# Industrial Landscape in the Period of Hydrological Drought

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*Abstract*

*The natural environment as a living organism changes continuously. Sometimes changes are gradual, other times they are relatively fast. Now the earth is experiencing a significant change that will affect hundred millions of people, especially in the area of surface water and groundwater deficit. The mentioned situation is beginning to manifest itself in the countries of the European Union as well. It will affect not only populations but also subjects of public and private infrastructures in various regions. Areas with high water consumption due to company manufacturing activities that are simultaneously situated in the climate zone of areas threatened by hydrological drought will be affected most severely.*

*With reference to the magnitude of the mentioned problem and its potential negative influence on the production basis as well as the environment of affected regions, the submitted article deals with methods and measures for coping with and eliminating newly emerging threats.*

*Keywords: aquatic ecosystem, water, water use, industry, hydrological drought, region, the environment*

**Introduction**

In the 21st century, the threat of water shortage of global extent is on the way. As a consequence, already at present strong population migration takes place and the given trend will continue with the increasing intensity of climate changes. The given changes will not only affect current areas of tropic and subtropical zones, but also, from the point of view of water use, will become evident in the temperate climate zone. The regional shortage of surface water for standard activities of industrial companies and also a decrease in groundwater resources used primarily for the withdrawal of water for drinking purposes can be expected, and nowadays even already documented.

According to prognoses in the conclusions of the UN climate panel and studies of scientists concerned with climatology and hydrology, the given trend will continue. As a consequence, this will require crucial changes in approach to water use not only in the natural environment but also in various companies and energy sector. Almost undoubtedly, it will be necessary to reassess operating regulations and regulatory rules for all hydraulic structures in the EU countries and amounts of permitted surface water withdrawal from recipients for industrial activities. It cannot be excluded that in the following years and decades, permitted water withdrawal limits will be decreased markedly and requirements put on the purification of discharged pre-purified industrial water will be increased.

For the creation of new conditions and basic changes in water use there is not much time left. The new situation cannot be avoided or ignored. User unpreparedness for reduced water amounts may result, in extreme cases, in the cessation of or considerable reduction in production activities.

**The influence of hydrological drought in regions**

In the area of the Czech Republic, there are not any significant surface water inflows from the surrounding countries that could improve the hydrological balance. The Czech Republic is fully dependent on the rates of rain and snow precipitation in individual years. At a decrease in or non-uniform distribution of the rates (storm rainfall), usable water volumes for the public water supply needs, industrial withdrawal and aquatic ecosystems are gradually reduced. The severity of the situation in various regions with focus on balance water resources is documented in the following figure.

In the figure can be seen clearly the regions of the state that are threatened already now by the shortage of water necessary for maintaining the current extent and function of infrastructure. Water authorities of areas threatened by shortage of water for use will be forced, probably as early as the year 2016, to order individual industrial entities to decrease the withdrawal of water from recipients and to modify the minimum residual flow of water in recipients, necessary for the ecological reservation of function of the water stream.

**Water shortage threat to citizens and infrastructure**

The Water Act [2] imposes a duty upon the water authorities to supervise maintaining the optimal way of surface water and groundwater use. To fulfil the given

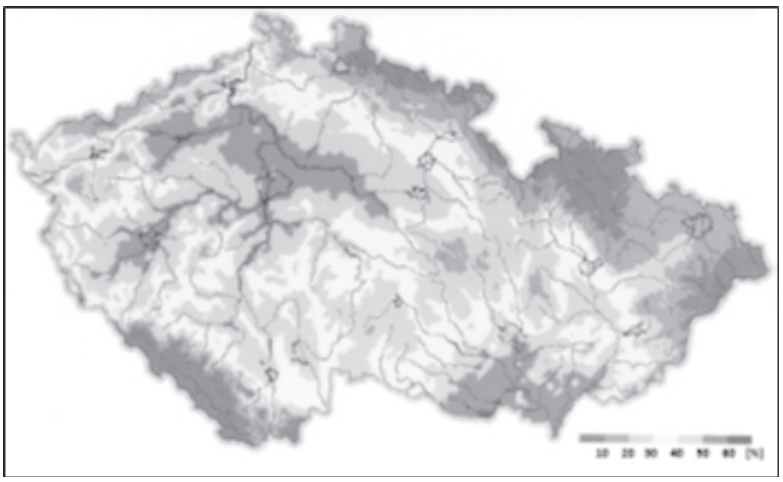

Fig. 1 A general map of the extent of hydrologic drought in % [1]

Rys. 1 Ogólna mapa suszy hydrologicznej , % [1]

task, the authority has many powers to enforce the provision concerned, if necessary.

One of these measures is, for example, a reduction in permitted withdrawal volumes for especially large users in the case of water shortage. The similar activity of the authorities can also occur with a change in water quality in the period of hydrological drought.

***Threat to the quality of raw water from the point of view of its treatment to drinking water***

Surface water as well as groundwater has a permanent tendency to changing quickly its quality for various reasons and binding a number of undesirable substances. If under standard conditions, "merely" its quality worsens, in the periods of hydrological drought the change can become critical.

The worsened quality of water will threaten the natural environment for fauna and flora of the given aquatic ecosystem and the water can also become non-treatable for the purposes of water supply. The given situation will happen mainly in the case of recipients with a decreased flow volume of water at a constant organic and inorganic matter load, e.g. during the discharge of purified municipal and industrial wastewater.

If insufficiently purified wastewater threatens seriously surface water, then old environmental burdens in the industrial landscape will almost surely lower the existing quality of groundwater. The situation is even worse because the water is used by citizens of the industrial landscape without further treatment for drinking purposes.

With regard to the fact that the human society has not yet any effective means to prevent climate change, attention must be nowadays paid at least to reduction in the hazard of water loading with harmful and dangerous substances.

***Change in possibilities of water withdrawal for industry from the point of view of balance.***

By alternative shortage, especially of surface water used for industrial purposes, the large part of infrastructure facilities in the industrial landscape will be threatened. It is mainly the case of entities taking water in the zone of negative balance of resources. In many catchment basins of the EU countries, the situation in surface water resources in recipients and reservoirs is already beginning to be serious, see Figure 2.

At present, the volume of water in the water structure presented in the figure is merely 20 percent of the original volume of accumulated water. It can be expected that owing to the shortage of snow and rain precipitation, the situation will not change for better, but on the contrary, the situation will probably even become worse considerably in summer months.

A similar situation will probably happen again regularly in the areas of negative water balance presented in Figure 2 in the period of long-term hydrological drought. Ways and measures suitable for dealing with the negative environment of aquatic ecosystems are presented basically in chapter 4 of this article.

***Threat to the sufficiency of water for fire protection in built-up areas***

By hydrological drought not only sources of drinking water and non-drinking water will be threatened but also almost certainly the number of withdrawal points in the sources of natural origin for firefighting water will decrease. All manner of local minor watercourses maybe will not have at least temporarily any flow rate or the flow rate will be minimal. A similar situation may occur in the case of accumulated water suitable for the fire protection of built-up areas by means of water of natural origin, see Figure 3.

Fig. 2 A water supply reservoir designed for the supply of industrial water
Rys. 2 Zbiornik przeznaczony do zasilania wodą przemysłową

Fig. 3 A dry reservoir intended for area fire protection
Rys. 3 Suchy zbiornik przeznaczony do ochrony przeciwpożarowej

If in the next years of the 21st century similar phenomena happen in municipalities fully dependent on fire protection from local surface water accumulations, preconditions for fast and efficient firefighting interventions will worsen significantly. Mobile (shuttle) transport from rather distant firefighting water sources not only will decrease the present level of fire safety of structures, but also will be a cause of increasing material damage as a result of shortage of water for firefighting purposes.

**Measures for and possibilities of elimination of safety risks of water shortage**

Ways and measures suitable for significant reduction in or elimination of safety risks induced by meteorological and subsequent hydrological drought, stated in the previous chapter, are presented briefly in the text below.

***Passive measures to reduce the hazard of water shortage to be implemented***

Passive safety measures are usually basic operational safety elements of risk reduction. It is suitable to use the properties of these measures also in the introduction of preventive measures reducing the consequences of hydrological drought.

To the basic passive measures enabling consequence reduction, the following items belong:

• change in agricultural-technical way of cultivating agricultural land for the purpose of increasing the infiltration capacity of soil,

• essential rapid change in the composition of farm crops on sloping land,

• gradual change in the composition of forest land resources, including the formation of artificial ponds in a forest environment,

• re-valuation of the function of ameliorative structures with a view to put them gradually out of operation,

• construction of new hydraulic structures in recipients, with a view of maximal delay in outflow of water after heavy and storm rainfall in individual catchment areas,

• construction of artificial hydraulic structures enabling the efficient infiltration of rainfall to groundwater in deficit areas threatened by hydraulic draught,

• change in and enhancement of the existing function of polders with a view of permanent improving surface water management in the groundwater deficit zones.

The above-mentioned passive and other measures following from the risk analysis of the region concerned must be, almost always, supplemented by active measures to use water, especially for the needs of energy industry and industrial activities.

***Active measures for and ways of reducing the threats of water shortage in regions***

Active measures improving relatively rapidly the management of surface water and groundwater can be implemented at low acquisition costs. The advantage of them is, on the contrary, both permanent reduction in operating costs and preparedness of subjects for the operation of technical and economic infrastructures in crisis situations.

To the basic active operating activities decreasing markedly the risk of shortage of drinking and industrial water during hydrologic drought, above all the following measures belong:

• making the safety analysis of risks and critical points of existing operations support systems by the methods of risk engineering,

• based on the outputs of the analysis, to adopt corrective measures aimed at minimization of consequences of extraordinary events on operations support systems,

• verification of the hydraulic efficiency of water supply operations support systems with a view to enable their operation at reduced or emergency supplies of drinking and non-drinking water,

• ensuring effective monitoring in the whole process of water management; on the basis of it then in crisis situations putting out of operation that part of equipment that does not fulfil parameters of hydraulic

efficiency and operation in emergency conditions as a result of hydrological drought.

By suitable combination of the active and passive measures, the maximum result of operation of infrastructure facilities and building complexes even in the most complicated alterative situations can be achieved.

**Conclusion**

From the submitted brief article dealing with the difficult situation due to the influence of hydrological drought on natural environments and operational needs of industrial agglomerations it follows that on condition that the mentioned procedures and measures will be used the situation can be handled.

However, there is not much time left for the effective risk reduction and elimination. Any delay in the implementation of countermeasures will result in not only useless material damage but also long-standing environmental damage to any landscape. In the case of industrial landscape, risks of severe up to irreversible damage are even amplified.

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## *Krajobraz przemysłowy w okresie suszy hydrologicznej*

*Środowisko naturalne jako żywy organizm zmienia się w sposób ciągły. Czasami zmiany są stopniowe, czasami są stosunkowo szybkie. Teraz Ziemia doświadcza znacznej zmiany klimatu, która dotyczy setek milionów ludzi, szczególnie w obszarze deficytu wód powierzchniowych podziemnych. Wspomniana sytuacja zaczyna się również ujawniać w krajach Unii Europejskiej. Wpłynie to nie tylko na populację, ale także na infrastrukturę publiczną i prywatną w różnych regionach. Obszary o dużym zużyciu wody w związku z działalnością produkcyjną, które znajdują się w strefie klimatycznej obszarów zagrożonych suszą hydrologiczną, będą odczuwały największe zagrożenie.*

*W odniesieniu do wielkości omawianego problemu oraz jego potencjalnego negatywnego wpływu na produkcję, a także na środowisko, przedstawiony artykuł dotyczy metod i środków zapobiegania i postępowania z nowymi zagrożeniami.*

*Słowa kluczowe: ekosystem wodny, woda, wykorzystanie wody, przemysł, susza hydrologiczna, region, środowisko*