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WHAT EXTENT CAN DRINKING WATER SAFETY PLAN REDUCE THE RISKS COMING FROM DISASTERS IN THE PUBLIC WATER SUPPLY?

Abstract

Drinking water security plan system, based on the principles of prevention, the ensuring of the safety drinking water supply system is a highly recommended method of the WHO. The properly operated system is suited for taking into account the risk type of disaster situations and analyzing the risks arising from them. In many cases, however, the experts making the water safety plans do not expect a possible disaster situation, so they do not integrate into the plans the risks and risks management in such cases. In certain the cases of disaster types of situations, the author makes proposal to integrate them into the drinking water security plan system.

A megelőzés elvén alapuló ivóvíz-biztonsági tervrendszer az ivóvíz-ellátó rendszer biztonsága szavatolásának a WHO által kiemelten javasolt módszere. A megfelelően működtetett tervrendszer alkalmas arra, hogy a katasztrófa típusú veszély-helyzeteket is figyelembe vegye és elemezze és az ezekből adódó kockázatokat értékelje. Sok esetben viszont a vízbiztonsági terveket készítő szakemberek nem számolnak egy esetleges katasztrófahelyzettel, így nem építik be az ilyen esetekben előálló kockázatok és kockázatok kezelését a tervekbe. A szerző egyes katasztrófa típusú veszély-helyzetek esetében javaslatot tesz az ivóvízbiztonsági tervrendszerbe történő integrálásukra.

Keywords: *disaster, drinking water safety planning, water supply, hazard analysis, risk assessment, sabotage, extreme weather ~ katasztrófa, ivóvízbiztonsági tervezés, ivóvízellátás, veszélyelemzés, kockázatértékelés, szabotázs, rendkívüli időjárás*

MAJOR DISASTER RISKS IN OUR COUNTRY

According to the XXXVII Law of Civil Protection of 1996. the disaster is "any occurrence that threatens or damages many people's lives or health, the considerable property values of the population, their basic care, or endangers the environment to the extent, that cooperation of authorities, institutions and organizations is necessary to avert and control of it." [1]

Several possible approaches exist for grouping the disasters. Common characteristics of the groupings are that they do not differ in content. Mostly, classification of according to their origin and / or nature is known. Regarding their nature or origin, we can talk about natural and man-made disasters. Natural disasters, regardless of human activity, due to the forces of nature as a natural disaster occur, so to these the people are vulnerable. Their formation and occurrence not or only rarely can be prevented. The formation and occurrence of certain types of natural disasters are partially predictable in advance, such as a flood, inland waters, while in other cases, such as during earthquakes, drought, lightning, their occurrence is sudden, and cannot be detected in advance. The man-made disasters are always tied to some kind of human activity, which may be intentional or unintentional consequences of human behavior. They could occur as an effect of such as improper human intervention, negligence, deliberateness or due to technical errors. Such disasters are as malfunctions, road traffic accidents, or hazardous material to escape. [2]

The Directorate General for Disaster Management of HO (herein under: HO DGDM) prepared the document of "National disaster risk assessment" in 2011 in respect of our country, which was made as specified in the conclusions No. 8068/11, of the Council of the European Union. The main threat of disasters for Hungary has been determined in the document, as follows:

- "1.flooding and inland waters,
- 2. fires,
- 3. earthquake,
- 4. industrial accidents,
- 5. civilization / social nature disasters
- 6. extreme weather events. " [3]

The Council of the European Union recognized, in connection with the defense against disaster, the importance of risk analysis and risk assessment. It noted, that creating the base needed for the risk assessment and management analysis of preventive and preparedness measures contributes to improve the protection against disasters. In support of that view, on 7th April 2011 on the No. of 8068/11 it has given out the conclusion of „the *further development of risk assessment for disaster management in the European Union*,".

The goal is to reach a common understanding within the Member States, with the respect of the threat of future disaster events, which facilitates the co-operation in efforts to prevent and mitigate common risks. [4]

Possible effects of disasters on certain elements of the water supply system

As the most often occurring disaster in the water supply, the flood and water hazards, landslides, industrial accidents, sabotages and last but not at least, the extreme weather conditions should be taken into account.

Hazards from each disaster for some aspects of the water supply chain are certainly not the same chance to occur.

Our country is the mostly threatened by the flooding and drainage, as natural disasters. The water leaving the riverbed is not only causes destruction by its flow, but also to dwindle, as the water soaked everything, causing serious damage. For the purpose of the flood protection, there is 4,220 km long first rate dam in our country. [5] In terms of the water supply system the flooding may cause damage in the condition of the water sources (injury of water wells) and contaminate, further on can contaminate both the surface and ground water quality, primarily due to the existence of is pathogenic organisms.

On the one hand, the extreme weather can cause electrical failures, disturbances in the water supply system, or damage the water wells, aquifers, the buildings of the water supply system, water treatment technology elements, artifacts, and the pipe lines, for instance, which can be a high-strength tornado or lightning.

Landslides and earthquakes mostly can cause injury, from the view of the water supply, in the pipelines of the distribution network. But the damage of the wells also can be expected. If there is a large earthquake or a landslide, each element of the water supply system, may suffer any damages.

The sabotage and vandalism may occur caused by deliberate human behavior, which unfortunately could eventuality happen at each element of the water supply chain, almost with the same probability. The deliberate poisoning, polluting and / or toxic substances getting into drinking water are constituted terrorist acts, sabotage. The religious sects with extremist views, nationalist terrorist organizations and individual terrorists may threaten with the usage of radioactive, toxic and infectious substances to achieve their goals. The pollutants that cause infection can be got into the unguarded or inadequately guarded water base easily, by sickening thousands of people in this way. While, the water sources are exposed the most likely to such disaster events, the substances harmful to human health also can be got into the water treatment technologies or distribution networks. They may cause damage at the last element of the water supply chain. It is scary, but I'd like to mention as an example, that the drinking water system of a city with 2 million inhabitants could be completely poisoned by one pound of botulinum toxin. Therefore, especially our water bases, water resources are a matter of important security issue. [6]

Among the man-made disasters, the industrial accidents are important to mention, which may have a negative impact on the water supply as well. Our water resources are the mostly exposed to this kind of disaster risk. As a well-known example now I'd like to only mention the cyanide pollution of the Tisza river, which started from the wash hole operated by the Aurul Romanian-Australian joint-stock company in Zavar, and 800 times higher of the permitted level of cyanide impurities got into the river of Lápos then to the Szamos and finally to the Tisza waters, resulting nearly total extinction of the wildlife of the Tisza river, in January 2000. [7]

The potential disaster hazards that may occur at each element of the water supply chain are shown in Table 1.

	Water resource	**Water treatment**	**Distribution network**	**Consuming points**
Primary risk	flooding and inland waters	industrial accident, technical breakdown	industrial accident, technical breakdown	breakdown
	sabotage and vandalism	sabotage and vandalism	sabotage and vandalism	sabotage and vandalism
	landslide, earthquake	landslide, earthquake	landslide, earthquake	landslide, earthquake
	extreme weather	extreme weather	extreme weather	extreme weather
	radiological risk			
Secondary risk	breakdowns (wells, pumps)	further breakdown	further breakdown	burst in a water pipes, breakdowns
				occurrence of pathogens, microorganisms
				chemical contaminations

Table 1. The appearance of risks, arising from disaster for each element of the water supply system

As you can see, any sort of disaster event may occur at each element of the water supply chain. The drinking water supply is considered to be a critical infrastructure element. "Critical infrastructures include networks, resources, services, products, physical or information technology systems, equipment, devices and components, of which operation failure, disruption, downtime, or destruction, directly or indirectly, temporary or on long-term may have a severe impact on the citizens' economic, social welfare and on the functioning of the public health, public safety, national security, the economy and the operation of the government." [8]

In connection with the water supply, the following safety and property protection topics raise. During the defense planning and implementation, in the area of the objects to be protected in the water supply, in the interest of the high level operation conditions of the mechanical – electronic and manpowered sub-subsystems, the planned safety engineering subsystems - such as in line with the purpose of such water production facilities – the main point of view is the conformity of them. In order to achieve the overall protection, during its implementation, regarding their operation, the coordination of the autonomous subsystems and the ensurement of the conditions of the implementation of supervision are fundamentally important. [9]

Maintaining the safety of the drinking water supply is not exclusively confined to the physical protection of the objects and engineering structure, ensuring the water supply. To ensure good quality drinking water should also be prominent, even in disasters.

RISK ANALYSIS AND ASSESSMENT SYSTEM OF THE WATER SAFETY PLAN

On the bases of the recommendations of the World Health Organization (WHO), the most appropriate method of ensuring the guaranty of safety of the drinking water supply system is the development and maintenance of the water safety plan. The drinking water safety plan is a tool for detecting and reducing the water supply risks, and thereby improves the public health and safety. The plan is intended to guarantee that at the locations of the water sources, the raw water sources, and water treatment equipments, distribution networks and consumer points, determined clearly the responses for the risks, to provide the highest quality, and from the view of public health, proper drinking water to the end users. [10] The basis of the drinking water safety planning - should be an extensive risk analysis and assessment, which should be predominated for each element of the water supply chain, from the sourcing of the water to the consumer. It should include the hazard analysis, risk assessment and management, control, measurements and description of the monitoring system, complete with the appropriate response and contingency and emergency plans, as documented by leading through the entire water supply system. [11]

The preparation of the water safety plans helped on one hand by the publications of the WHO, the „Guidelines for Drinking-water Quality", on the other hand: "Guidelines for the construction, operation of drinking-water systems safety plan, information from the National Institute of Environmental Health, 1/2009.

Preparatory step of the planning is the creation of a group, who prepares the water safety plan. Most members of the group are leaders, engineers, water quality experts, technical operators. The first step of the assessment system is, to outline completely the water supply from the water base to the consumer. Next step is to identify hazards. The potential hazards are to be identified on each point of the water supply system (following the path of the water is the easiest). Then, the risks given by the hazards and their severity shall be given and determined assigned to them the appropriate control measurements. [12] The risks can be weighted, on the basis of which the intervention options will be ranked. The calculation of risk happens based on the assessment of the probability of occurrence and the severity of the consequences of the specific hazardous event. There are several possible methods for the risk analysis and evaluation. The application of the two-dimensional matrix is frequent. This method is also used in connection with the document of "National disaster risk assessment. To illustrate, the table below is a good example for it. [13]

Probability of the occurrence	Severity of the consequences				
	Insignificant	Moderate	Significant	Severe	Catasztrophic
Almost certain	5	10	15	20	25
Likely	4	8	12	16	20
Moderately likely	3	6	9	12	15
Low probability	2	4	6	8	10
Rare	1	2	3	4	5

Number of the points	> 6	6-9	10-15	< 15
Risk	low	medium	high	extremly high

Table 2. Simple scoring matrix used for ranking of the risks
(Source based on: WHO: Guidelines for Drinking-water Quality; edited by Berek) [13]

In connection with the operational monitoring and control, the control measurements of protection of water resources, water treatment, and distribution network and customer point must be established. The selected control points are to ensure that any operational or other disturbances can be detected, and immediately recognizable. For each control value, interventional limit value shall be defined. [14] In relation with the procedures of measures, each element of the drinking water system security plan shall be documented, including the evaluation of the system, monitoring system, recordings of the non-conformances, deviations, and the description of the interventions. Followed by the examination of the deviations, the appropriate corrective and preventive actions and communication processes shall be identified. [15] The water safety plan should include emergency measures, which should touch upon the description referring to emergency situations, the risk assessment, the tasks to be performed linked to the specific positions. The action policies should be designed so that with their help, both the occurring effects of the drinking water supply system operation and the outer effects endangering the safety of the water supply, situations should be manageable. The system of measures should provide both a review of the policies and the drinking water production processes, in the interest of the implementation of the necessary modifications. [16]

Obligations related to drinking water safety plans 201 / 2001 (October 25) the Government Decree requires the drinking water quality requirements and control arrangements. This Government regulation in December 2013, and based on the modification of the Gov. Decree of 430 / 2013 (XI 15) about the water quality requirements and the order of inspections of the 201/2001 (X. 25) Government Decree, the authority of the National Institute of Environmental Health (hereinafter referred to as OKI) significantly expanded, in relation with the drinking water safety plans. In legal sense, the release of the expert's opinion for the authority permissions of drinking water safety plans has become mandatory, which is prepared by OKI. At the present time, in the significant part of my work, I deal with the expertise opinions of the water safety plans. My insight into the drinking water safety plans are continuously growing.

RISK ANALYSIS AND ASSESMENT OF DISASTERS IN DRINKING WATER SAFETY PLANNING

Water safety plans should be based on the principle of prevention. In this way, during the disclosure of risks, such hazards shall be listed and collected, which may not have occurred in the context of a water supply system. This is not an easy task. The disaster type of risks, however, typically belongs to these types of hazards - which usually have not occurred yet.

In the cases most of the water supply system, for this type of risks fortunately there is no or hardly any example. Therefore, they can be simply got forgotten from the plan. Although their presence is mentioned in both the document issued by WHO in 2011, and the guide written by OKI 2009.

It is difficult to find the expected probability of occurrence of natural hazards in a certain area of water supply system. Furthermore, because of the probability of the occurrence of the disaster risk is so small, so in the calculation of the risk the value of occurrence is set 0, so that the risk can be obtained will be 0, due to the multiplication. Probably their indication in the plan and the risk assessment is considered to be unnecessary. The hazards even are worth being expressed and risks are calculated for them as well as indicating the relevant points of intervention, control measurements, monitoring system and supervisory scopes, if the probability of occurrence or the severity value is 0. Thus, it is more worth applying such risk assessment calculations, where the smallest probability and severity of the occurrence, expressed number is not 0, but 1.

The primary natural and man-made disasters in the rarest cases are the only threat. These can be considered to be as primary disaster risks, their effect cause additional hazards, sources of risks and risk events. (see Table 1) One of the dangers entail the creation of another danger, domino principle applies. For example, such as extreme weather causes structural damage of the wells. In this case, you will not only have to worry about repair of them, and it is not enough to look at the proper operation, and maintenance of the wells. Turbidity, oil pollution, and especially the overgrowth of microorganisms, pathogens that appear in the well water can be expected as well. Thus, not only the water quantity but also the quality problem appears.

Not only is a kind of technical problem, a risk event has occurred, but also - in the case of improper intervention - further hazard event will occurred, as a result of additional risk, such as the epidemiological hazard. On these occasions, of course, there will be many kind of intervention processes, which entails that each intervention point will have different monitoring process and to further a variety of monitoring activities, as well as a variety of troubleshooting and preventive action should be considered.

Based on my experience of drinking water safety plans, the primary disasters, especially the nature of their origin, rarely or not at all are shown. However, the secondary hazards generating from them has great emphasis. From the view of disasters, secondary hazards can be regarded as can develop themselves as well, and their formation are more frequent and substantial in a water systems 'life', so they are indicated as primary risk that require special emphasis is placed on the plans.

Although the risk is formulated by the WHO document, such a way, that any physical, chemical, biological and radiological agent can be considered to be danger, which has the potential to cause any damages, but the plans repeatedly miss to contain the radiological and radiological threats, so the risk assessment is left out.

Example for taking into account the risks emerging from disasters in the drinking water safety planning

Luckily, there are water safety plans, which included the possibility and risk of sabotage. There is a specific example to show it, in which, according to the water safety planning is not only the risk calculation is done but the necessary regulatory measures, intervention, and prevention opportunities, corrective activities are indicated as well. Currently, used in the risk analysis, the well-known two-dimensional matrix method was applied to calculate the risk. (Table 3 - Table 5 has been prepared from the simplified data sheets of Regional Water Supply Water Safety Plan of Sümeg [17].)

Serial No.	**Risk specification**	**Type[1] (S,B, K,F)**	**Description/ effect**	**Source**	**Control measures, referred documents**	**Proba-bility**	**Con-sequ-ence**	**Risk**
1	Drinking water storage in service pool	K	Toxic compounds in the water released for the network	Foul play, deliberate contamination	Service limitation, its shutdown	1	6	6
2	Drinking water storage in service pool	B	The colony number of the bacteriological characteristics of the network water is high / proliferation of other micro-organisms	Foul play, deliberate contamination	Service limitation, its shutdown	1	6	6

1, Type signs: S: radiation, B: biological, k: chemical, F: physical.

Table 3. Risk analyses data sheet for two foul plays case

Description	**Source**	**Intervention parameter**	**Intervention value**	**Proce-dure**	**Frequ-ency**	**Respon-sible**	**Note**
Toxic compounds in the water released for the network	Foul play, deliberate contamination	Intrusion, opening detection	--	Inspection	Occasi onal	Dispatch er	Event log
The colony number of the bacteriological characteristics of the water network is high / proliferation of other micro-organisms	Foul play, deliberate contamination	1. Intrusion, opening detection 2. Bacteriological characteristics of the water network	2. Number of the coliform bacteriums $x \leq 0$ number/100 ml 2. Escherichia coli number $x \leq 0$ number/100 ml 2. Colony number 22 °C-on $x \leq 100$ number/ml	1. Inspection 2. Laboratory-test examination	1. Occasi onal 2. Week-ly 1	1. Dispatch er 2. Areal laborator y leader	1. Event log 2. Labor subsystem

Table 4. Intervention opportunities for two foul plays case

Serial No.	Correction	Preventive action	Referred controlling	Note	Verifying person	Frequency	Evaluation
1. and 2.	Service limitation, its shutdown		Service limitation, its shutdown Water works mechanic/According to the controlling	Works log	Each employee of the water works	Occasional	I/N
1. and 2.		Prevention of intrusion of unauthorized persons	Service limitation, its shutdown Each employee of the water works / Immediate measures	Event log	Each employee of the water works	Permanent, continuous	I/N

Table 5. Corrective and preventive actions for two foul plays case

It can be concluded, that taking into consideration both the natural and social disasters in the drinking water safety planning is important. The mentioned two examples clearly show, that in the same way, you can proceed, and the risks can be taken in account, and parameters of intervention may be included, and the scope of the responsibles can be assigned, a variety of documented administrative options, preventive and corrective actions can be applied, like in case of the other non-emergency types of hazards, emergency events. The drinking water safety plan may therefore be suitable for the indication of the water supply chain disaster events that may occur, for enumeration, their analysis and risk assessment.

SUMMARY

The amount of the natural and man-made disasters has increased in recent years, against which defense and prevention new kind of approach was required. It was not enough to use the principle of prevention in the disaster management. The method of risk analysis and assessment, which provides a new approach to disaster management, allows more to prevent hazards. This type of approach has been formulated in our country as well, in the document of "National Disaster Risk". The measures of the HM DGDM Director-General of 63/2012. was issued, which determines the order of the set into practice of risk analysis procedures, and this document also supports the continuous enforcement of the domestic and international experiences and scientific findings. [18]

The drinking water safety planning used in the water supply for is a method also based on the risk analyses and assessment, which serves the principle of prevention. The principle of the method of managing the individual risks with the design of the water supply in our country arose nearly a decade ago. However, man-made and natural disasters can occur also in the water supply, which in my experience, most of the water safety plan does not cover.

They use risk analysis and risk assessment and management system, however, is highly similar to the methods used in disaster management as well. During the risk analysis, in both cases, the two-dimensional matrix method is the most likely to be used, the risks to which they assign numerically value to the risks, from the product of the occurrence and severity. Consequently, the approach and method is therefore the same.

In case of a possible occurrence of a natural disaster in the water supply or event of a disaster caused by men, the workers in different professional fields and in different places need to unite and to act against evolved situation together. And this time it's just a great convenience and advantage, if they apply the same perception and insight to stop and eliminate the arisen risk event together.

Taking into account the possible occurrence of natural and man-made catastrophic events in the water supply and their risks in the drinking water safety planning is important. The method and the approach of the system of drinking water safety plan could help better to manage the possibly formed disaster situations, in the area of public utility potable water supply.

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