Protection of Aquatic Ecosystems Against Accidents in the Czech Republic

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Abstract

The 21st century begins to be characterised by certain climatic changes that do not fit into common cycles of the past several centuries. In many regions, the level of surface water falls to the minimum level, especially in the summer months, and thus the risk of worsening the quality of water in the case of various accidents involving the inflow of contaminated water into watercourses increases markedly. The most common operating structures and equipment, which can supply this water to the recipient, are public and private sewerage systems. To reduce the given risks in newly formed conditions, it is suitable to implement a number of operational and technical measures that can minimize the risks to an acceptable and manageable level.

Keywords: water, aquatic ecosystems, contamination, climatic environment, risk management, vulnerability assessment, extraordinary event

Introduction

The 21st century finds itself in the state of global climatic changes. The given trend has not been scientifically investigated and considered entirely, but the majority of outstanding scientists dealing in climatology do not doubt about forthcoming changes. So far the share of human activities on the changes has not been clarified. Nevertheless, it is not important if it is a man or natural phenomena that are responsible but it is necessary to find a solution for the given state. This trend is enhanced on a world-wide scale along with growing population which has already exceeded 7 milliards people and more intense agriculture there is also a significant increase in water consumption. This happens also in the Czech Republic. After 1990, there has been charging for water abstractions and restructure industry to some decline in donations, but for the next period may not be sufficient to decrease water consumption. For example, for increased energy irretrievable water consumption from 118,7 mil.m^3 in 1990 to 141,5 mil.m^3 in 2012. If there is an accident in this period, from the ecological point of view a very serious situation may arise. For example, in 2012 the Czech Environmental Inspection registered 196 cases within the Czech republic[1] of surface water contamination due to accidents. The most numerous group of pollutants were oil substances. Out of the total number of accidents they represented 54,1% of cases, followed by waste waters with 9,7% , chemical substances with 9.9% [1]. In each accident what is always extraordinarily important is the readiness of entities who deal with the accidents. Within the Czech Republic three entities are strategic in the majority of cases:

- Fire Rescue Brigade of the CR
- Operators of Sewer Systems
- Water authorities

It is suitable for the organizations and authorities to have procedures prepared to fight contingencies threatening water ecosystems. One of the basic possibilities is processing of the following documents:

- developed risk management,
- developed crisis and emergency plan,
- connection system for crisis management,
- list of critical outfalling objects from the sewage system,
- list of premises with higher risk of a contingency for the ecosystem,
- list of mobile equipment suitable for co-action.

According to local conditions these and other documents/materials are always important for the elimination of the accident consequences and minimization of damage. In the preparation of primary analyses it is convenient to process a primary plan of risk management.

Cycle of basic target and system risk determination

Prior to the definition of an interactive cycle of risk assessment in running public and, in some cases also private sewer systems, in order to determine acceptable risks it is suitable to prepare a primary and secondary plan of risk management, See Figures 1 and 2.

Based on the made primary plan of risk management of public sewer system serviceability, in the secondary phase we prepared an ex-

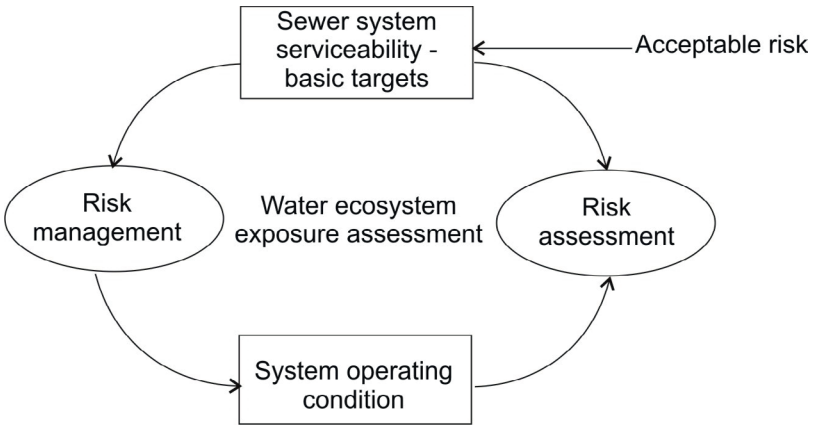

Fig. 1. Primary plan of risk management [modified 2]

panded plan [modified 2] by two basic control approaches.

Cycle setting basic objectives, risks of widespread scheme of risk management is an important prerequisite for the addiction study, criticality and the process of happening.

Examination of dependence of action process criticality

Before the tertiary level of the previous determination of risk management of water management entities it is necessary to examine the dependence of negation action on the state, sector and other entities of critical infrastructure in terms of disruption of standard operation or emergency regime in case of a contingency.

It is the quality of risk management preparation that frequently influences the minimization of damage on property and water ecosystems. The given material should be gradually processed by all operators of sewer systems to prevent needless secondary and tertialy damage which very often occurs due to lash-up solutions dealing with contingencies.

The principle methods of assessing security risks sewage waste water systems

The security risks have different degrees of importance in dependence on the aquosity of the given receiving body. In influent streams with minimum water flow volume in v m^3/sec. draining into the sewage treatment plant as shown in Figure 4, it is necessary to analyze the situation very carefully to prevent environmental damage to the aquatic ecosystem.

In the Czech Republic there is a large number of urban wastewater treatment plant opens out into small streams with minimal water flow and high volatility depending on the season.

It is not suitable to build on average annual values only, but current states must be considered according to seasons and simultaneously take into account the trends of water passage development in the receiving bodies, e.g. using the method of security risk assessment.

The basic principle of the method is carefully differential and strategically important evaluation of the individual criteria. The criteria should comprise the vulnerability factor, value of vulnerability or also a definition of its negative impact on the technical, public infrastructure and water ecosystems should make part of the evaluation. The vulnerability factor may be defined as follows:

- ability to protect the element,
- relative vulnerability to attacks,
- possible threats to health and life,
- environmental impacts,
- functional importance,
- evaluation whether the object is vital for functioning of public infrastructure,
- evaluation of danger for fauna in the ecosystem,
- evaluation of the object significance in dealing with a contingency, etc.

Vulnerability is assessed according to the above mentioned criteria while each criterion is, for example, evaluated by a four-degree scale (1–low, 2–medium, 3–significant, 4–high). From the partial criteria evaluation, the total vulnerability assessment is calculated, which permits a more illustrative risk assessment of the individual system elements. The method in question may be modified for individual cases, based on the examined system, irrelevant criteria may be omitted or, on the contrary, new criteria may be included, or subgroups of the criteria may be labelled differently.

In order to evaluate vulnerability in total, in the given case of sewer systems, the Table must also

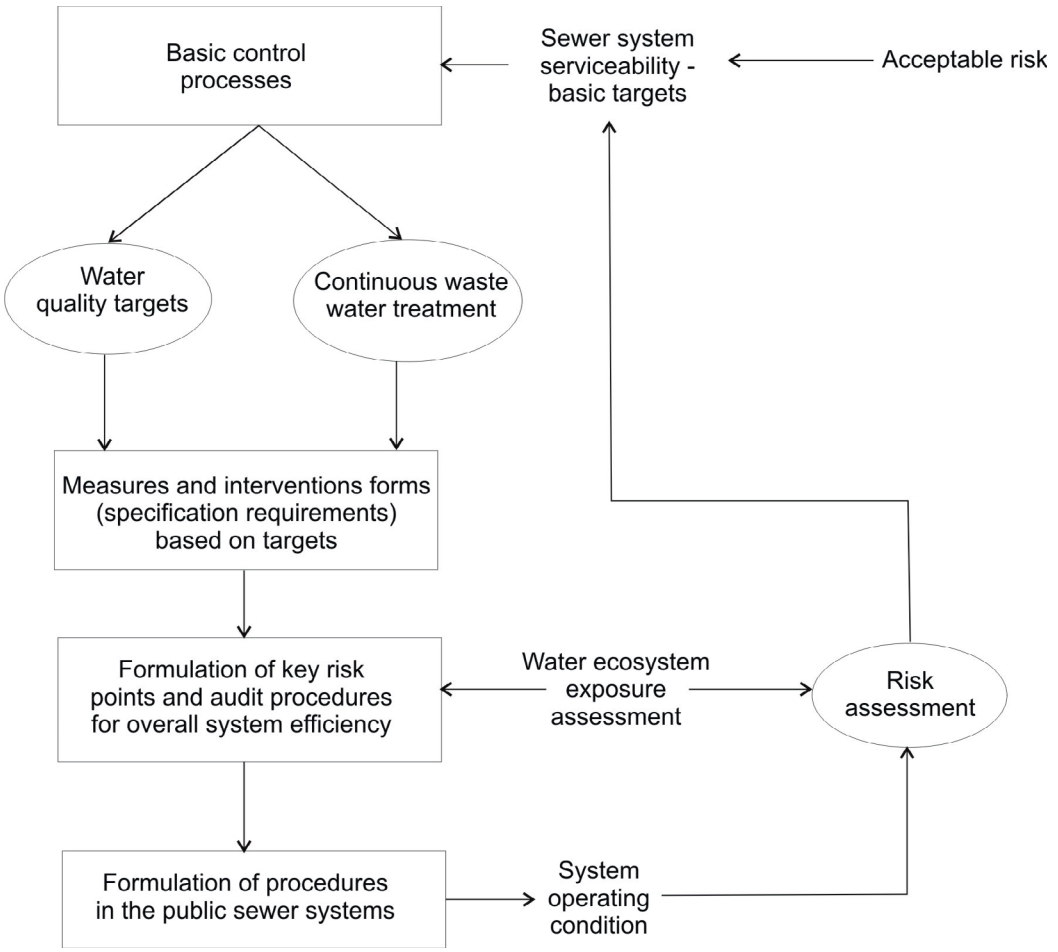

Fig. 2. Secondary expanded plan of risk management

define their basic functional units. The basic functional units of sewer systems are made up by:

- sewerage system,
- waste water treatment plants,
- free outfalls of untreated waste water,
- overflows,
- sewage pumping stations.

The evaluation of the vulnerability factor in the Table is carried out based on realistically acquired risks which endanger the given sector the most and which concurrently may have the most prominent negative impact on other public infrastructure and water ecosystems. For such purposes, for example, it is possible to use the vulnerability factor definition mentioned in the following table showing 14-degree scale, given in Tables under letters A–N. The definition of the vulnerability factors cannot be done routinely. Always, in the processed documents it is necessary to build on wider relations and bonds on the ground water quality analysis in the water course of the region in question, its flow rate, surface water pollution and prevailing risks, which threaten in case of a contingency caused by natural phenomena, technical failures or potential terrorist attacks.

Total assessment of vulnerability

Legend to the assessment

- The assessment is carried out using a four-degree scale (1 – low vulnerability, 2 – medium, 3 – significant, 4 – high vulnerability) according to 14 criteria. The total assessment of vulnerability of the individual parts of the system may theoretically reach 56 points in maximum.
- The stated vulnerability assessment does not take into account the attractiveness for terrorist attacks on the individual parts of the system. The attractiveness for terrorist attacks is evaluated by a separate criterion – rate of dangerousness of the system.

Note:

It is apparent from the Table that in principle, it is not possible to effectively protect public sewer systems against natural phenomena or deliberate criminal offences, or terrorist attacks. At the same

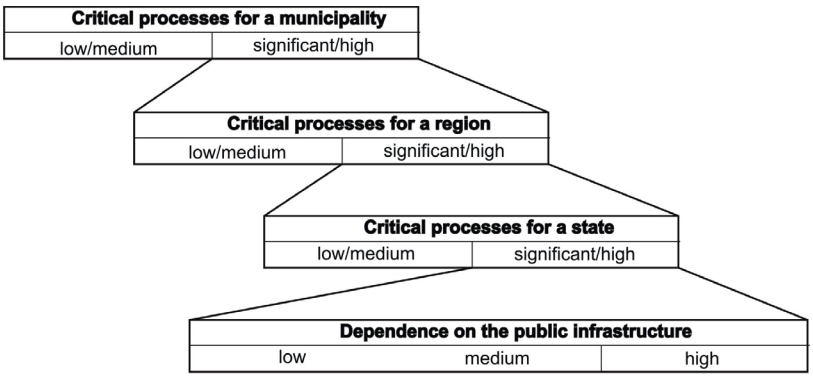

Fig. 3. Dependence of elimination of public sewer systems on the public infrastructure, modified [3]

Fig. 4. Sewage treatment plant with an outcome into a small water resource

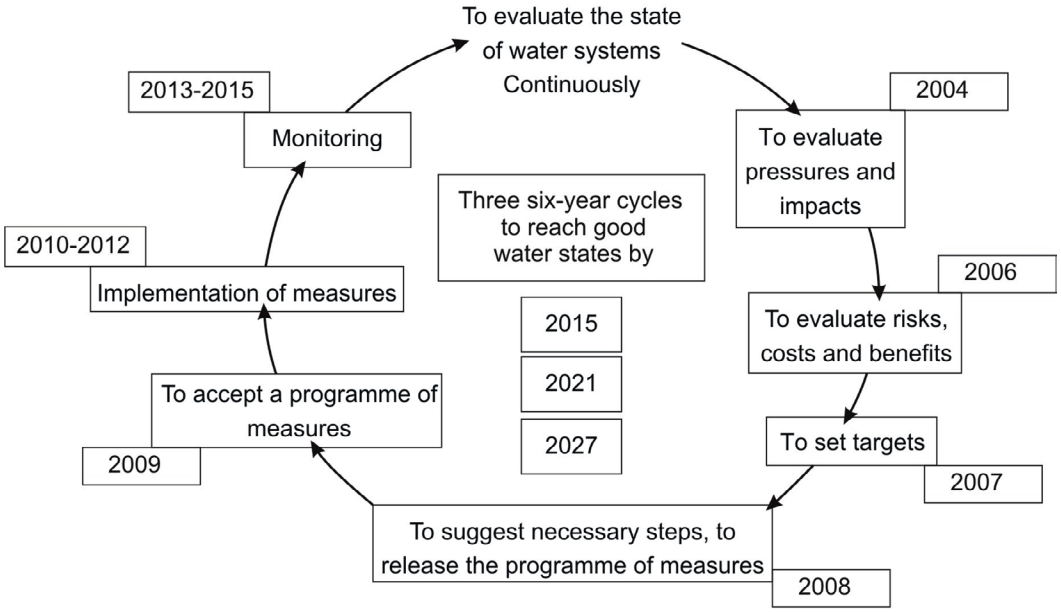

Fig. 5. Process of significant improvement of European water [4]

Tab. 1. Vulnerability assessment of system parts of waste water drainage and treatment

Critical element	Vulnerability factor														Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	assessment
Sewer system	4	4	4	1	3	3	4	2	3	2	1	1	4	1	37
Waste water treatment plants	4	4	4	2	4	4	4	4	2	4	2	3	2	1	44
Free outfalls of untreated waste water	4	4	4	1	3	3	3	1	1	2	1	1	3	1	32
Overflows	3	4	2	1	3	2	3	2	1	2	1	1	2	1	28
Sewage pumping station	4	4	4	3	3	3	3	2	1	3	1	1	4	1	37

time, it implies a high level of vulnerability of the system and negative impacts in different seasons of the year, impact on the quality of surface water. The majority of accidents and their negative effects on the environment may be eliminated to an acceptable minimum through a quality risk analysis. This minimum may be further reduced by the co-operation of the units of the Integrated Rescue System with relevant waterworks companies and water-managing authorities.

Conclusion

The drawback of the current analyses of risk factor assessment in water management is their regional dimension and a limited temporality. In analyses or estimates it is suitable to accept the idea that water has always been and will be a basic precondition for life on Earth with no exception. Its protection must be a priority of all countries. In medium-term horizon, See Figure 5, the water ecosystem assessment must be complex with no respect to state borders or boundaries of higher regional complexes.

As an indispensable precondition for human life as well as for other animals, water has no limits. Therefore, it is necessary to maximally protect the raw material and use it in a way its majority returned into the natural water cycle without more serious physical damage. Perhaps this article will contribute to the reflection on water protection against contamination caused by human activities or insensitive approach to aquatic ecosystems.

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