ENVIRONMENTAL STATUS OF SMALL AND MEDIUM BARRIER LAKES

Loredana Andreea POPOIU[1], Raluca MITROI [1]

e-mai: popoiu_loredana@yahoo.com

Abstract

Water Framework Directive introduces a new concept on the state of water bodies heavily modified, represented by the ecological potential and chemical state. The ecological potential is achieved on the basis of biological, physicochemical quality elements and specific pollutants, whereas the chemical status is evaluated based on the impact of priority/ priority hazardous substances (non-synthetic and synthetic substances) represented by heavy metal ions and organic micropollutants. In the case of barrier lakes there are defined two classes of ecological potential: maximum and good ecological potential, firstly, and moderate ecological potential, secondly. In determining the ecological potential there is considered the "worst-case establishes quality status" principle. Thus the worst potential of barrier lakes is the moderate one. The environmental objective for a barrier lake is considered to be achieved when the monitored water body falls into good ecological potential. There were analyzed qualitatively several small and medium-sized barrier lakes in the catchment Prut - Barlad, by integrating the following quality elements: biological (phytoplankton and phytobenthos), physico-chemical (nutrients, salinity, acidification status, oxygenation conditions) and specific pollutants (synthetic and non-synthetic). After monitoring a total of 17 small and medium barrier lakes in the catchment it was found that in the years 2012, 2013, 2014 the ecological potential was moderate or good, being mostly maintained the moderate potential. However there is observed a removal of the elements that lead to the blocking in the attainment of environmental goals. Since 2012, the environmental objective has been reached for 3 of the 17 monitored barrier lakes, while in 2014 the number reached 6. To determine the chemical status of these small and medium barrier lakes, for each monitored substance there was calculated the annual average concentration and annual maximum concentration for those substances that are set quality standards for the environment, because any excess in quality standards for these concentrations cand lead to poor chemical status. For the monitored barrier lakes there was observed an improvement in the chemical status since in 2012 only 6 lakes had good chemical status, while in 2014 their number increased to 9.

Key words: ecological potential, chemical status, barrier lakes quality monitoring, quality elements.

Initially in our country, water quality assessment with the aim of its management was based mainly or exclusively on the analysis of physico-chemical indicators, biological evaluation methods becoming fully accepted later.

The only biological and microbiological parameter determined for the barrier lakes was the phytoplankton biomass.

Since the first standard which specified the categories and quality conditions of surface waters (STAS 4706-55), national standards for water quality have evolved, thus today they include more indicators.

Currently, in Romania, surface water evaluation is based on Normative 161/2006. According to it, surface waters are classified dependent on ecological and chemical characteristics.

This standard has been issued under the provisions of the Water Law no. 107/1996 with subsequent amendments, Article 3 and Article 10 of Government Decision no. 351/2005 on the approval of the gradual elimination of discharges, emissions and losses of priority dangerous substances.

Water Framework Directive introduces a new concept on the state of water bodies heavily modified, represented by the ecological potential and chemical state.

The evaluation of the ecological potential is achieved on the basis of biological, physicochemical quality elements and specific pollutants.

In determining the ecological potential it is considered the „one out - all out" principle, respectively the worst situation establishes quality status.

The chemical status is evaluated based on the analysis of the impact of priority/ priority hazardous substances (non-synthetic and synthetic substances) represented by heavy metal ions and

[1] "Gheorghe Asachi" Technical University of Iaşi, Faculty of Hydrotechnics, Geodesy and Environmental Engineering

organic micropollutants (National management plan, 2010).

MATERIAL AND METHOD

Biological quality elements used to evaluate the environmental potential of barrier lakes are: phytoplankton and phytobenthos.

Evaluation of the ecological potential in terms of biological elements is obtained by applying the "worst element" principle. The worst-given potential by the biological elements is the "Moderate" one.

Phytoplankton is sensitive to the following pressures: intake of nutrients, organic pollution, variations in level and overall degradation.

To evaluate the ecological potential it must be taken into account the algae from the photic zone and the maximum period of vegetation, that period being from May to September. The evaluation is done by section and then by the whole water body.

The selected parameters for assessing the ecological potential of barrier lakes regarding phytoplankton are: the index number of taxa, index of biomass, chlorophyll "a", biomass cyanobacteria abundance and diversity index Shannon-Wiener.

For each indicator is calculated the Environmental Quality Ratio (RCE) based on the value obtained and the matching guide value for the corresponding reference state. It is always divided the lesser to the greater for a ratio between 0 and 1, and where the values obtained are higher than the guide values for the corresponding reference state, the Environmental Quality Ratio is considered equal to 1. When calculating the RCE there should be studied the proposed values for each index reference and for the reference status and ecological potential to see their trend, of increase or decrease from the maximum ecological potential to moderate ecological potential. For selected indices it was proposed a weighting of their importance for the assessment of the ecological potential, as follows: index number of taxa (10%), index of biomass (20%), chlorophyll "a" (15%), biomass cyanobacteria abundance (30%) and diversity index Shannon-Wiener (25%). This formula is used to determine multimetric index: Multimetric index = $0.1 * RCE_{INT} + 0.2 * RCE_{CYANO} + 0.3 * RCE_{BIO} + 0.15 * RCE_{CHL} + 0.25 * RCE_{ID}$.

The multimetric index value will give the ecological potential, which must be between 0 and 1. In order to grade the ecological potential it is proposed to subdivide the multimetric index values as follows: maximum ecological potential - min. 0.8, good ecological potential -min. 0.6, moderate ecological potential - min. 0.4.

In case of more seasonal results, the evaluation of the ecological potential of barrier lakes is based on the annual average of the multimetric index, including those for which there are several stations. There are not taken into account the values of the parameters from the tail of the lake. The assessment of the ecological potential is based solely on data provided by middle lake and dam sections.

When we reffer to the benthic algal communities (phytobenthos) they are susceptible to the following pressures: intake of nutrients, organic pollution, hydromorphological degradation, general degradation (non-specific pressures).

The evaluation is done in the section level and then for the whole water body. The parameters for assessing the environmental potential of barrier lakes based regarding phytobenthos are: the index number of taxa, Shannon-Wiener diversity index, trophic index TDI.

There are calculated the Environmental Quality reports (RCE) for each mentioned index.

In calculating RCE, each index is related to the matching guide value for the corresponding reference state. It is always divided the lesser to the greater for sub-par ratio between 0 and 1, and where the values obtained are higher than the guide values for the corresponding reference state, the Environmental Quality Ratio is considered equal to 1. When calculating the RCE there should be studied the proposed values for each index reference and for the reference status and ecological potential to see their trend, of increase or decrease from the maximum ecological potential to moderate ecological potential.

For selected indices it was proposed a weighting of their importance for the communities of benthic diatom algae and for the evaluation tge the ecological potential as follows: index number of taxa (30%), Shannon-Wiener diversity index (40%), trophic index (30%). This formula is used to determine the multimetric index: Multimetric index = $0.3 * RCE_{INT} + 0.4 * RCE_{ID} + 0.3 * RCE_{TDI}$.

The multimetric index value will give the ecological potential, which must be between 0 and 1. In order to grade the ecological potential it is proposed to subdivide the multimetric index values as follows: maximum ecological potential - min. 0.65, good ecological potential - min. 0.40, moderate ecological potential - min. 0.40.

When referring to the methodology for assessing the ecological potential of barrier lakes for the general physico-chemical elements it was taken into account: acidification status – pH, oxygen regime - in terms of concentration of dissolved oxygen, CCO-Cr si CBO5 and nutrients - N-NH4, N-NO2, N-NO3, Ntotal, P-PO4, Ptotal.

The evaluation of ecological potential in terms of physico-chemical elements and specific pollutants is obtained by applying the "worst element" principle. The worst given potential by physico-chemical elements is the "Moderate" one.

To determine the chemical status of these small and medium barrier lakes, for each monitored substance it was calculated the annual average concentration and annual maximum concentration to those substances that have set quality standards for the environment because any overtake in quality standards for these concentrations could lead to a poor chemical status (National management plan, 2010).

After the determination of the ecological potential and chemical status, the overall status can be determined. This is based on: monitoring data provided by the surveillance program and the operational program group and on the principle of risk analysis updated on the attainment of environmental goals (Water quality bulletin, 2014).

Table 1

Elements, parameters and frequency of monitoring barrier lakes

Elements	Parameters	Barrier lakes Surveillance program	Barrier lakes Operational program
Biological elements			
Phytoplankton	The index number of taxa index of biomass, chlorophyll "a", biomass cyanobacteria abundance, Shannon-Wiener diversity index.	4/year	4/year
Phytobenthos	The index number of taxa, Shannon-Wiener diversity index, trophic index.	1/year	2/ year
Physico-chemical general elements			
Acidification status	pH	4/ year	4/ year
The oxygen regime	Dissolved oxygen, CCO-Cr, CBO5	4/ year	4/ year
Nutrients	N-NH4, N-NO2, N-NO3, Ntotal, P-PO4, Ptotal	4/ year	4/ year
Specific pollutants			
Non-synthetic	Cu, Zn, As, Cr	4/ year	4/ year
Synthetic	Xileni, PCB-uri, toluene, acenaphthen, phenol, detergents and total cyanide	4/ year	4/ year

RESULTS AND DISCUSSION

The hydrographic basin Prut-Bârlad consists of middle and lower basin of the river Prut, the Bârlad river basin and left affluents of the Siret river in Botoşani and Galaţi counties, with a total area of 20,267 km^2.

Prut river basin is located in the north east of the Danube basin, having in the north west the Tisza basin, Siret - west and Nistru - north and east.

Bârlad river basin, left affluent of Siret, is bounded in the north and east by the Prut river basin.

From the administrative point of view, hydrographic basin Prut - Bârlad occupies almost entirely Botoşani, Iaşi, Vaslui and Galaţi counties and partially Neamţ, Bacău and Vrancea counties.

In the space river Prut - Bârlad there are 75 barrier lakes, 49 of them with complex use and with a totaling volume of 614.85 mil. cubic meters (National management plan, 2010).

Water quality is an issue of utmost importance that should concern all of us. Our health is directly dependent on the water source and the main pressure on the status of surface waters, and beyond, is exercised by man through the discharge of wastewater into the environment, untreated or insufficiently treated.

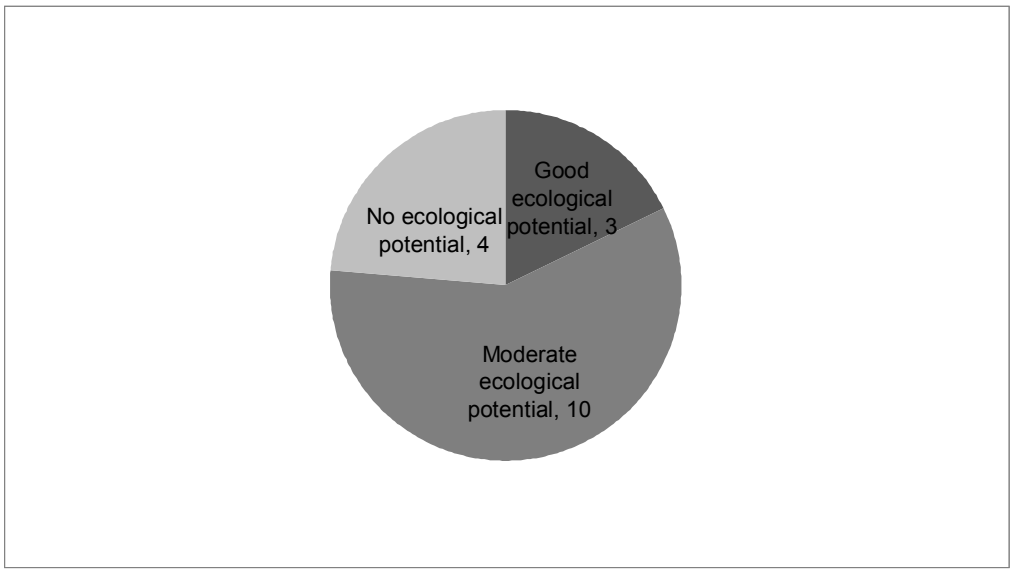

Figure 1 **Ecological potential of small and medium barrier lakes in the catchment Prut - Bârlad 2012**

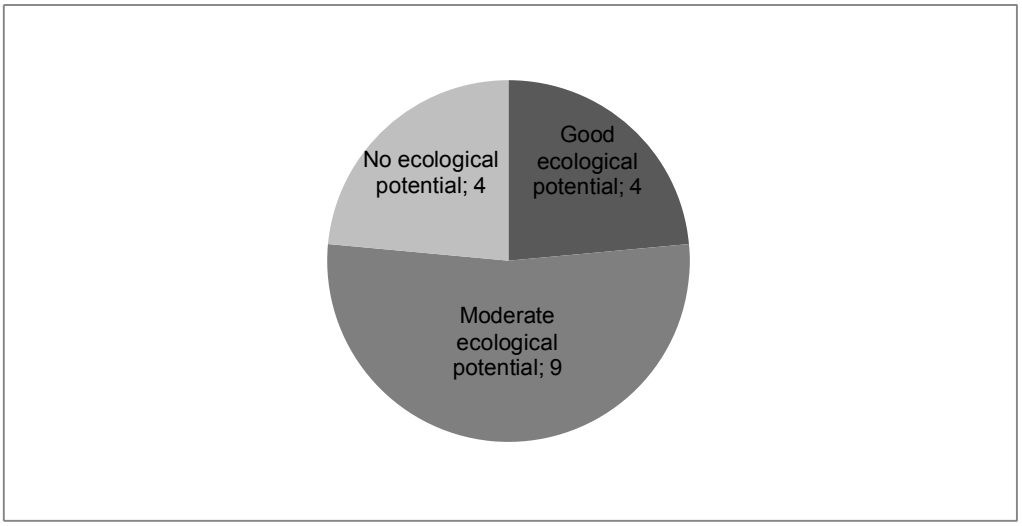

Figure 2 **Ecological potential of small and medium barrier lakes in the catchment Prut - Bârlad 2013**

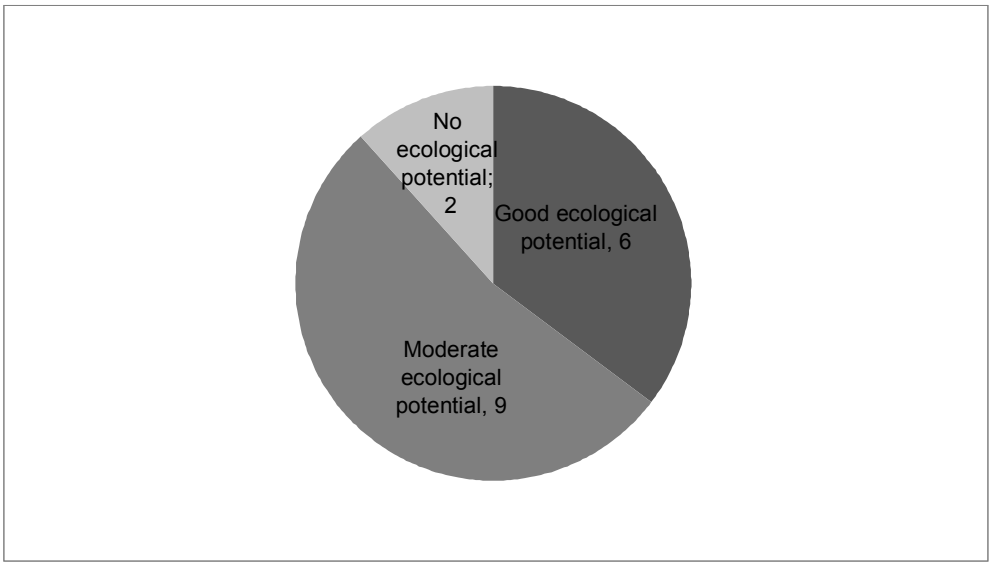

Figure 3 **Ecological potential of small and medium barrier lakes in the catchment Prut - Bârlad 2014**

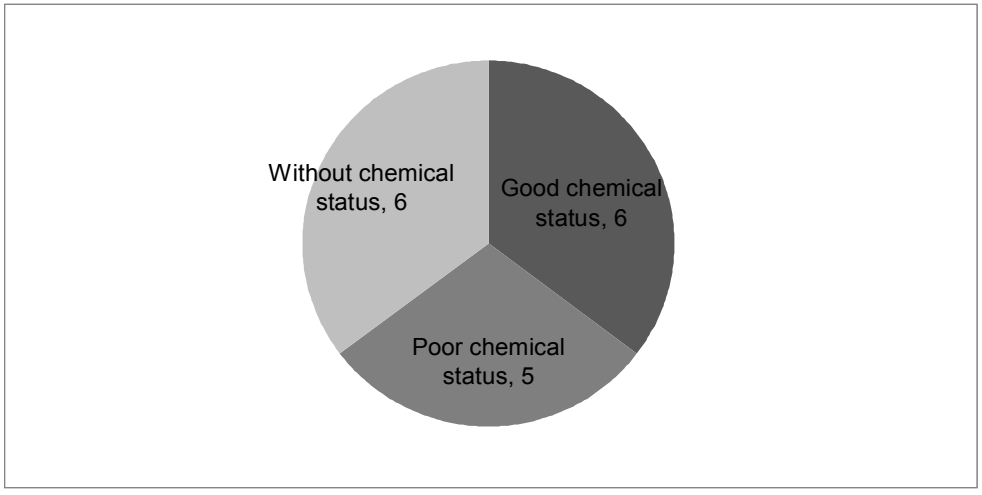

Figure 4 **Chemical status of small and medium barrier lakes in the catchment Prut - Bârlad 2012**

Table 2

Failing to achieve quality objective for small and medium barrier lakes in the catchment Prut-Bârlad with a moderate ecological potential

Elements that led to the attainment of the objective quality	2012	2013	2014
Barrier lake Negreni	Oxygenation conditions, acidification status, nutrients, chloroform	Oxygenation conditions, status acidification, nutrients, chloroform	Oxygenation conditions, acidification status, nutrients, chloroform
Barrier lake Mileanca	-	Oxygenation conditions, nutrients	Oxygenation conditions, nutrients
Barrier lake Cătămărăşti	Oxygenation conditions	Oxygenation conditions	-
Barrier lake Hălceni	Oxygenation conditions, acidification status, nutrients, chloroform	Oxygenation conditions, acidification status, nichel	Acidification status, nutrients
Barrier lake Tansa	Oxygenation conditions, acidification status	-	Oxygenation conditions, acidification status
Barrier lake Podul Iloaiei	-	Phytobenthos, oxygenation conditions, acidification status, nutrients	Oxygenation conditions, acidification status, nutrients
Barrier lake Cucuteni	Oxygenation conditions, acidification status, nutrients	-	Oxygenation conditions, acidification status, nutrients
Barrier lake Poşta Elan	Status acidification, nutrients, chloroform	Nutrients, chloroform	Nutrients
Barrier lake Tungujei	Oxygenation conditions	Chloroform	-
Barrier lake Puscaşi	Nutrients	Nutrients, chloroform	Nutrients, chloroform
Barrier lake Cuibul Vulturilor	Acidification status, nutrients	Chloroform	Chloroform
Barrier lake Talabasca	Phytobenthos, oxygenation conditions, acidification status, nutrients	Oxygenation conditions, acidification status	Phytobenthos, oxygenation conditions
Barrier lake Lazova	Oxygenation conditions, nutrients	Oxygenation conditions	Phytoplankto, oxygenation conditions

Of the total reservoirs in Prut Barlad basin, for 17 small and medium barrier lakes (Negreni, Mileanca, Cătămărăşti, Hălceni, Pârcovaci, Tansa, Podu Iloaiei, Cucuteni, Poşta Elan, Tungujei, Căzăneşti, Puscaşi, Soleşti, Râpa Albastră, Cuibul Vulturilor, Talabasca, Lozova) there was evaluated the evolution for three years: 2012, 2013, 2014.

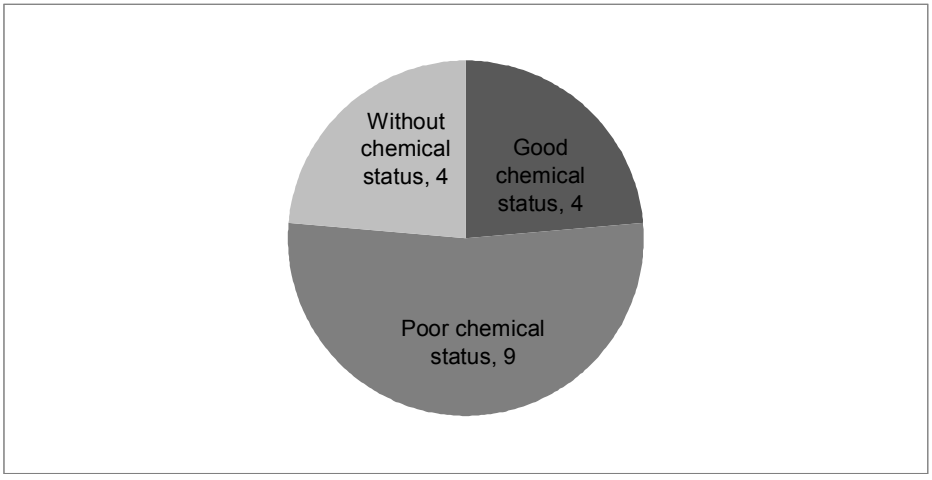

Figure 5 **Chemical status of small and medium barrier lakes in the catchment Prut - Bârlad 2013**

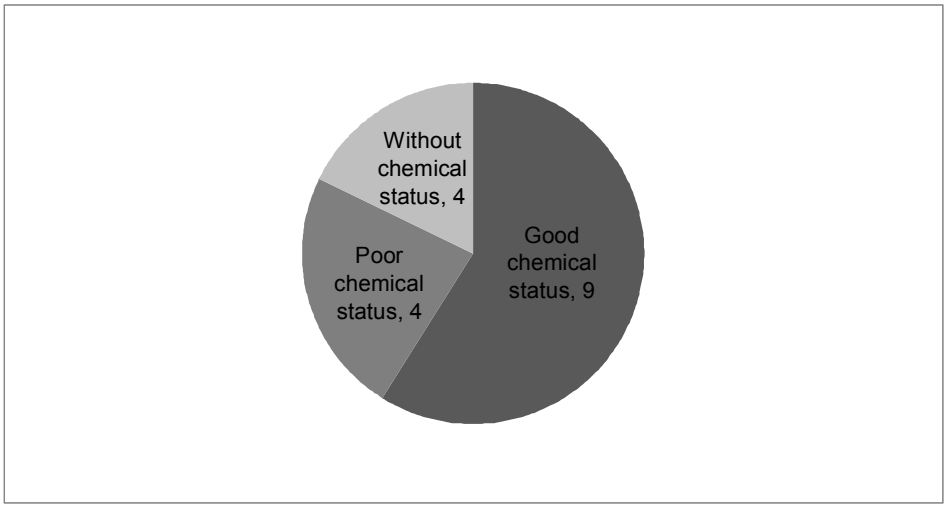

Figure 6 **Chemical status of small and medium barrier lakes in the catchment Prut - Bârlad 2014**

CONCLUSIONS

Analyzing the quality status of these lakes over three years, it can be seen a positive development in terms of water quality.

Thus, if in 2012 only 3 of them had a good ecological potential (Pârcovaci, Soleşti, Râpa Albastră), in 2013, 4 lakes reached a good potential (Tungujei, Soleşti, Râpa Albastră, Cuibul Vulturilor) and in 2014, 6 of the lakes analyzed set a good ecological potential: (Cătămărăşti, Pârcovaci, Tungujei, Soleşti, Râpa Albastră, Cuibul Vulturilor).

Regarding the chemical status of small and medium-sized barrier lakes in the catchment Prut-Bârlad, in 2014 from 17 lakes analyzed, 9 have achieved a good status: Negreni, Mileanca, Halceni, Pârcovaci, Tansa, Podul Iloaiei, Poşta Elan, Tungujei, Căzăneşti.

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