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TYPES OF POLLUTION AND POSSIBILITIES OF IMPROVING THE MONITORING OF FRESHWATER ECOSYSTEM

Summary*: A significant problem in environmental protection, especially in the field of water resources, is the quality of surface waters. Large quantities of untreated or insufficiently treated waste water arrives directly into the open watercourse and underground of it, degrading and disrupting their natural ecological balance. Complex use of surface water imposes the need to constantly monitor its quality and to provide better protection of it against pollution. The most dramatic effects of water pollution are encountered in surface waters, even though groundwater is also not spared. Water pollution involves the degradation of water quality that partially or completely prevents its use for the purpose for which it is intended. Water protection is a complex problem and requires an interdisciplinary approach to the problem of water protection and teamwork.*

Key words*: water pollution, eutrophication, cyanotoxins, monitoring*

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INTRODUCTION

Today, typical sources of individual groups of pollutants and their effects (effects) to the aquatic ecosystems recipients are well known (Gajin and Svirčev 2002, 46). However, it is important not to leave out other types of pollution, because the circulation of substances in the hydrosphere also includes the circulation of pollutants, and hard-biodegradable chemicals have a negative impact (selective lethal impact) on hydro-bionics, or otherwise their bioaccumulation happens.

The intensity, nature and duration of the effects of pollution on sanitary regime, the chemical composition of the water and the living conditions of aquatic organisms determine their properties. Reducing compounds that are easily oxidized by oxygen dissolved in the water, are causing a sudden disruption of the water balance of the basin immediately after discharging waste water. In contrast, some of the biologically degradable organic compounds (pesticides with organic compounds of chlorine) can be detected in the water far (tens and even hundreds of kilometers) away from their inflow into the basin. Infringing the life activities of aquatic organisms and deterioration of water quality can be cause by compounds that produced by some groups of microorganisms in the basin (microalgae toxins, antibiotics, etc.). For stagnant and slow surface water to which hydroacumulations belong, large-scale development of algae is characteristic. Ecological importance of microalgae and cyanobacteria as producers of organic matter in aquatic ecosystems can have both the positive and negative characteristics. As primary producers of aquatic ecosystems, with extremely high nutritional value of biomass, microalgae and cyanobacteria are of utmost importance for the life of all hydrobiota. However, primary producers may, under certain conditions, be a significant source of unsolicited, usually toxic substances for aquatic wildlife, and nearby terrestrial ecosystems (Gajin et al. 1998.64).

1. SOURCES OF POLLUTION

Water pollutants are numerous and can be classified to “concentrated” and “bulk” (diffuse) pollutants (Dalmatia 2000, 22). It should be borne in mind that the adverse effects of diffuse pollutants usually do not manifest

now, but have the cumulative effect over an extended period of time, which further complicates the analysis of their impacts and possible consequences. Agriculture is considered to be one of the biggest polluters of surface water and groundwater. According to the Environmental Protection Agency (EPA), agriculture is the predominant factor in the degradation of waters. In doing so, the most common adverse effects of diffuse pollutants to local waters, according to the FAO, arise due to the accumulation of nutrients (37% in rivers, 40% in accumulations) and sediments (45% in rivers, 22% in accumulations), followed with a share of 20-30 % in pesticides, heavy metals, pathogenic microorganisms and so on. (Savić and associates 2002, 16). The increased concentration of nitrogen and phosphorus in water causes a stronger development of higher aquatic plants that have an ability of healing of the water pane (reservoirs, canals) and other water bodies with slow current. To develop massive phytoplankton, algae that cause blossom it is sufficient to increase the concentration of phosphorus in water up to several mg in 1 h. Changes in water quality at the time of flowering and disturbance of the oxygen regime in the mass phytoplankton and aquatic vegetation dying out contributes to the deterioration of water quality. As a result of these processes, there is an increase of organic compounds in drifts and the increase of nutrients in the water body, that is, accelerated eutrophication of the basin happens. (Đukić and Ristanović 2005, 227)

1.1. Eutrophication and "bloom" of aquatic ecosystems

Cyanobacteria bloomings that draw special attention occur in the accumulations for water supply, irrigation, recreation, in ponds and in hydro system. Danger due to the occurrence of cyanobacteria bloomings in aquatic ecosystems comes from several reasons. Dense blooming may block the passage of light into the water, thus preventing photosynthesis process which ultimately leads to the mortality of wildlife in the water due to a complete lack of oxygen. Toxic blooming can harm the health of humans and animals and can also harm the stability of the flowering and the surrounding ecosystem. Cyanotoxins, that are considered to be among the most potent natural toxins for which there is no suitable antidote, are usually excreted in the water during the flowering. For these reasons, it is

necessary to know the conditions that accelerate blooming of cyanobacteria, and to implement prevention and rehabilitation of aquatic ecosystems (Svirčev and associates 2011, 12).
Due to numerous adjustments and lack of challenge in eutrophic waters, they are fully capable to overcome other species and to create a very large biomass, the process we call blooming of cyanobacteria (Svirčev and Sedmak 2011,16). All changes of state and processes in aquatic systems directly affect the living world of water, and plant and animal species as indicators of water quality at the same time represent with its life activity an active participant in the formation of this quality. Due to the importance of eutrophication impact on the quality of water, great attention is paid to this process (Dalmacija 2001, 25).

1.2. The Effects of Cyanotoxins

Various cyanotoxins have different modes of action; Cyclic peptides of micro purifying type in their work are focused on the liver, alkaloids act on the nervous system and are neurotoxic, lipopolysaccharide, which are dermatotoxic act on the skin and mucous membranes (Sedmak and Svirčev 2011, 7). Considering that cyanotoxins can be lethal in relatively small amounts, each occurrence of cyanobacteria blooms in aquatic ecosystems must be seen as a potential threat to the living world. Until recently it was thought that only 10% of the toxic blooms is toxic, however recent research in Europe, Canada and the United States have shown that the percentage is much higher and ranges from 45% to 75%. Among cyanotoxins the most widespread and the most tested is microcystin (MC). The presence of ADDA (3-amino-9-methoxy-2-6.8-trimethyl-10-phenyl-deca-4,6-dienoic acid) is unique and particular in the structure of the microcystins and plays an important role in its biological activity. The toxicity of microcystin is reflected by the inhibition of a serine / threonine protein phosphatases 1 and 2A, enzymes that are especially important in the regulation of genetic, metabolic and physiological processes in all living organisms (Stryer 1995, 67). Especially sensitive to these toxins are liver cells, because once they enter into hepatocytes the microcystins localize in the nucleus, where ADDA toxin chain blocks the active site of the nuclear protein phosphatase (Mackintosh et al. 190). In this way, intoxication leads to disruption

of the structure and function of the liver, necrosis of hepatocytes and ultimately to hemorrhage. Aside from liver damage in case of acute poisoning, hypoxemia, cardiovascular collapse and shock may also occur. Because of the frequent problems that occur due to exposure of the human population to cyanotoxins, the World Health Organization (WHO) has established that the maximum permissible concentration of microcystin LR in drinking water is in the amount of 1 g / l. In some cases, it is possible that the concentration of microcystins in water is significantly higher, especially in countries where there are no statutory allowable values and monitoring of these parameters. For this reason, the limit values for cyanotoxins should be revised and carefully introduced into domestic legislation (Svirčev and associates 2011, 13).

1.3. Control of Cyanobactera Blooms

The most effective long-term measure is to prevent or reduce the intake of nutrients from flowing into the water body. This is the best measure because it has no side effects. So, in that way, so the new hazardous chemicals do not enter into the water and therefore we reduce the possibility of carcinogens in contact with organic products, as it is the case with chlorination of potable water obtained from the surface reservoirs. With different treatment of cyanobacteria in water bodies sudden release of large amounts of harmful active substances into the aquatic environment can occur. Treatment of the flowering aquatic ecosystems with herbicides, algaecides, copper sulfate or lime is not recommended because it leads to rapid death of the cyanobacteria cells and instant release of the larger amount of cyanotoxin into the water. Beside this, there is an additional burden to ecosystem in the form of unnecessary chemicals. (Svirčev and Sedmak 2011, 9). One of the ways to control includes regular maintenance of rivers and waters used for water supply, by combining technique for eliminating stratification and reduction of release of nutrients from the sediment into the water pool.

The measures to prevent the external and internal nutrient loads can reduce the frequency and size of cyanobacterial blooms in a specific aquatic system. The internal nutrients cycle can usually be prevented with the treatment of lakes such as aeration. In this way, movement of water can be achieved which helps to maintain a constant temperature from top to bottom

of the water ecosystem. Ecoremediation has a special role in restoring the ecosystem. Natural cleansing in the ecosystems is based primarily on the activities of microorganisms and plants that can survive in polluted water or soil by absorbing, degrading or neutralizing harmful waste products.

1.4. Fecal Contamination of Surface Waters

Fecal contamination is one of the most important issues when it comes to microbiological water quality. The presence of fecal microorganisms in water is considered a good indicator of the potential presence of intestinal pathogenic microorganisms in the water. In surface water, pathogenic microorganisms originating from the intestinal tract of humans are not desirable because the growing problem of water supply is more and more being solved by their use as water intake facilities. Various microorganisms may be present in natural and waste water - bacteria, viruses, protozoa.
Viruses, in relation to environmental conditions, have a greater degree of stability than pathogenic bacteria and have an ability to maintain longer in the water. Complex tests have shown that, among the enteroviruses, bacteriophages of intestinal bacteria can be used as sanitary indicators. Protozoa are unicellular organisms. Some protozoa have the ability to form cysts (cocooned forms of microorganism waiting for favorable conditions for development) that can survive in water or feces for a long time, and the conditions in which the protozoa would not survive. Organisms such as *Entamoeba histolytica*, *Giardia* and *Cryptosporidium,* arrive into the water supply system (water source) through fecal contamination (of human or animal origin). Protozoa cysts, such as *Cryptosporidium* and *Giardia*, can be effectively removed from the water intended for human consumption by using slow sand filters (Đukić and associates 2000, 47).

2. MONITORING FRESHWATER ECOSYSTEMS AND IMPROVING MONITORING

The aim of testing the quality of surface aquatic ecosystems is to determine the status, indentify the pollution and surveillance zones, as well as to provide input data for the design of comprehensive water monitoring in the future and approaching the integrated river basin management, in

accordance with the ecosystem approach and sustainable development of the region. In order to ensure long-term rational exploitation of water, it is necessary to preserve the functional integrity of aquatic ecosystems (Gajin and Svirčev 2000, 274).

Control of point source of pollution is the first link in a complex chain to safeguard hydroecosystems. However, the emission standards that in the world have very important role in water conservation politics are not legally regulated in our country, and regulation in the field of water conservation are based on the so-called emission standards. Instead of emission standards, the law provides, in the case of waste water discharges directly into surface waters, analysis of their impact on the watercourse. In practice, this is tantamount to taking a sample of the current on the river upstream and downstream of the discharge, but tests involve the same parameters as in the effluent. (Dalmacijia 2001, 25).

The most important parameters used for monitoring are water temperature and air temperature, salinity, chlorophyll, as well as vertical and horizontal flow of water due to the transfer of toxic producers. Knowing weather and geographical distribution of inorganic substances and their sources, as well as other phytoplankton growth factors, is certainly of great importance for the planning and execution of the monitoring program. The issue of water protection is an extremely complex problem that requires an interdisciplinary approach and teamwork of experts of various profiles.

In doing so, different norms and standards on water quality, as well as prohibition on the import of waste and harmful substances, a ban on the marketing of substances that do not decompose, etc. are prescribed. Important measure is the obligation of the construction of the sewerage network and construction of wastewater treatment plants.

The regulation of the discharge of hazardous and harmful substances in natural water must be in accordance with the Water Act, the Regulation on water classification and categorization of watercourses, as well as with all the other regulations for the protection of the environment, regulations for waste water treatment plants, whereby local conditions in the recipient should be taken into account in the technological, environmental and economic sense. In the case of substances for which there are no relevant international standards, establishing of limit of the allowable values shall be governed by a

separate procedure on the basis of data on toxicity, bioaccumulation and persistence of these substances in the aquatic environment whilst taking into account the technical possibilities of their removal, the risk to human health and techno-economic analysis of different removal procedures.

CONCLUSION

Pollution of aquatic ecosystems is mainly the result of uncontrolled discharges of pollutants of various origins.
A large contribution to the preservation of aquatic ecosystems is legislation that prescribes the exact amount of allowable concentrations of substances that are imported into waterways and the introduction of biological parameters as mandatory. The problem of our legislation is that it is based only on the principle of physical-chemical analysis as the only indicator of water quality and the user approach, instead of the ecosystem approach to the issue of protection. It is necessary to introduce regular monitoring that would include regular analysis of water samples to determine degree of water saprobity, chlorophyll analysis and determination of phosphatase activity of water. The level of phosphatase activity reflects the balance of the total organic load of aquatic ecosystems as a recipient of allochthonous contaminants.
Monitoring the presence of toxic and potentially toxic strains of cyanobacteria in aquatic ecosystems in order to assess the environmental and health risks due to the cyanotoxins presence is very important. Special emphasis should be put on microcystins as they are considered to be the most present in the waters with a conspicuous flowering phenomenon. Water protection is a complex problem and requires an interdisciplinary approach to the problem of water protection along with the teamwork.

REFERENCES

1. Dalmacija, Božo. 2000. Kontrola kvaliteta voda u okviru upravljanja kvalitetom. Novi Sad: Institut za hemiju.
2. Dalmacija, Božo. 2001. Kontrola kvaliteta voda. Novi Sad: Institut za hemiju.

3. Đukić, Dragutin i Gajin, Slavka i Matavulj i Milan, Mandić, Leka. 2000. Mikrobiologija voda. Beograd: Prosveta.
4. Đukić, Dragutin i Ristanović, Vitko. 2005. Hemija i mikrobiologija voda. Novi Sad: Stylos.
5. Gajin Slavka i Svirčev Zorica. 2000. Biološki aktivne materije mikroalgi i zdravlje ljudi. VIII Kongres mikrobiologa Jugoslavije – uvodno predavanje. Kratki sadržaji radova 273-274.
6. Gajin, Slavka i Svirčev Zorica. 2002. Prirodne organske materije u vodi. Novi Sad: Departman za hemiju, PMF.
7. Gajin, Slavka i Svirčev, Zorica i Matavulj, Milan. 1998. Biološki aktivne materije viših biljaka, algi, gljiva i bakterija. Novi Sad: Institut za biologiju PMF-a.
8. Savić, Radovan i Belić, Sima i Belić, Anđelka. 2002. "Poljoprivreda kao rasuti zagađivač voda". Rad prezentovan na konferenciji, Zaštita voda 02. Kopaonik, Srbija, april, 15-20.
9. Sedmak, Bojan i Svirčev, Zorica. 2011. Cijanobakterije i njihovi toksini – Ekološki i toksikološki rizici i cvjetanje cijanobakterija u Srbiji, Visoka škola za varstvo okolja/EPC-Environmental Protection College, Velenje, Slovenia.
10. Stryer, Lubert. 1995. Biochemistry. W H Freeman & Co, ISBN-10: 0716720094.
11. Svirčev, Zorica i Baltić, Vladimir i Simeunović, Jelica. 2011. Cvjetanje cijanobakterija u Srbiji. Putevi ekspozicije, zdravstveni i zakonodavni aspekt. Novi Sad.
12. World Health Organization. 1998. Guidelines for drinking water quality,2 ed. Addendum to Vol.1.pp.13-14. Geneva,World Health Organization