Threats of Water Contamination in an Industrial Landscape

Šárka KROČOVÁ[1)]

[1)] Doc. Ing., Ph.D.; VŠB-Technical University of Ostrava, Faculty of Safety Engineering, 700 13 Ostrava-Výškovice, Lumírova Str. 13, Czech Republic; email: sarka.krocova@vsb.cz

DOI: 10.29227/IM-2015-02-21

Abstract

An industrial landscape and industrial agglomerations have a whole series of characteristic properties and features that distinguish them markedly from a natural landscape. In the beginning of the 19th century, industrial landscapes began to be formed in places of finding of some of various types of natural resources of the state concerned. Subsequently, towns with another big technical infrastructure changing the natural landscape pattern have been developed in their surroundings. At present, some industrial zones can also be regarded as industrial landscapes. A primary feature of all industrial landscapes, especially heavy industrial landscapes, is emission releases to air and gradual contamination of groundwater and surface water due to industrial activities.

Although emissions remain in air for a relatively short time, then contamination, especially groundwater contamination, has long persistence and acts very frequently even after termination of source operation. With reference to the fact that water is a precondition for the life of humans, fauna, flora and the functions of infrastructure of towns and municipalities, it is necessary to cope with the effects of water contamination in a way that minimizes the given risks and maximizes the result of the solution adopted.

The following article defines natural and anthropogenic threats arising in an industrial landscape, their negative influences on aquatic ecosystems and a means of minimizing their negative effects. The effects of these threats are to be reassessed with regard to the changing world climate and a gradual decrease in freshwater resources. The reassessment is necessary because the volume of inorganic contaminants in old environmental burdens remains the same, but the volume of water decreases, and thus the current quality of water for drinking, agriculture and industrial needs changes.

Keywords: the environment, industrial landscape, risk, water, contamination, solution, developmental trends

Introduction

In 19th century with the scientific development and technological knowledge it came into being first industrial complexes. Their primary feature was mainly production and goods production, irrespective almost untouched nature. The negative result came very soon. There has been substantial air quality deterioration, only in the immediate surroundings of industrial plants and a gradual reduction in groundwater and surface water quality in particular recipients.

With the increasing number of industrial areas the situation culminated on the whole European continent already within the first half of the last century. Fortunately, responsible staff and scientists realized in time that the trend continuation is unsustainable for the nature, later for people, and that it is completely devastating. To avoid deepening of the resulting state and its gradual improvements there was adopted a huge number of legislative steps and technical countermeasures. Some of these steps have only a national character but most of them have already an international dimension in the European Union. Currently there is a special group of leading scientists and climatologist from the whole world under the auspices of OSN which follows up issues concerning environmental protection.

Despite of the considerable progress in the environmental protection the situation is not satisfactory especially in developed countries. Why is this so and if it is possible to change the situation for better quickly suggesting the following post on the Czech Republic example.

Industrial agglomeration in the context of the environment in the Czech Republic

The Czech Republic is a sufficiently illustrative example of large agglomeration formations in the world. Industrial agglomeration does not create itself at any point in the state but it is primarily bonded to mineral resources. Secondarily places, where it is possible to process local or imported raw materials efficiently and get a higher value in total.

In the Czech Republic it is primarily the area of northern Moravia and northern Bohemia. Both mentioned localities have had and still have sufficient amount of raw material sources for heavy industry development and connected light industry. Given positive for the state can become for nature, with energy resources rough handling, a very grave danger. The proof is easy to see during the last century, especially its first half.

Both sites negative impacts will be necessary to solve at least until the mid-21st century. Where-

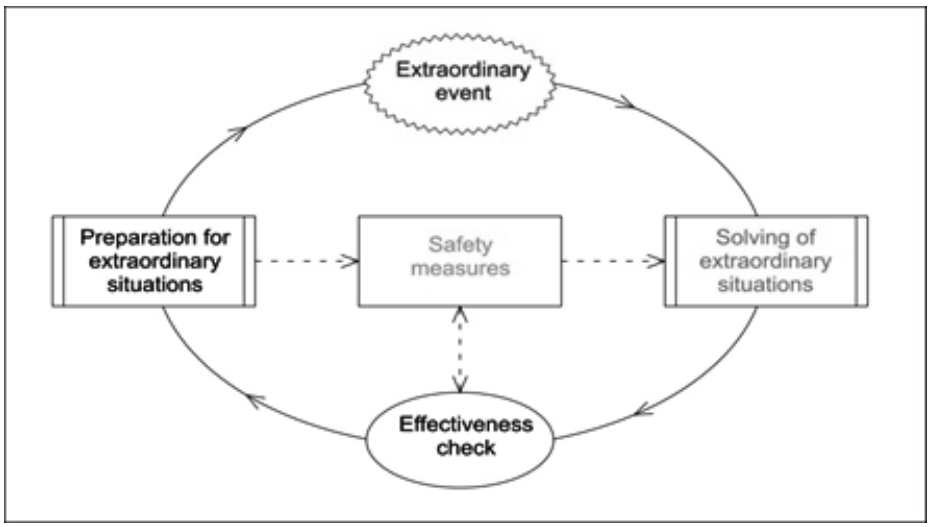

Fig. 1. Conception of management of extraordinary situations in the Czech Republic [1]

Rys. 1. Zarządzanie kryzysowe w Republice Czeskiej [1]

as their solutions were neglected in the primary stage they have a cumulative effect and thus increasing disposal costs. Some negative industrial activity impacts disappeared automatically by sources extinction, for example air pollution, other still remain. In particular the aquatic ecosystems deterioration and original natural environment in the area cope with built changing environment effects and transport infrastructure to new conditions. Some threats are constantly serious and unsolved, others have a potential to be solved over the next decade.

Are threatened of natural environment disruption real?

Already in the beginning of this charter may be stated that the natural environment threat caused by human activities are always realistic. However, with a wide range of human activities the nature can cope itself at different time intervals. Some special incidents may disrupt flora and fauna environment structure, so that the response may take many decades, in extreme cases even several centuries. In particular we speak about the civilisation effects phenomena which give raise to technique, social and economic impacts depending on their input intensity.

Scientifically and industrially developed state has always means which may defend negative phenomena in prevention or if they occurred, decrease them. This mean is a safety system and its organizational and operational components. There is a sufficient coordination between emergency plans and plans for emergency preparedness in particular subjects with a high degree of accidents risk; it is possible to minimize accidents risks in the industrial landscape. Accident risks and subsequent special events can be only minimized. Realistically absolute security cannot be fully achieved in practice. For this reason it is necessary, based on risk analysis, to know potential hazards and also their impact on region or state environment.

Which environment areas have the highest risk degree?

Almost always the most vulnerable environment parts in the industrial landscapes are aquatic ecosystems. Given conditions are causes by water which smoothly accepts wide range of substances and has ability to dissolve these organic or inorganic substances quickly.

Unlike areas with a little or no industrial activity occurs in industrial agglomerations wide huge number of hazardous and extremely hazardous substances which may in risk underestimation seriously damage the natural groundwater and surface water environment. If there occure an accident and leakage of these substances in the area of water collector, the source of water can be excluded for the operation until its decontamination.

From the group of hazardous and extremely hazardous substances are mainly included following substances:

Hazardous substances

- substances which have an harmful effect on water taste or smell intended for water drinking,
- toxic or persistent organic silicon compounds and another compounds which may give raise to such water compounds,

Fig. 2. Technological object destruction cause by flood event [2]

Rys. 2. Zniszczenia spowodowane powodzią [2]

- inorganic phosphorous and fluorides compounds,
- silage effluent, industrial and farm manure and aerobically stabilized compost.

In the conditions of Czech Republic it is not allowed to produce drinking water from any surface or groundwater but only from waters that fulfil quantitative raw water indicators. Apart from hazardous substances mentioned above the raw water quality may compromise metalloid presence, metals and their compounds, presence of lead, arsenic, chromium, uranium and other substances listed in the Water Act.

Extremely hazardous substances

- organohalogen and organophosphorous compounds,
- substances showing carcinogenic, mutagenic or teratogenic properties in the aquatic environment or its influence,
- cyanides, cadmium and its compounds,
- mineral persistent oils, petroleum origin carbons, persistent synthetic substances which may float or sink into water intended for water treatment.

Most of these hazardous or extremely hazardous substances are increasingly found in industrial agglomerations and industrial areas. They occure not only in closed-cycle production processes, but also occure increasingly in industrial plants wastewaters.

The Water Act imposes special producers in their effluent handling before discharge into recipients or sewage system for public use but the practice is often different. Some of these environmentally hazardous wastewaters usually leak and infiltrate into the soil and cause a long-term negative effect in groundwater quality.

Ways and risk reduction possibilities of aquatic ecosystem damage

Outside the gradual but continuous natural environment industrial landscape undesirable substances from primary or secondary danger sources, the aquatic ecosystem is relatively often endangered by alternative special events. Despite the security measures decreasing it can be never excluded extraordinary event formation at two basic areas:

- natural effects,
- anthropogenic events.

Every responsible technical infrastructure operator, mainly infrastructures handling dangerous and extremely hazardous substances, must be ready for an extraordinary event formation. In prevention terms, contingency planning or emergency development preparedness plans of subject should be based on an actual emergency risk respect. The procedure is illustrated in the following figure 1.

When planning safety measures to reduce emergency risk and the range of emergency it is necessary to take into account not only own risks which may arise during the production cycle, but also the environment in which the factory is located. Large industrial agglomerations are usually displaced at relatively vulnerable landscapes areas in terms of nature effects.

Natural effects in the industrial landscape

In real practice industrial agglomerations almost always occure in the flat area near water

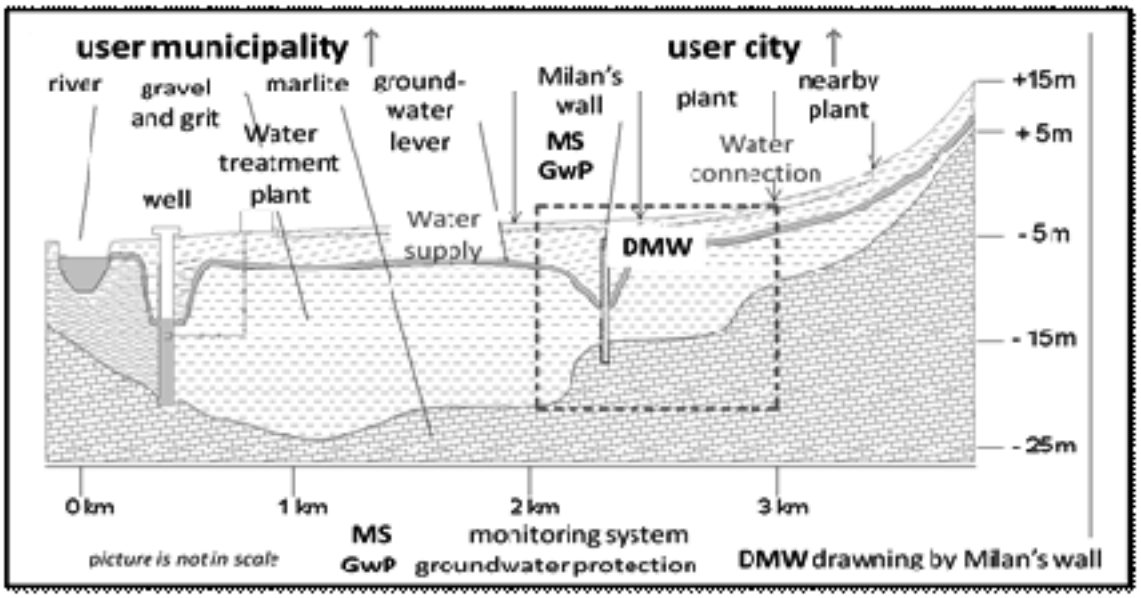

Fig. 3. The diagram of Milan's wall at the source of groundwater contamination

Rys. 3. Wykres Milana dla źródła zanieczyszczenia wody powierzchniowej

flows. This is given historically and resulted from various factors necessary for efficient materials transportation and high water process consumption in industrial plant. At the same time it gives a higher subjects risk by natural phenomena action. The most serious natural phenomena is flood event, see figure 2.

After relatively quiet period in the end of 19th century and a large part of 20th century the number of floods is increasing in the whole world. The huge number of industrial enterprises was convinced in Moravia (1997) and in Bohemia (2002). It can be expected that similar events will be repeated several times in this century. It will cause big material damage in industrial subjects and seriously damage environment because of a big amount of harmful substances leakage in industrial landscape. As it has been already mentioned the most serious damage almost always occure in aquatic ecosystem. Putting aquatic ecosystem to a steady state can take several years to decades.

Anthropogenic events in industrial areas

More often than natural phenomena, with less negative effects, there are anthropogenic events in industrial landscape. Types of events are following:

- technological equipment for raw materials processing accidents,
- warehouse and chemical containers accidents,
- linear constructions accidents.

Above mentioned events and a lot of another are mostly caused by occurrence risk underestimating.

If the technological equipment and chemical product storage can be relatively easy to minimize by building safety modifications (impervious tub), the situation is more complicated with linear constructions. Detailed analysis of the risk accident should be always preceded to constructions themselves. The analysis should turn into results what kind of building materials will be used for pipeline, in what ways the monitoring and hydraulic efficiency will be operated and how the building control system will be conceived.

Given that the most of existing industrial agglomeration was carried out in completely different safety and operating conditions (low safety and ecological parameters), also old environmental burdens are parts of it.

Old environmental burdens of industrial landscape

Old environmental burdens in industrial landscape are the biggest threat for aquatic environment and aquatic ecosystems. Especially because of the groundwater quality and harmful substances treat. It is necessary to have permanently in the mind that down sources closing does not mean water pollution elimination. Spot threat groundwater contamination can resist for hundred years. One possibility how to protect water source, mainly source of drinking water, against secondary contamination is illustrated in figure 3.

That level of water resources protection is relatively capital intensive and cannot be used in any location. To fulfil 100% its purpose the protection must be waterproof and therefore it is difficult to implement it in undermined and geologically unstable area. In many cases it can be achieved adequate water sources contamination by hydraulic barrier construction. Thanks to observation wells which are connected to groundwater monitoring systems it is possible to see on-line its real quality, in case of exceeding specified limits of this groundwater, it can be drained away before its own affluent [3].

Conclusion

From this post dealing with water protection operational and safety problems in industrial landscape it is showed that current scientific knowledge and technical awareness in the Czech Republic allow to protect water in industrial landscape effectively against alternative substances contamination. The protection must result from risk analysis not only to be effective, but also economically implemented according to local conditions. It cannot be forgotten on investments costs in building security systems and operating costs which can be in wrong implementation way higher than investment costs.

Literatura – References

1. Kolektiv autorů. 2008. *Zranitelnost kritické infrastruktury.* Ostrava: VŠB – TU Ostrava.
2. Ondeo Suez, [citováno:12.11.2007]. Available online: <http://www.ondeo.cz/>.
3. KROČOVÁ, Š. 2013. "Contamination of Water with Noxious and Hazardous Substances." *Inżynieria Mineralna* 14(2): 131–136.
4. MONOŠI, M., JÁNOŠÍK L. 2014. "Tactics of interventions in traffic accidents [Taktika zásahovej činnosti pri dopravných nehodách]." *Bolyai szemle: a nemzeti közszolgálati egyetem katonai müszaki tudományági folyóirata* 3: 297–305.

Zagrożenia krajobrazu przemysłowego skażeniem wody

Krajobraz oraz aglomeracje przemysłowe przedstawiają całe zestawy charakterystycznych cech i właściwości, które znacząco odróżniają je od krajobrazu naturalnego. Na początku XIX wieku krajobrazy przemysłowe zaczęły się formować w miejscach wydobywania różnego rodzaju surowców naturalnych. Następnie w okolicy rozwinęła się infrastruktura techniczna, która odmieniła elementy krajobrazu naturalnego. Obecnie niektóre strefy przemysłowe również uważane są za krajobrazy przemysłowe. Podstawową cechą krajobrazów przemysłowych, a w szczególności krajobrazu przemysłu ciężkiego, jest emisja do powietrza oraz stopniowe zanieczyszczenie wód lądowych i powierzchniowych. Jest to spowodowane aktywnością przemysłową.

Choć emisja pozostaje w powietrzu w relatywnie krótkim czasie, to z kolei zanieczyszczenie wód, w szczególności lądowych, pozostaje na bardzo długo, a jego skutki zagrażają na długo po zakończeniu aktywności przemysłowej. Biorąc pod uwagę fakt, że woda to podstawowy warunek istnienia ludzkości, fauny oraz flory oraz efektywnego działania infrastruktury miejskiej i gminnej, ważne jest znalezienie takiego sposobu walki z efektami zanieczyszczeń wody, który zminimalizuje ponoszone ryzyko.

Niniejszy artykuł omawia naturalne i antropogeniczne zagrożenia powstające w krajobrazie przemysłowym, ich negatywny wpływ na ekosystem wodny, oraz sposoby na minimalizację tego wpływu. Oddziaływanie tych zagrożeń należy ponownie ocenić ze względu na zmieniający się światowy klimat oraz stopniowy zanik źródeł świeżej wody pitnej. Ponowna ocena jest konieczna, ponieważ o ile ilość zanieczyszczeń nieorganicznych w dawniej obciążanych środowiskach pozostaje taka sama, to ilość wody maleje, dlatego obecna jakość wód pitnych oraz na potrzeby rolnictwa i przemysłu wymaga poprawy.

Słowa kluczowe: środowisko, krajobraz przemysłowy, ryzyko, woda, zanieczyszczenie, rozwiązania, trendy rozwojowe