Water management development trends in the 21st century

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Abstract. To ensure the long-term sustainability of each technical infrastructure it is necessary to know the alternative development trends in the raw material base and the technical development of the systems in questions. The findings are valid for non-renewable sources. Even these renewable sources of raw materials and water can have a very significant capacity differences in different time periods. One of the causes of unevenness in the aquatic ecosystem abundance in the world is today’s ongoing global climate change. It raises already among other things, the considerable movements of the population from the affected territories and the trend which will be probably potentiate. The following article is the basic scope of this issue and indicates the ways in which to recognise the treat in a timely manner and the use appropriately chosen methods to minimise its effects to an acceptable level.

1. Introduction
Aquatic ecosystems and their long-term sustainability in the world are essential prerequisites for flora fauna and human life concerning population. Historically it is widely known that in the past the country has undergone a wide range of climate change from a very warm period through the Ice age. Even today one of these climate change is underway. The scientific teams examine how the human population shares this change and what the work is the natural act. Climate change will bring negative and also positive developmental trends. In some parts of the world it will allow economically viable areas to be exploited in others it triggers a major climate change and the need to move people and their economic activities to other areas. From the whole spectrum of changes, the most dramatic and with highest negative impacts will be on the water ecosystems. It will certainly force a significant change in access to the surface and groundwater treatment including those for drinking purposes. The current person gradually lost the opportunity without endangering health and life to use a drinking water technologically adapted for the purpose. Accelerating the concentration of people into the relatively small areas of the big city, industrial agglomerations provokes and will in the long term induce higher demands for the production connected with this indispensable raw material, thereby also unevenly to draw raw surface or groundwater from aquatic ecosystems [1]. Obviously, with increasing water consumption, the production of waste water will also increase, which needs to be treated to prevent further pollution of surface water, as research suggests [2, 3, 4].

This will increase the imbalance between need and natural possibilities in a number of countries around the world. There are already a few billion people with acceptable access to quality drinking water and the number of these people will be getting higher the whole 21st century [5].

2. The treat of drinking water shortages for its consumers.
With the upcoming passive balance of water supplies suitable for treatment on drinking water it is necessary to closely monitor the developmental trends of decreasing inventories and to look for the cause of this physical phenomenon. With the shrinking volume yield of drinking water sources it is possible to expect at the same time a higher substance load of these waters not only from natural sources
but also anthropogenic causes in particular from old ecological burdens and excessive use of inorganic substances in agriculture and forestry activities. The sample phenomena tend to change the original physical and chemical composition of the water substantially until the state of its unavailability to water supply purposes. For example, in the European Union countries drinking water cannot be produced yet from sources other than crude water fulfilling the water criteria A1, A2, A3 [6]. The criteria cannot be maintained in the real environment of individual states only by some one-off measures, but only by a long-term trend in evaluating the quality of surface water or ground water and by adopting appropriate operational and safety measures. The basic cycles to achieve good status of aquatic ecosystems are shown in Figure 1.

![Figure 1. The process of significantly improving European waters quality [7].](image)

The process of improving the long-term sustainability of water ecosystems surface or ground water quality must never be closed. Depending on the scientific knowledge about the effects of individual actions and influences, the possibilities for ways and technical means to realistically not only in time but also in the economic possibilities of the individual states, the negative trends in question should be further explored. Given that it is not possible to resolve all the threats at the same time, the operational programmes reducing at least the biggest threats must be carefully weighted and scientifically supported. Throughout 21st century this primary threat will be climate change. Recognising the emerging risk of global change in the natural environment depends on whether, in coming years, the human society will be able react adequately to the upcoming new living conditions and the possibilities for their use for the human population.

3. Risk identification and its scope for different areas of state infrastructure

Ensuring the uptime of the countries’ infrastructure in the world depends on many factors. The common denominator of all modern infrastructures in towns and municipalities is to maintain a seamless supply of drinking water in operation. Without its supply it is not possible to use the housing stock to operate accommodation and other services and in particular to produce food and to ensure very important functions as in hospitals and other types of medical facilities. With the modernisation and higher technical equipment of households and operational files, the requirements for the reliability of drinking water supply are increasing. For certain systems, emergency supplies of drinking water in this event of water supply services can be ensured in the case of a disruption to a large extend. However, the solution
is not sufficient for the infrastructure of towns and municipalities, including critical infrastructure elements of the state. These entities are fully dependent on direct and reduced supplies, drinking water from the water mains with the usual hydraulic parameters. If there is a risk that the supply of water to the strategic consumer will be interrupted for various technical and operational reasons, it is necessary not only to realize the risk in time but on the other hand also to know how to work with the threat. The risk is most commonly expressed in accordance with the Czech State Standard as a combination of frequency and probability of occurrence of a specific undesirable condition and its consequences [8]. For the need to quantify the risk, they can be expressed by the following symbolic relationship:

\[ R = P \times C \]

in which
- \( R \) - measure of the risk
- \( P \) - frequency (or the probability) of danger occurrence (unwanted condition)
- \( C \) - consequences of the unwanted condition

Unwanted conditions and uncertainty connected with it are considered to be two main components of the risk. Public administration and crisis management work with risk in different documents. Risk and security threats are covered in crisis plans, crisis preparedness plans for major actors and other legislative or working documents [9]. However, in many cases the solution to the issue is too formally and statistically with a slow response to emerging threats. For example, in new climatic conditions there may not be enough water for long-term maintenance of the territory function, its infrastructure and also for fire protection of buildings extinguishing water from natural sources. One of the options, particularly in border areas and the most endangered state floods, is international cooperation on water management [10]. In the area of water management, water supply and other associated industries, new threat trends and their consequent negative impact on the natural environment and human populations are not yet adequately investigated. In particular, the following areas are concerned:

- development and use of chemicals relationship to the latest scientific knowledge and their long-term impact on human populations, fauna and flora
- the impact of the transport infrastructure development on the infiltration ability of rainfall depending on the soil environment in new climatic conditions
- the growing trend of rainfall inequality, their intensity and negative consequences on the extend of scientific knowledge of the process and the technical possibility of eliminating emerging security risks
- considering new study disciplines introduction in universities dealing with systematically new climatic threats for 21st and 22nd century

The above mentioned and other development trends of solutions to emerging and already ongoing threats can have a major impact on the overall solution in the early implementation. For example, in the section of aquatic ecosystems and water supply, they can take the following form.

4. Consequences reducing and development trends ensuring long-term water constructions sustainability

Water, in all physical forms, unlike other energy sources, have to be seen as a renewable primary raw material for the flora, fauna and human populations survival. In spite of water resources recoverability, it is necessary, with increasing human population in the world, to fundamentally change the current approach to the general management of water and its industrial treatment [11]. Last time the meteorological and the next hydrological drought is a very discussed topic as well as the possible threat itself [12]. One of the basic steps of changing the current approach to addressing the existing security
threats is to optimally incorporate them into the landscape configuration, taking into account qualitative and quantitative elements, see Figure 2.

**Figure 2.** Diagram of the alternative process of evaluating crisis situations [8].

This model suitable for aquatic ecosystems and water systems can be adequately applied to most of the construction and operational systems of the technical infrastructure. Although they have to always respect the sectoral fair values of the subject under consideration, which have a major impact on the end effect in the incident reduction.

In development trends and water management efficiency it is necessary to reduce the natural environment abstraction in every state in the world. In water supply, this given requirement may be met by a substantial reduction in water losses in local water supply networks by increasing the hydraulic efficiency of the pipe series.

Water losses reduction in the drinking water system have to be accompanied by further steps to ensure that the quality of distributed water is maintained throughout its flow through the pipe line to the final consumer. Simply reducing the volume of realized water threatens to change the hydraulic parameters in the subsequently relatively oversized water supply network, increase the delay time, reduce the level of health protection of water and consequently occurrence risk of incidents about health consequences for water consumers. In the current scientific knowledge of the process and the technical possibilities of their monitoring, this risk can be considerably minimised.

### 5. Discussion

Development trends can never be a fixed quantity. Their content is constantly changing depending on the natural environment and anthropogenic threats. Given the current situation it is therefore appropriate to define their ongoing discussion. In the present time it could be focused on the following areas:

- focusing on the development of monitoring technology and its sensitivity to increase current theoretical knowledge of hydraulics and hydromechanics of surface and ground waters,
- the discussion whether to change or maintain the current trend in the use of plastic materials in the water industry in the light of the latest scientific knowledge.

### 6. Conclusion

Water as one of the most vulnerable natural substances can no longer be left to its own development in the face of new treats. Industrialization of the territory and human intervention into the natural environment tend to accumulate and increase the emergencies consequences. This article suggests how
to reduce dangerous development risk in the field of water management and how to minimize the given trend. In the file with other preventive measures mentioned in this paper it is possible not only to identify the threats in time, but also to minimize them sufficiently and to an economically feasible extent.

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