include supply sources, main transporting lines, water treatment, storage tanks, and water distribution systems to a wide range of consumers, and; therefore, constitute a major infrastructure in each city. The occurrence of natural and abnormal events can lead to the formation of various crises such as the destruction of these systems, the lack of water and the release of chemical and biological pollutants that may have consequences such as disease and death of humans due to the use of contaminated water or the lack of access to adequate water [3].

Another category of threats is the intentional (human-made) abnormal threat. These human-made threats can be either direct explosive attacks or as the input of pollution into the drinking water supply [2]. The use of passive defense measures will be aimed at reducing the vulnerability of infrastructure, promoting national sustainability, protecting the people and national resources of the country, and ensuring the continuity of their services to complete the civil defense cycle [4].

With what was stated, protect the urban water supply system, including water distribution networks and water treatment plants, pumping stations, dams, wells, is essential and a major concern in protecting human life. Therefore, this requires a complete and comprehensive evaluation and study. Therefore, in the current research, the issue of vulnerability of urban water supply facilities, which includes dams, water treatment plants, pumping stations, reservoirs, and storage tanks and rivers against the threats of human and terrorists was examined. And while providing a suitable model for vulnerability assessment, the facility was evaluated quantitatively to obtain the vulnerability of each asset and ranked according to the criteria defined in terms of vulnerability. A case study of this research was a water supply facility in Tehran.

To achieve the objectives of each research, the use of a scientific and systematic research method is essential.

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The methodology used in this research was "descriptive-analytical," which was used to integrate the two methods of RAMCAP and the Analytic hierarchy process (AHP), which is one of the decision-making methods.

For this purpose, quantitative and qualitative methods were used simultaneously. The case study selected for this research was the urban water supply facilities in Tehran, considering the population density, strategic, cultural, social, and political situation, as well as the value of the property of the city's water supply system.

The following authorities were assisted in collecting information and data, respectively. Center for Nonproliferation Studies and Crisis Management, Tehran Water and Wastewater Company, Tehran Regional Water Companies, Water Resources Management Company of Iran, Water Research Institute, Dam building and irrigation facilities (Sabir), Design and Water and Wastewater Researches, Iran Water and Power Resources Development Company, Nonprofit Defense Group of Imam Hossein University, Nonprofit Defense Forces and Defense Structures of Malek Ashtar University of Technology and National Defense University.

Firstly, due to the nature of the subject, the distribution method of questionnaire template expert format was used among qualified individuals to complete the questionnaire. Subsequent targeted selective interviewing methods and library and documentary reviews were also used to complete the content. In this research, a targeted simple non-random sampling (predetermined)of simple sampling was used. The number of experts identified was 42, who were considered as a statistical population.

2. MATERIAL AND METHOD

The RAMCAP method uses criteria C[1] A[2] R[3] V[4] E[5] R[6] to estimate the vulnerability [2]. The following criteria was considered for analyzing potential and actual damage: the criteria for the ability to discover and identify, the criteria for the ability to reach the target, the criteria for weakness, the criteria for the index of resilience, the criteria for the index of secondary damage, the criteria for the indicator of the effects of the combination Each of them has a separate and qualitative table [4].

1 Criticality
2 Accessibility
3 Recuperability
4 Vulnerability
5 Effect
6 Recognizability

To obtain a vulnerability prioritization number quantitatively, the AHP method was used by applying Super Decisions software version 2.8 (2015). At first, a questionnaire based on the RAMCAP method was designed based on the six criteria mentioned and distributed among the relevant experts and comments were collected. To obtain the asset vulnerability prioritization number, the questionnaire data for AHP modeling was introduced into the Super Decisions software version 8.2 (2015) [5, 6].

The number of important assets of the water supply facilities of Tehran according to the experts in this study were 25 cases including: Amirkabir Dam, Taleghan dam, Latyan Dam, Lar Dam, Mamlu dam, Nimrod Dam, Ziarat Dam, Shahid Ghafouri dam (wells, Springs, Rivers), No. 1 (Jalaliyah), No. 2 (Kan), No. (3 and 4), No. 5, No. 6, No. 7 (Sohanak), Sahebqeraniye Sewage Treatment Plant, Municipality wastewater treatment plant, Zargand sewage treatment plant, Gheytariye sewage treatment plant, Qods town sewage treatment plant, Shoosh sewage treatment plant, Ekbatan sewage treatment plant, pumping stations, storage tanks, water distribution network.

3. CONCLUSIONS

We obtained the vulnerability of Latyan, Amirkabir and Taleghan Dam components of the water supply system. The storage tanks and distribution network with the vulnerability have the least vulnerability based on the defined criteria. Concerning the above, it is concluded that the water supply system is considered as a vital infrastructure for any society and country. Therefore, planning to take protective measures from this network is very important.

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