EUTROPHICATION PHENOMENA IN RESERVOIRS

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ABSTRACT – Eutrophication phenomena in reservoirs. If in the last few decades eutrophication represented an isolated incident affecting only some small lakes, now, dam projects have the potential to change the flow of nutrients and energy flow in river systems. Often, they provide ideal conditions for algal blooms, leading to eutrophication of the lake.

In this paper, the authors aim to provide the mass trophicity level assessment of water in the Solesti lake, other issues and mitigation of eutrophication.

Keywords: eutrophication, trophicity level.

1. INTRODUCTION

The deteriorating quality of terrestrial water resources has been one of the largest and most widespread environmental problems in the world. Eutrophication is a particularly severe problem for reservoirs. It represents a focus of applied ecology and ecosystem management in many parts of the world.

Many aquatic ecosystems have become more eutrophic over the past decade due to increasing of anthropogenic inputs of nutrients, in particular nitrogen and phosphorus. Typical symptoms of this process are the sudden bloom of obnoxious algae species and the frequent occurrence of visible water coloration.

The "trophic status" of lakes is the central concept in lake management. It is based on overall system productivity and is a function of physical features (latitude and elevation as they affect sunlight and air temperatures, ratio of watershed to water body areas, reservoir depth or hydraulic residence time), chemical features (nutrients, oxygen) and biological responses (primary productivity, zooplankton and biomass).

Table 1. ***Relationship between trophic levels and lake characteristics***

Trophic status	**Organic matter mg/m^3**	**Mean total phosphorus mg/m^3**	**Chlorophyll maximum mg/m3**	**Secchi depth m**
Oligotrophic	Low	8.0	4.2	9.9
Mesotrophic	medium	26.7	16.1	4.2
Eutrophic	high	84.4	42.6	2.45
Hypertrophic	very high	750-1200		0.4-0.5

Therefore, eutrophication represents the process of change from one trophic state to a higher trophic state by the addition of nutrient.

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2. TROPHICITY LEVEL EVALUATION IN SOLEŞTI LAKE

Figure 1. ***Soleşti lake satellite view***

The Soleşti lake is situated at about 20 km from Vaslui, near the village Soleşti, on Vasluieţ river. From this reservoir the Vaslui city is supplied with drinking water. It has an area of 452 ha and a volume of 15.8 million cubic meters.

There are necessary two categories of analysis to determine the phenomenon or the degree of eutrophication in reservoir:

– level of trophicity is characterized by chemical analysis of the main nutrients; the acquired results may be affected for example by an accidental discharge;

– assessing the quantitative development of phytoplankton.

In order to assess the level of trophicity water mass, a method that determines an index trophicity based on the next relation is used:

$$IT = \log RT \qquad (1)$$

where: IT - trophicity index; RT - trophicity ratio, which is calculed with:

RT = phytoplankton biomass (mg/l) / value (5 mg/l) (2)

The results are compared with values from trophicity scale in table 2.

Table 2. ***Trophicity scale***

Trophicity class	IT Value
Ultraoligotrophic	Under –1,222
Oligotrophic	-1,222…- 0,222
Mesotrophic	-0,222…0
Eutrophic	0…1,000
Polytrophic	1,000…1,301
Hypertrophic	Over 1,301

This method is applied on Soleşti lake to obtain the results for the lake eutrophication state in 2009 (table 3).

Table 3. ***The results for Soleşti lake***

Collection point	Phytoplankton (mg/l)	RT	IT	Evaluation
Near dam	3.452	0.6904	0.1608	Mesotrophic
Outlet dam	3.032	0.6064	0.2172	Mesotrophic
50 m from dam	3.271	0.6542	0.1842	Mesotrophic

Phytoplankton density varies between 202.500 ex. / l and 1.33 million ex. / l, the average value being 576 875 ex. / l and algal biomass between 0.82 mg / l and 4.91 mg / l. The mean value of - 2.41 mg / l frames the accumulation in oligotrophic lakes category. Total phosphorus ranges from 0.105 MGP/l and 0.329 MGP/ l, the mean value of - 0.185 MGP / categorise the accumulation in hypertrophic lakes. Total mineral nitrogen varies between 0.13 MGN/l and 1.54 MGN/l, mean value of 0.346 MGN / framing the accumulation in oligotrophic lakes.

The values of chlorophyll "a " is between 4.93 mg/l and 49.83 mg/l, mean value of - 25.83 mg/l categorise the accumulation in hypertrophic lakes.

As indicators of the eutrophication degree, the Solesti reservoir fits in the mesotrophic lakes.

Table 4. ***The characterization of Solesti reservoir function trophic state***

No	Reservoir	Water course	Total phosphorus (mgP/l)	Total mineral nitrogen mgN/l)	Chlorophyll "a " (µg/l)	Phytoplankton biomass(mg/l)	Trophic state	
							2009	**2008**
1	Solesti	Vaslui	H	O	H	O	**M**	**E**

UO – ultraoligotrophic, O – oligotrophic, M – mesotrophic, E – eutrophic, H - hipertrophic

Therefore, in 2009, the Soleşti lake was framed in the mesotrophic category, function of phytoplankton biomass and trophicity level.

3. THE IMPACTS OF EUTROPHICATION PROCESS

The problems derived from eutrophication affect the quality of water in reservoirs used for irrigation and human consumption, but they also have an adverse effect on the river and reservoir fauna.

The water body becomes anaerobic due to the decomposition of the dead algae that can lead to excessive consumption of dissolved oxygen. The anaerobic conditions can cause death of fish and other macro organisms.

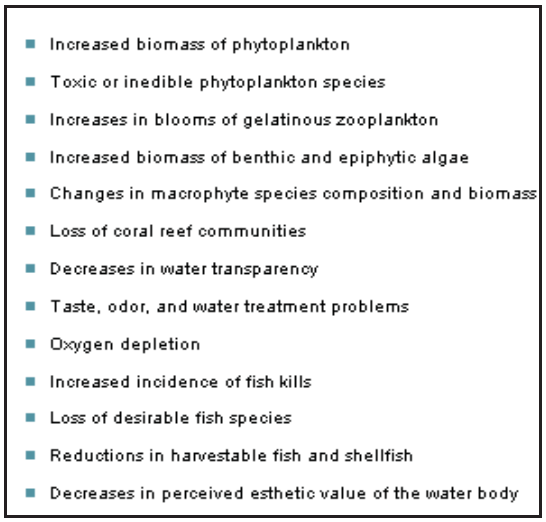

Figure 2. ***Various effects caused by eutrophication***

The growth of phytoplankton influence water turbidity which reduces the penetration of light in the reservoir. The reduction of light can interfere with photosynthesis of submerged aquatic plants, and this way their growth is affected.

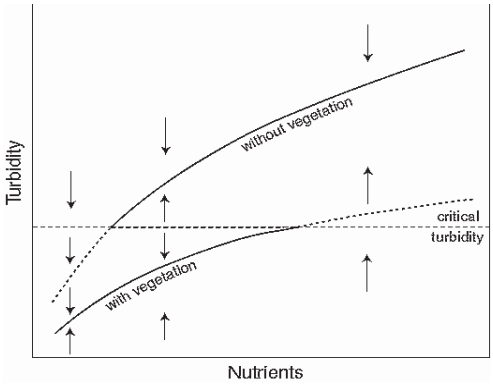

Figure 3. ***The influence of high turbidity on the death of submerged vegetation***

Eutrophication can also adversely affect a wide variety of water uses such as water supply (e.g. algae clogging filters in treatment works), livestock watering, irrigation, fisheries, navigation, water sports, angling and nature conservation.

When algal blooms increase in intensity and frequency, the results can cause community concern, health problems and in some cases can be catastrophic to the environment. The impacts are ecological, social and economic. Eutrophication has been shown to cause competitive release by making abundant an otherwise limiting nutrient. This causes shifts in the composition of ecosystems.

For instance, an increase in nitrogen might allow new and more competitive species to invade and out compete original species.

Some algal blooms, otherwise called "nuisance algae," are toxic to plants and animals. Therefore, this toxicity can lead to decreased biodiversity or it can manifest in primary producers, influencing the food chain. As a result of these toxic algae, animal mortality has been observed.

Therefore, the data collected from water quality monitoring allow the early detection of changes and trends in water quality, the evaluation of alternative remediation strategies and contribute to the advancement of the fundamental understanding of the behavior of these water bodies.

4. MEASURES TO REDUCE THE EUTROPHICATION PROCESS

Eutrophication poses a problem not only to ecosystems, but to humans as well. Reducing eutrophication should be a key concern when considering future policy and a sustainable solution for everyone.

The primary step in the reduction of eutrophication of a lake or reservoir is to limit, divert or treat inputs of nutrients and associated particles. However, because lakes and reservoirs can trap and recycle nutrients and organic matter, reduction in loading from the watershed may not reverse the impact of eutrophication. Therefore it may be necessary to modify internal chemical, biological and physical processes. It is suggested that the prediction of changes of physical, chemical, and biological processes should be based on available information on the lake and reservoir.

In some cases, measures for reducing or removing nitrogen and/or phosphorus in eutrophic reservoirs were taken to improve water quality, but they had no effect. This is largely due to the enormous amounts of nutrients stored in sediments being constantly released into the water. Therefore it is shown the need to avoid nutrient loading into the water bodies as early as possible by proper management and planning practices.

New monitoring technologies employing robotics and advanced probes or sensors open new horizons in water quality protection. Also, the last two decades have seen a dramatic increase of numerical simulation models in a variety of large water bodies.

Prevention is certainly easier than treatment. This principle is perfectly valid in the water domain, being important to prevent pollution of rivers and lakes. When preventive measures came too late or had no effect, the authorities have to appeal to water treatment. This can be extremely costly, complicated and may present risks and unwanted side effects.

Evaluation of eutrophication, particularly in developing countries, must balance benefits gained from increased fertility of lakes or reservoirs against problems associated with the degraded quality of water used for domestic and industrial purposes.

5. CONCLUSIONS

As consequences, eutrophication produces a general reduction of possibilities of water use, this way the importance of reservoirs can be compromised seriously as primary resources for socio-economic development.

Thus, coherent actions are needed to eliminate the causes that generate the problem of water availability and quality caused by eutrophication, using large scale integrated water management in order to protect and preserve water resources.

REFERENCES

1. *"A Coordinator's Guide to Volunteer Lake Monitoring Methods",* Carlson, R.E. and J. Simpson, North American Lake Management Society, 1996
2. *"Eutrophication: causes, consequences and control"*, Abid A. Ansari, Sarvajeet Singh Gill, Guy R. Lanza, Walter Rast, Springer Science+Business Media
3. *"Impactul ecologic al lucrărilor hidrotehnice",* Tobolcea Viorel, Cretu V., 1995
4. *"The protection of reservoir water against the eutrophication process"*, W. Balcerzak, Polish Journal of Environmental Stud., vol. 15, no. 6 (2006)
5. http://www.epm.ugal.ro/ – *Curs de hidro-biologie*
6. http://www.greenagenda.org