CONTRIBUTION IN LACUSTRINE ENVIRONMENT NUTRIENTS ANALYSIS

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This paper considers the development of a lacustrine ecosystem mathematical model that allows the ecosystem's main nutrients analysis. It had been necessary lacustrine ecosystem's specific nutrient's by-products and nutrient-environment interplay knowledge in order to develop the mathematical model.

The aim of the modelling process is to show the nutrients and theirs by-products concentration variations in the interplay with the biotope, the biocenosys and other characteristic factors for the environment.

The model represents Siutghiol lake in Romania. The study period lasted a few months, from March 1st until November 30th, 2000. During this period, for the lake in question, there had been recorded data about nutrients' and theirs by-products' concentration variations, continually with daily frequency.

We tried to show the part that nutrients play in the lacustrine environment, especially their effect on the lake's biocenosys during the important time periods in one year; we also showed the main causes that can lead to eutrofisation of the lake.

We have tried to emphasize the variation of the nutrients during the spring, when algae and other simple life forms begin to appear in the lacustrine environment, and continuing with the summer when their numbers increase and other superior life forms appear and they influence the cycle of the simple ones, and ending with the autumn when most of the biocenosys dies by decay.

Keywords: phytoplankton, epilimnion, hypolimnion, phosphorus, nitrogen.

1. Introduction

Siutghiol Lake's origin is of river-marine-lagoon type, but it is separated from the Black Sea's waters through a sand stripe, heavily grassed with macrophyte vegetation. Due to it's powerful underground and fluvial headsprings and the loss of linkage with the sea, the lake turned entirely mellow.

Considering its geographical position, the communities and objectives developed on its shores, the use of water in agricultural and industrial specific activities it is safe to say that Siutghiol Lake still stand as an important social and economical site, also being an attractive touristy area, especially since Mamaia summer resort is located on its eastern shore. Furthermore, the lake has a great ecological value, considering its significance for the migratory aquatic birds and its available and serviceable fish resources in the littoral area.

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Unfortunately, the touristy and industrial activities led to the catastrophical disturbance of the lacustrine ecosystem, meaning the decrease in specific biodiversity and, therefore, the decrease of fish productivity. All these contributed to the habitat depreciation, affected the ecological processes, leading to dramatic consequences on the environment and aquatic live quality. The ecological disequilibrium formed in time was described in different studies and research, carried out over a large period of time.

The study is based on the analysis of the nutrients' and their derivates' concentration variation during their interaction with the biotope, biocoenosis and other specific factors along a period of time from March to October with daily frequency. The time interval chosen covers the period of phytoplankton life development and decrease.

The mathematical modeling of the ecosystem consisting of the Siutghiol Lake basin was carried out using a complex mathematical model and a series of typical initial parameters for the lake, such as: lake's area (73,7 x 10^6 m^2), lake's water volume (88,7 x 10^6 m^3), lake's average depth (14,90 m), maximum depth (30 m) and basin's area (92 x 10^6 m^2).

Considering previous studies and the specialty literature available we draw the conclusion that inorganic nutrients constitute the chemical base for the life development in the water. In water quality modeling is usually used four of the main nutrients: phosphorus, nitrogens, carbon and silicon. Beside those elements, the living cells also use sulphur, iron, manganese, zinc, copper etc., also known in the specialty literature as complementary nutrients.

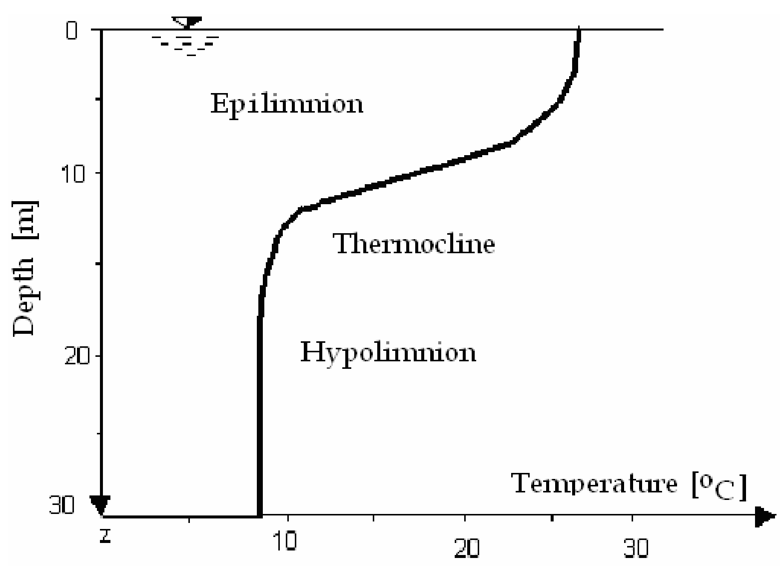


Fig. 1. Siutghiol Lake stratification.

It is common knowledge that lakes, during summer time, present quite well defined bedding, as you can see in Figure 1. The top layer is called *epilimnion,* is made by warm water, has better lighting and is the place where algae photosynthesis converts the dissolved nutrients in particular organic matter. The bottom layer – hypolimnion, is made by cold water, has less lighting and it is not favorable for algae activities. The two areas are separated by metalimnion, a limited – depth area but with a strong temperature gradient, also called thermocline, that sensibly decreases the vertical mixture.

During autumn season the water temperature drops, the thermocline vanishes and in the water mass circulation is formed that brings up from the bottom of the lake nourishing substances, sediments, gases etc. During summer time, the water temperature is quite homogeneous and internal circulation takes place that helps in the lake oxygenation. Along with the solar radiation increase, the algae activity begins for the species more resistant to the low temperatures (diatoms).

The water layer bordered by the superior layer of sediments and the processes and essential transfers that take place in it are described in figure 2.

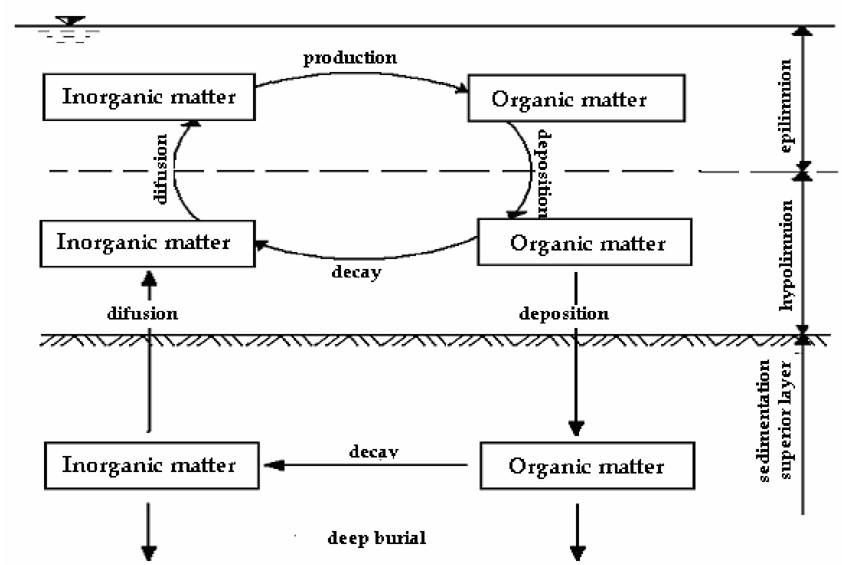


Fig. 2. The processes/transfers that take place inside a lake.

The participants in the processes described in Figure 2 are considered:

- nutrients: are found as ammonium nitrates (N_a), nitrates (N_n), soluble phosphorus (P_s) and organic carbon, non-included in the active biomass and also as dissolved fraction (C_d) and particular fraction (C_p)

- trophic link : represented by algae (A), herbivorous zooplankton (Zi) and carnivorous zooplankton (Zc).

The interplay between those participants is described in figure 3.

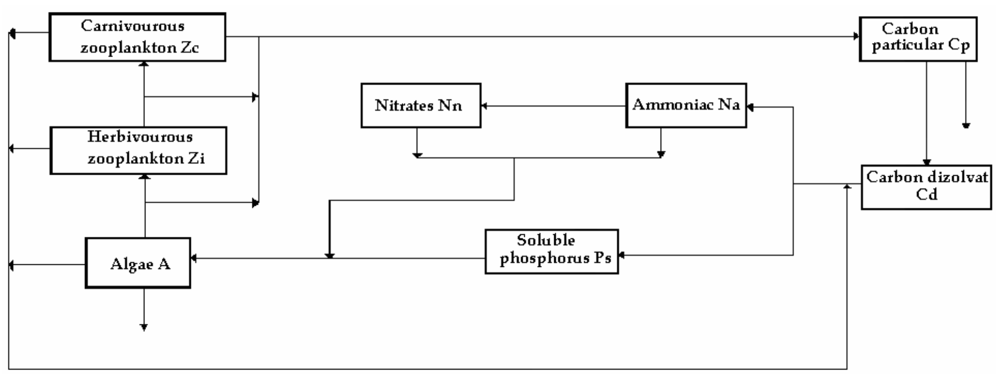
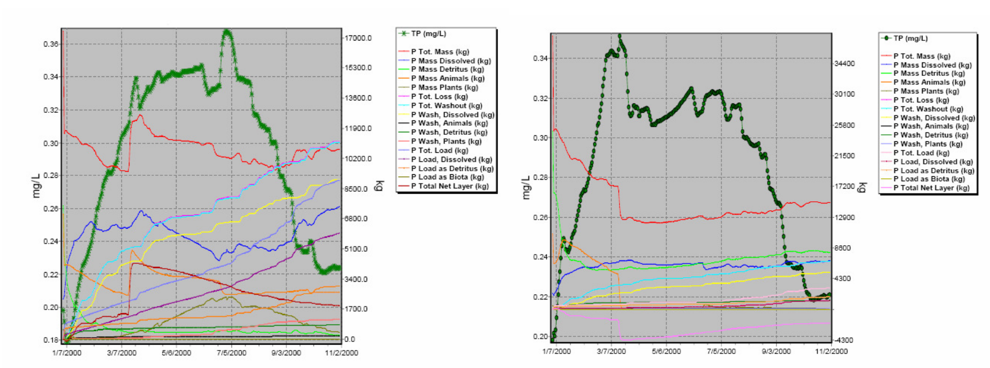


Fig. 3. Interplay between lacustrine environment constituents.

The study showed that the phosphorus and the nitrogens are the main nutritional elements for the lacustrine biomass. The two elements can come from both urbane and agricultural environment.

2. The phosphorus and the nitrogens balance

The balance of the considered nutrients was differently made on the two layers – epilimnion and hypolimnion – like the next pictures show:



(a) Epilimnion (b) Hypolimnion

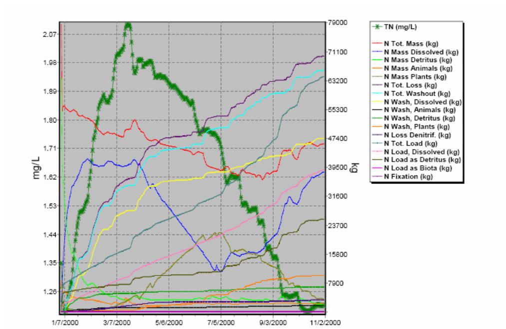
Fig. 4. The nitrogens balance on the two layers in Siutghiol Lake.

In the images from above we can see that the phosphorus mass growth lost to the plants and rocks are assimilated by the plants and animals to be changed afterwards in sediments. Therefore, the phosphorus cycle is renewed in the lake mass by plant assimilation and consequently by the biomass.

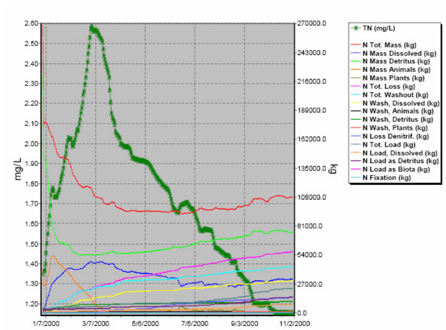
In hypolimnion, Figure 4(b), we can easier see the masses bedding considering their origin and the plants, the animals and the lake's sediments contributions. In this case, the setting becomes anorexic but abundant in phosphorus.

Starting in February, when the algae biomass begins to develop and the predators number is proportionally growing, the phosphorus quantity that results from the dead matter decomposition or organic residues decay begin to deposit. We can also see a growth in the phosphorus quantity placed on the bottom of the lake and moving along with the other sediments contained by the bottom mass (the phosphorus quantity involved in the biota), all these processes taking part in the natural nutrients cycle.

About the nitrogens balance in Siutghiol Lake, depending of the two lake's layers this is how it looks (see figure 5):



(a) Epilimnion



(b) Hypolimnion

Fig. 5. Nitrogens balance in Siutghiol Lake's two layers.

In epilimnion, Figure 5(a), we can see an nitrogens total mass decrease in the first part of the year because of the development of the different algae species that use nitrogens. This decrease continues until September when the algae activity begins to slow down.

Meanwhile, the dissolved nitrogens total mass shows a growth period (February-April) then to vertiginous decrease until July. This variation is due to the lake's biomass activity that assimilates this nutrient.

In hypolimnion, *Figure 1(b),* where, during summer time we can see the bedding of the nutrients masses, some significant variations are recorded in the nitrogens total mass: a decrease during the two months previously mentioned and then a constant period until the autumn end.

By comparing the two images, we can observe that, during the year, the lake's water is simply and quickly stratified like this:

- a worm but nutrient-poor layer that that most of the year hosts the biomass and most part of the primary production;
- a cold but nutrient-rich layer, being anorexic does not allow the biomass activity.

The nutrients concentration fluctuations have important consequences over the development of the algae groups. The decrease in nutritive substances concentration preferred by the dominant species can lead to the stop of population growth, making it easy for the development of other algae populations that have different nutrition needs.

3. Conclusions

By comparing the proportions of N, C and P discharge in epilimnion, Haris (1986) made evidence that the phosphorus is recycled in the bedded epilimnion of the oligotrophic bedded lakes by a medium 20 time faster than N and C. Also, Tirtizer (1990) says that in natural bedded lakes, during summer time, more than 2/3 of the net primary production is recycled in the euphotic zone, in this process an important part being played by the small sized zooplankton and decomposers.

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