Physical-Chemical Parameters of Tasaul Lake during 2006 - 2007 *(Dan Vasiliu, Luminita Lazar, Laura Alexandrov, Adriana Cociasu, Daniela Rosioru, Razvan Mateescu)*	"Cercetari Marine" Issue no. 37 Pages 51-65	2007

PHYSICAL-CHEMICAL PARAMETERS OF TASAUL LAKE DURING 2006 - 2007

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ABSTRACT

Monthly vertical profiles of physical-chemical parameters (temperature, dissolved oxygen, salinity, TOC, and nutrients) carried out in the period June 2006 - November 2007 at the deepest site of shallow lake Tasaul (mean depth 2.4 m), between Ada and La Ostrov Island, generally showed homogeneous distributions due to permanent and complete water mixing induced by the wind regime. Samples have been collected in monitoring system.

Seasonal variation of physical-chemical parameters was influenced by the semi-arid climate (evaporation), hydrology (droughts, heavy rainfall events), primary production and allochthonous nutrient input. Mean Soluble Reactive Phosphorus (SRP) and NO_3-N concentrations were 0.02 mg/l and 0.25 mg/l, respectively. pH values were more than 8.1 and dissolved oxygen (DO) ranged between 3.9 and 17.1 mg/l, showing significant oversaturation (120-210 %) correlated with high algal biomasses (chl. *a* 46.22-417 µg/l) and primary production.

KEY-WORDS: temperature, dissolved oxygen, salinity, TOC, nutrients, SRP, pH

INTRODUCTION

Tasaul Lake is a eutrophic, shallow lake (mean depth of 2.4 m, maximum depth of 4 m); with an area of about 2,335 ha and a volume of about 49.45*106 m^3 (Breier, 1976).

From the genesis point of view, Tasaul Lake is a river-marine bank (liman), situated in extension of the asimcea River. It is elongated in shape and a little sinuous because of promontories and large bays alternance. The lateral shores are steep (5-10 m or more) as carved in compact Jurassic limestone (northern border) and green schist (southern border). In geological times, two islands were eroded from respective shores: Ada Island, calcareous, with an area of 30.3 ha and a maximum altitude of 12.8 m, and La Ostrov Island of green schist with an area of 3.0 ha and a maximum altitude of 4.6m (Breier A, 1976).

The nutrient regime, and therefore the primary productivity of the system, is strongly influenced by the human activities in the region (mainly the farming activities in the Casimcea River catchments area, but also industrial and municipal waste water discharges). Recent studies concerning on the main pollution sources were carried out in the framework of the project "The assessment of anthropogenic impacts on Tasaul Lake, Romania, and ecosystem rehabilitation" (Rosioru et al., 2008; Vasiliu, pp. 39-50, Mateescu, pp. 17-31, this volume) with special focus on the nutrient distribution in the surface layer.

In addition, the present work aims to study the seasonal variability of the main physical-chemical parameters in the water column, at the deepest site, less affected by the pollution, for a better understanding of the limnology of Tasaul Lake.

MATERIALS AND METHODS

Fig. 1. a, b, c. Water sampling in Tasaul Lake

During June 2006 - November 2007 water samples were collected almost monthly at the deepest site from different depths (0 m, 0.5 m, 1 m, 2 m, and 3 m). The following physical-chemical parameters were measured:

Temperature (˚C) and Dissolved Oxygen (mg/l) - were measured *in situ* with an YSI (Yellow Spring Instrument) 556 MPS (Multi-Probe-System) made by YSI.Inc, USA;

pH - was measured *in situ* using a field pH-meter;

Chlorinity - was measured by the titrimetric method of Mohr-Knudsen (Grasshoff et al, 1998);

Chemical Oxygen Demand (COD-Mn) - the organic and other oxidation substances reduce part of the permanganate and the permanganate left over is determined iodometrically (APHA, 1985);

$P–PO_4$ - the inorganic phosphate ions react with ammonium molybdate, in acid medium, forming a phosphomolybdic complex (light yellow colored).This complex is reduced to a blue colored compound. The color intensity of this compound is measured spectrophotometrically in VIS (Murphy and Riley, 1962);

$N–NO_3$ - the method is based on the nitrate reduction to nitrite in a glass column filled with Cadmium granules. The nitrite formed in this way, is measured spectrophothometrically in VIS (Grasshoff et al., 1998);

$N–NO_2$ - the nitrite ions react with an aromatic amine forming a diazonic compound which reacts with a second aromatic amine forming a colored azoic compound. The color intensity is determined spectrophotometrically (Bendschneider and Robinson, 1952);

$N–NH_4$ - the method is based on the ammonium ions reaction with hypochlorite, in a slight alkaline medium in order to form a monochloramine which, in the presence of phenol, catalytic amounts of nitroprusiate and excess of hypochlorite forms a blue indophenols complex. The color intensity of this complex is measured spectrophotometrically in VIS (Koroleff, 1969);

$Si–SiO_4$ - the silicates ions react with ammonium molybdate in acid medium forming a silicomolybdic complex (light yellow).This complex is reduced to an intense blue colored complex. The intensity of color is determined spectrophotometrically (Koroleff, 1983);

Total Nitrogen (TN) - was determined by 720˚C combustion catalytic oxidation/chemiluminescence method, using TOC-V CSN Total Organic Carbon Analyzer, Shimadzu (Suzuki et al., 1985).

RESULTS AND DISSCUSSION

Surface temperature peaked in summer (27.9°C, June 2006), while the minimum (4.9 °C) was observed in January 2007 (Fig. 2). The vertical profiles showed homothermic conditions and no hypolimnion at all times (Fig. 3). In summer, the shallow lake is heated up down to the bottom to 24-25°C.

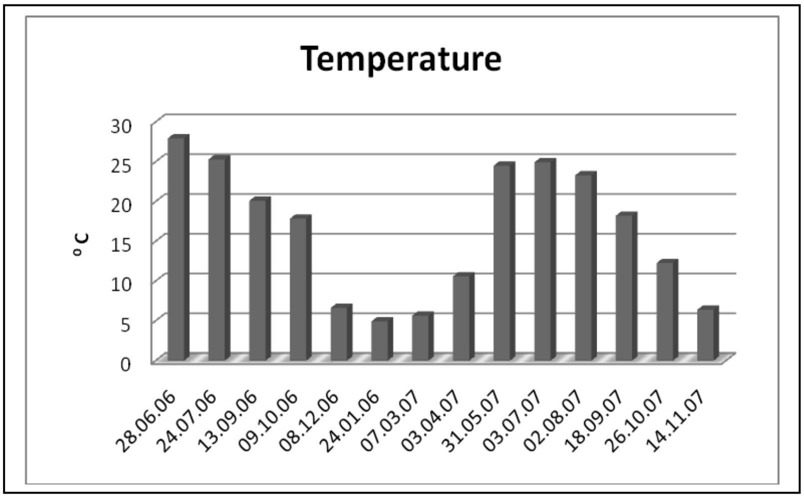

Fig. 2. Seasonal variation of surface temperature in Tasaul Lake

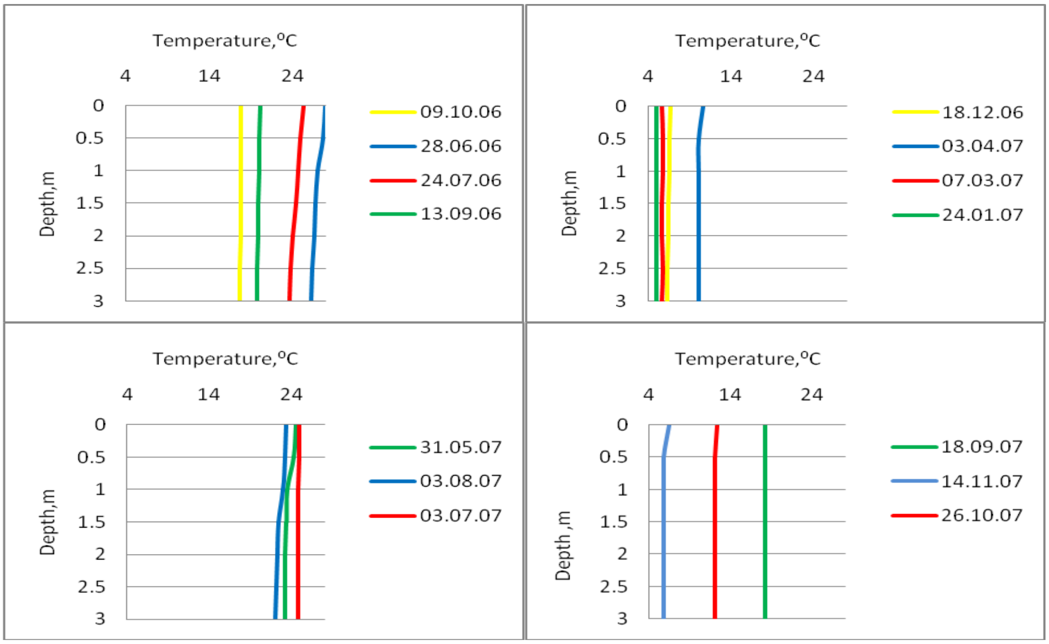

Fig. 3. Temperature distribution in the water column

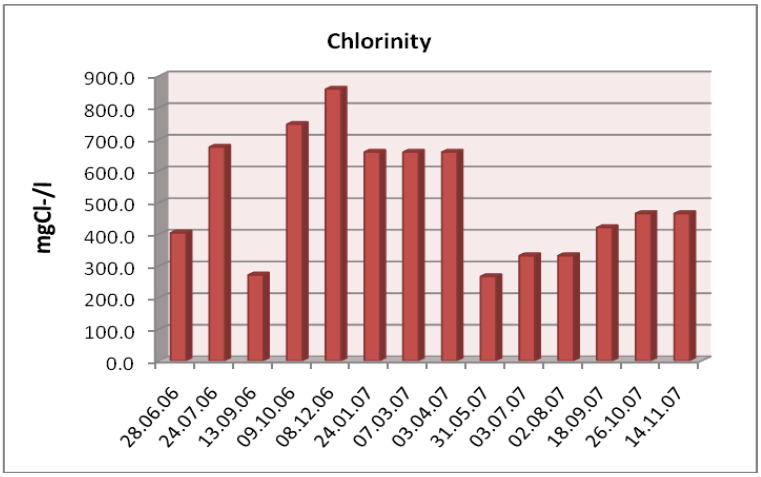

Fig. 4. Seasonal variation of surface salinity

Chlorinity ranged between 276 mg Cl^-/l (September 2006 and May 2007) and 830.3 mg Cl^-/l (December 2006) and was correlated with the precipitation regime and the Casimcea flow variation (Fig. 4). The low values observed in spring 2007 were associated with abundant rainfall in May 2007, when the Casimcea River flow was high - $0.255 m^3/s$ (Mateescu, this volume, pp. 17-31). The higher values observed during October 2006 - April 2007 were related to a drought period (the Casimcea flow was low - Mateescu, this volume, pp. 17-31). Hence, excess freshwater input has an effect of dilution, while dry periods show higher salt concentration due to excess evaporation. Chlorinity vertical profiles were rather homogeneous except of three profiles in June, July and October 2006 (Fig. 5), probably the consequence of some internal turbulence.

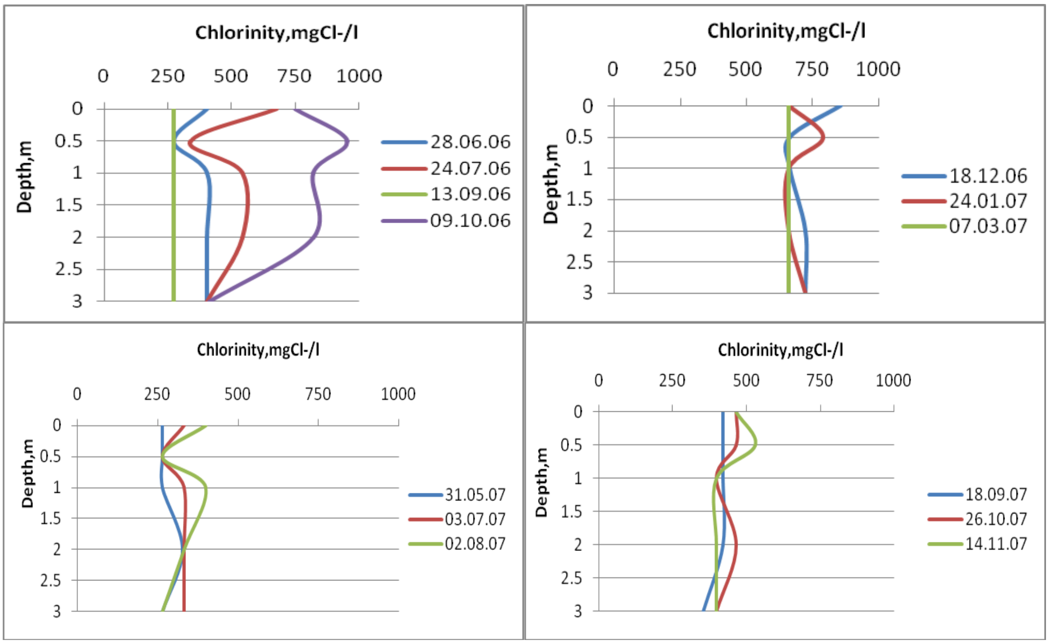

Fig. 5. Salinity distribution in the water column

pH values exceeded 8.0 in all samples. The highest surface pH values were recorded during May 2007 - November 2007 (the maximum of 9.4, in June 2007) (Fig. 6), suggesting intense phothosynteticallly processes, reflected by higher chlorophyll *a* concentrations (Rosioru et al, 2008). In terms of vertical distribution, the pH profiles were quite homogeneous (Fig. 7).

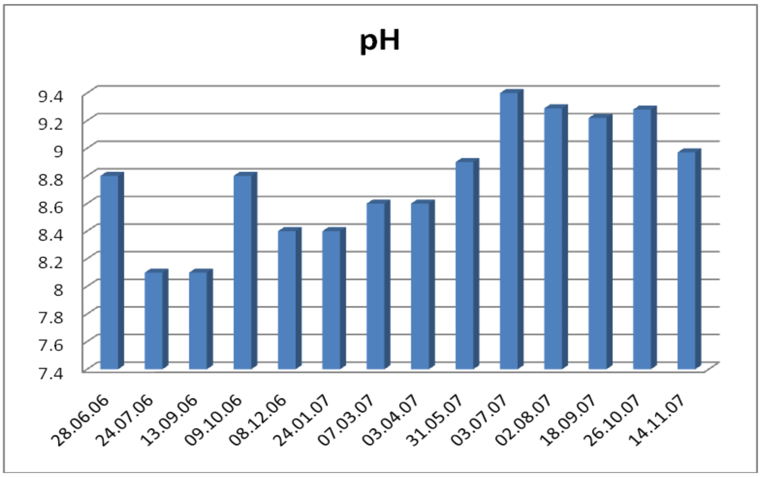

Fig. 6. Seasonal variation of pH in the surface layer

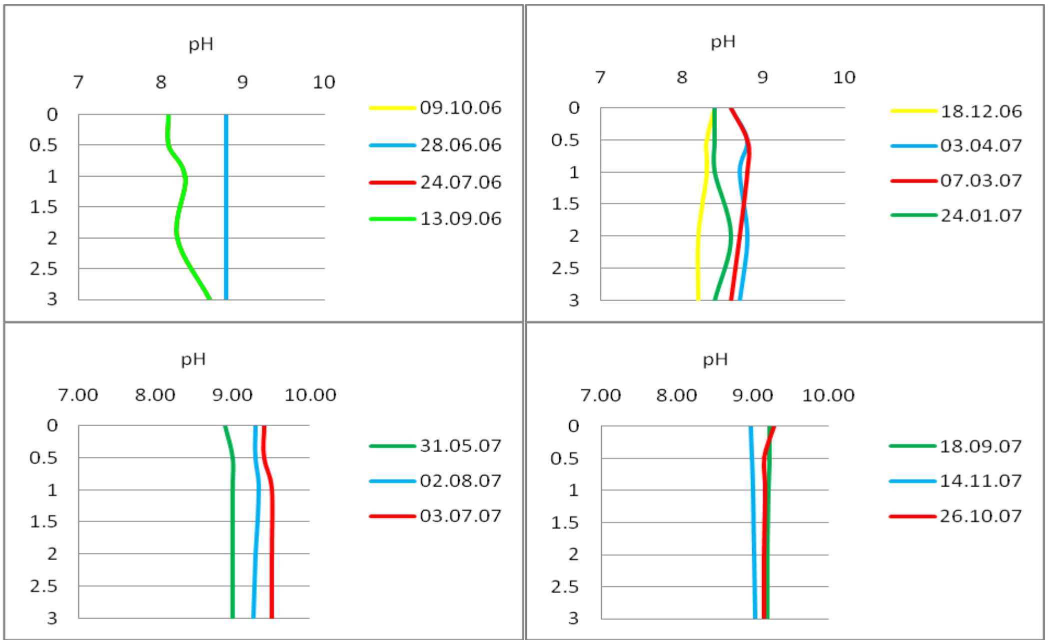

Fig. 7. pH vertical distribution in the water column

High pH values play an important role in phosphorus release from the sediment, reducing the capacity of iron to bind phosphorus (Lijklema, 1977). Elevated pH values found in the water column of Tasaul Lake can affect the pH of surface sediment, promoting the release of iron-bound phosphorus.

The oxygen regime is governed by physical and biological processess. The strong mixing of water masses during the cold season generally lead to well-oxygeneted water, but also the seasonality of biological processess play a significant role. Thus, during the warm period, the photosynthesis rate increased (Rosioru et al., 2008) and besides oxygen, there was produced a large amount of organic matter. The organic matter decomposition depends on the water temperature; it is faster at higher temperatures, consequently more oxygen was consumed at higher temperatures.

Hence, the lower oxygen concentrations in summer and higher concentrations in winter (Fig. 8) reflect the competition between production and decomposition of organic matter. During the warm periods, decomposition outcompetes production, hence leading to lower oxygen concentration.

Oxygen oversaturation (120-210% 10 the surface layer) is caused by high primary production with continuous algal blooms.

Due to high turbulence, the vertical oxygen profiles are mostly uniform, except for summer months when some oxygen depletion probably due to enhanced decomposition can be observed (Fig. 9). However, oxygen concentrations never decreased below 5 mg/l despite of anoxic sediments, because mixing processes support oxygen down to the lake bottom.

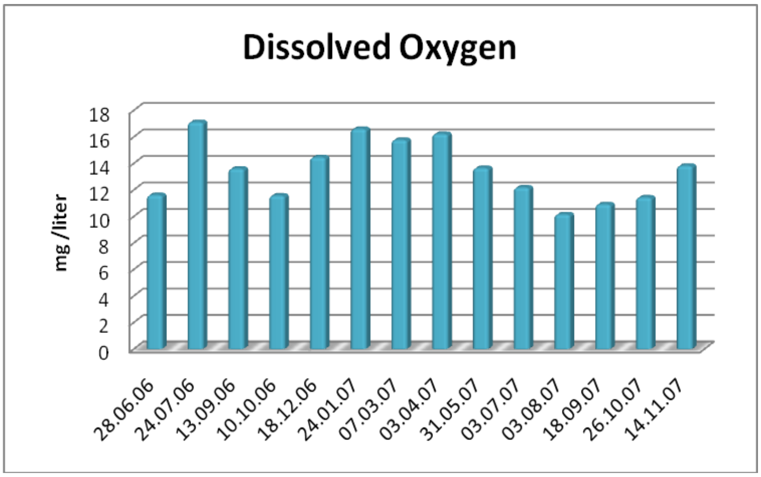

Fig. 8. Dissolved oxygen seasonal variation in the surface layer

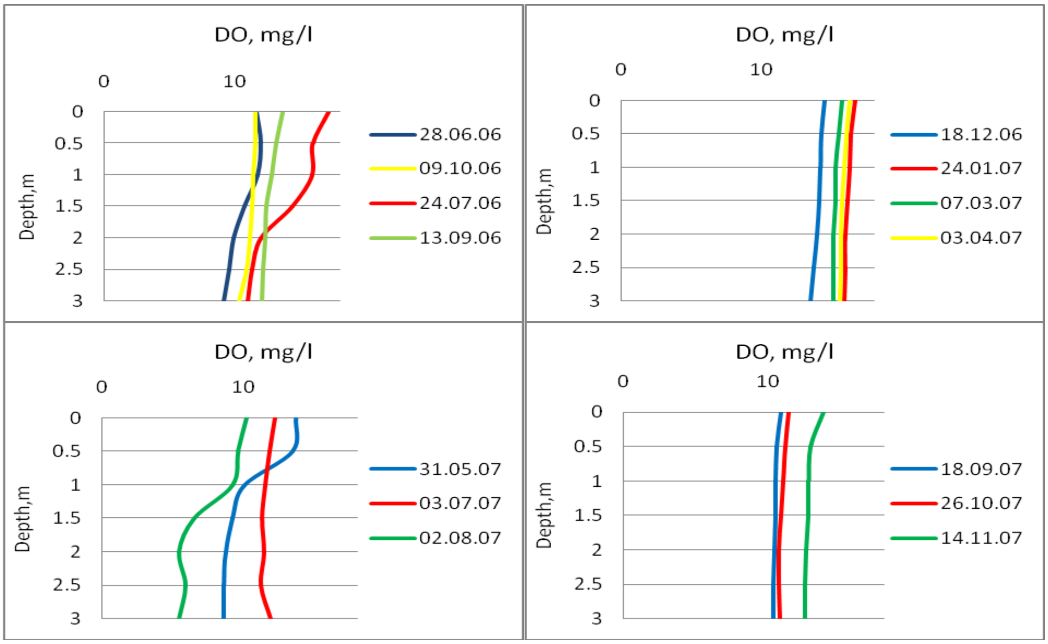

Fig. 9. Dissolved oxygen distribution in the water column

The COD-Mn values, reflecting decomposable organic matter, ranged between 7 and 12 mg O_2/l except for winter 2006/2007 with only 1-3 mg O_2/l (Fig. 9). The highest COD-Mn values were registered during May 2007-November 2007 due to more intense phothosynthetically processes (chlorophyll concentration exceeded 150 μg/l - Fig. 10). In terms of vertical profiles, no significant differences were observed (Fig. 11).

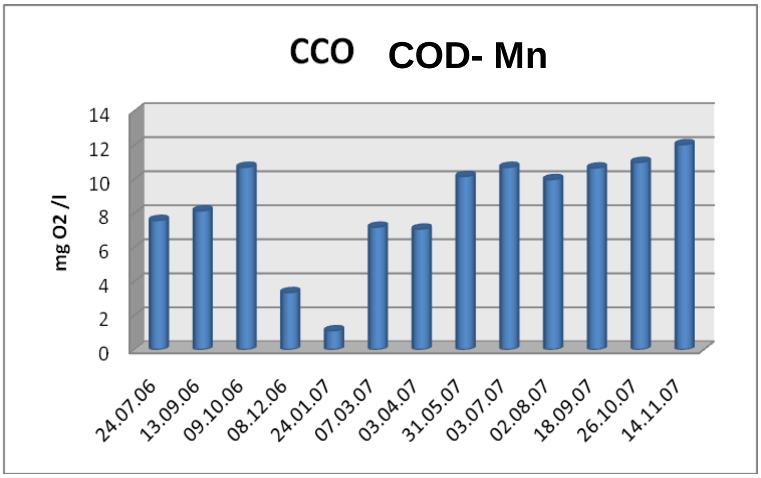

Fig. 10. Seasonal variation of COD-Mn in the surface layer

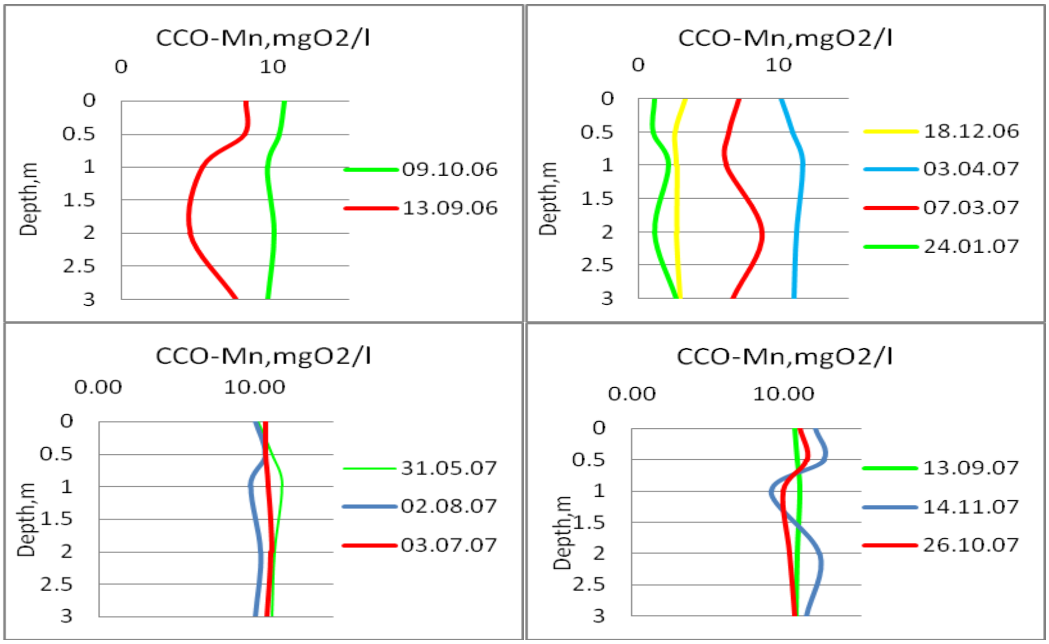

Fig. 11. COD-Mn distribution in the water column

In most of the temperate zone lakes, phosphorus is growing limiting nutrient for the most aquatic organisms and occurs as soluble and insoluble, both organic and inorganic form in aquatic systems (Scheffer, 2004).

Phosphate (SRP) concentrations in shallow Tasaul Lake were rather low for a highly eutrophic system (0.01 - 0.07 mg/l, Fig. 12). The lowest phosphate concentrations were recorded during September 2007 - November 2007; this can be explained by the intense primary production and P-uptake by the phytoplankton. The highest phosphate concentrations were found in May and August 2007 in the surface layer, in connection with the higher Casimcea River input (Mateescu, this volume, pp. 17-31), thus suggesting the tributaries as the main phosphorus sources. With few exceptions (September 2006, May and August 2007), the vertical phosphate profiles were rather uniform (Fig. 13).

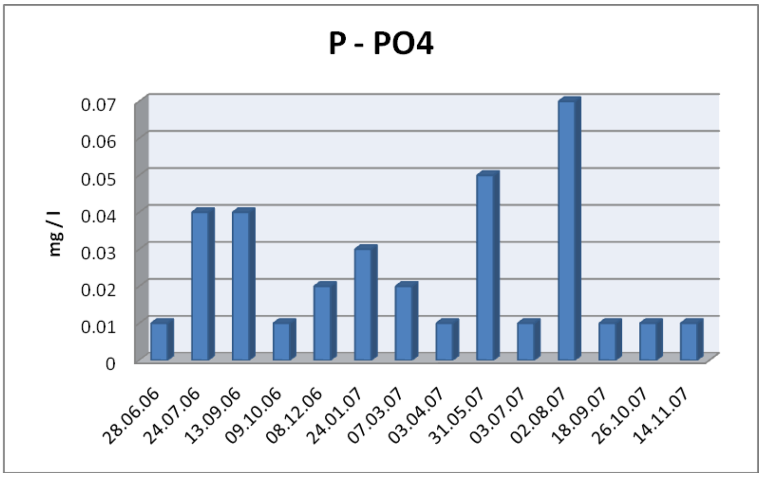

Fig. 12. Seasonal variation of surface P - PO_4

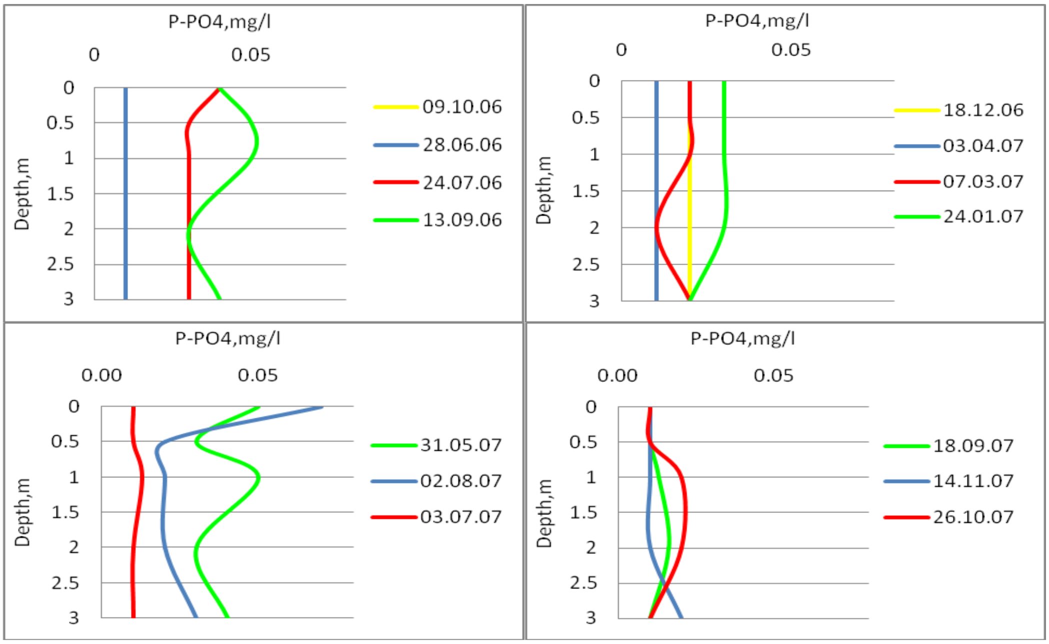

Fig. 13. The vertical distribution of P-PO_4

The nitrogen external input in Tasaul Lake generally shows high temporal variability, closely related to the farming activities in the Casimcea River basin and seasonal flow variation.

Total nitrogen (TN) values ranged within 1.10 - 2.625 mg/l; higher values were found during the warm period. Also, very high TN concentrations were observed in all four tributaries (3.10 - 15.66 mg/l - Mateescu, this volume, pp. 17-31).

$N\text{-}NO_2$ and $N\text{-}NO_3$ showed higher values in the periods March 2007 - April 2007 and September 2007 - November 2007 (Fig. 14 and 15). The concentrations of ammonia showed a high seasonal variability with higher values in summer of 2006 and autumn of 2007 (October - November) (Fig. 16), when it represented the main form of inorganic nitrogen. The sharp shifts in the ammonia regime were observed especially after a high productivity period when the intensity of newly formed organic matter decomposition increases. The inorganic nitrogen forms were quite homogeneous distributed in the water column (Fig. 17 and 18).

Ammonium and nitrates are hardly adsorbed by sediment particles and do not normally precipitate to insoluble forms in the sediment either. Therefore, the strong accumulation in the sediment that is found for phosphorus in eutrophied lakes does not occur for nitrogen (Jensen et al., 1991). This is probably the reason why lake water concentrations of nitrogen tend to respond more promptly to reduction of the external loading than phosphorus concentrations (Scheffer, 2004).

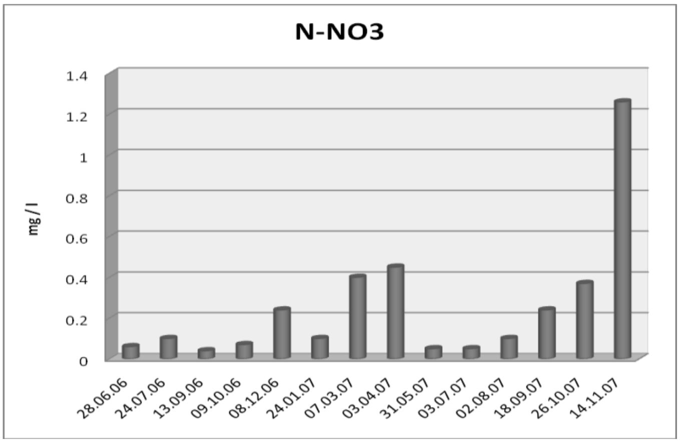

Fig. 14. Seasonal variation of $N\text{-}NO_3$ in the surface layer

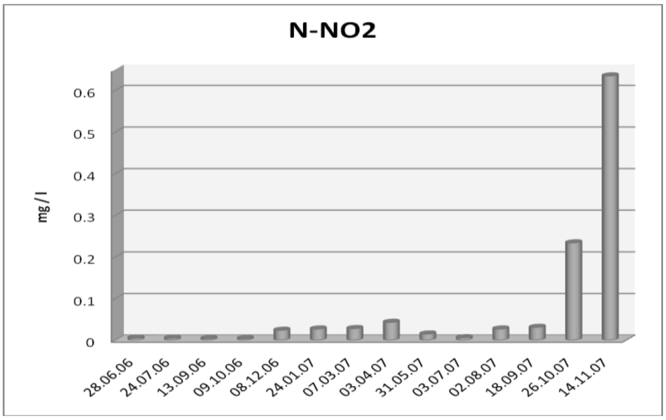

Fig. 15. Seasonal variation of surface $N\text{-}NO_2$

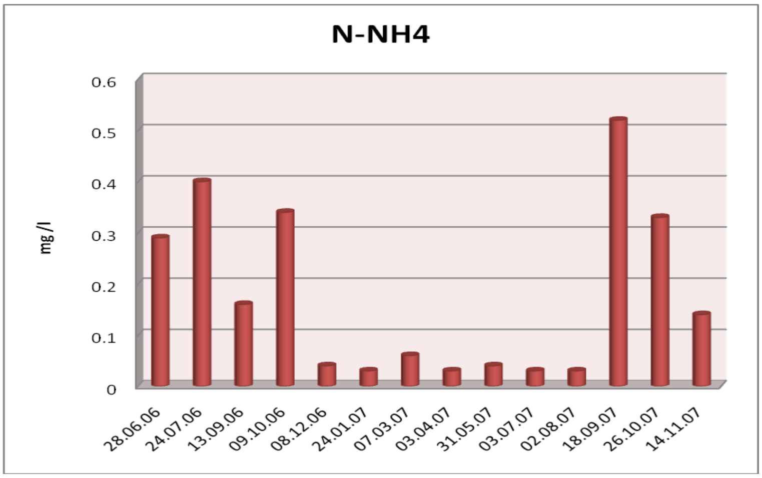

Fig. 16. Seasonal variation of N-NH_4 in the surface layer

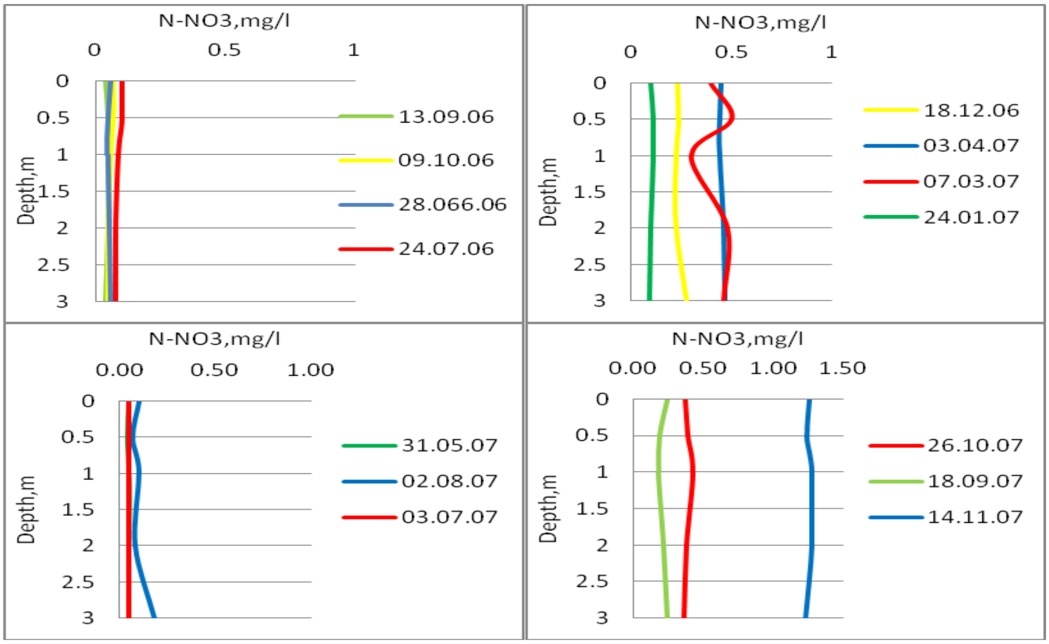

Fig. 17. N-NO_3 distribution in the water column

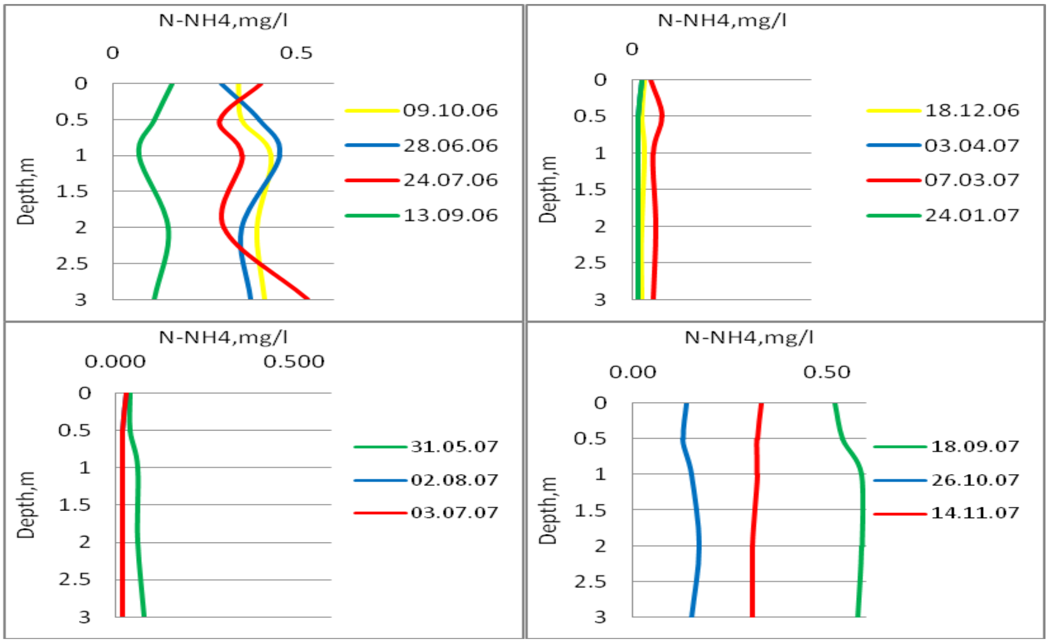

Fig. 18. N-NH_4 distribution in the water column

Silicates showed also a high seasonal variability; the lowest concentrations were observed during January 2007 - March 2007 and in May 2007 (Fig. 19), most probably linked to strong diatom blooms. Similar to other nutrients, silicates showed a rather uniform distribution in the water column (Fig. 20).

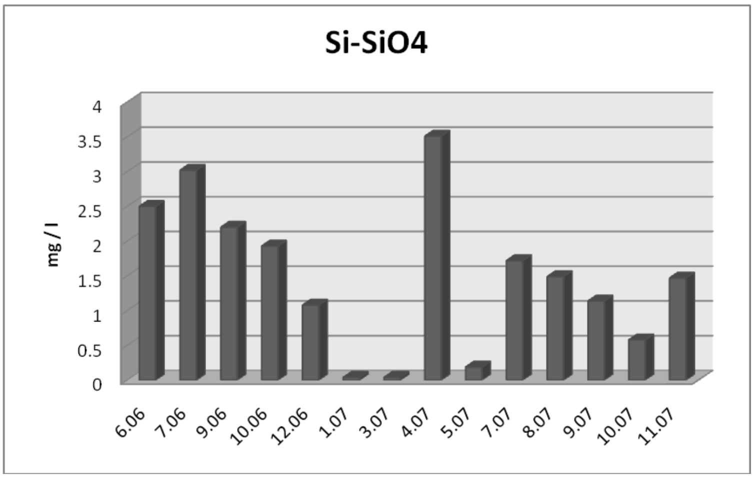

Fig. 19. Seasonal variation of silicates in the surface layer

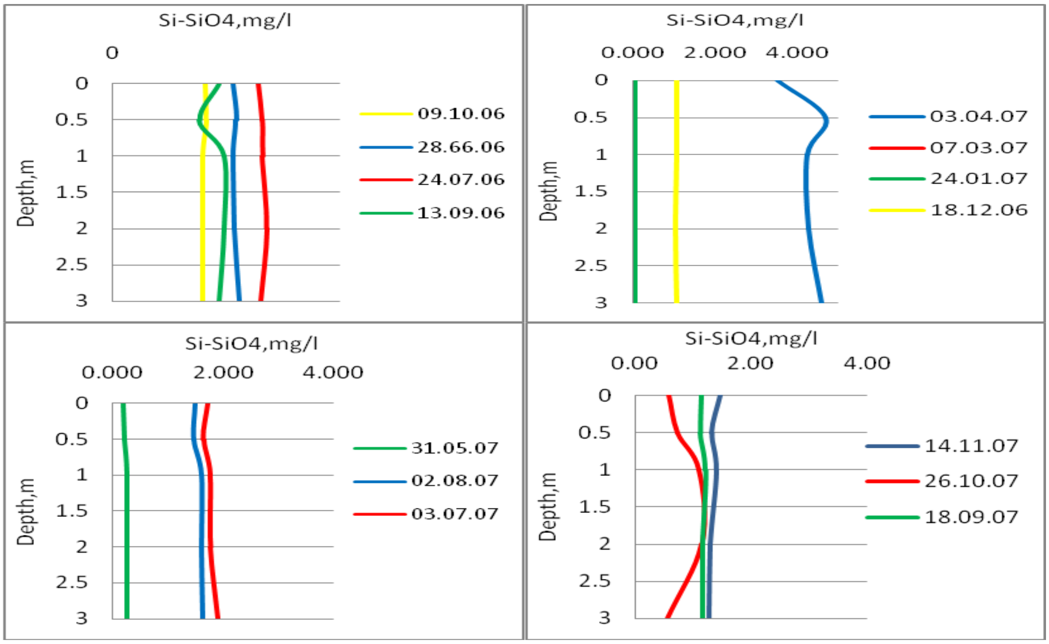

Fig. 20. Silicates distribution in the water column

CONCLUSIONS

The seasonal dynamics of physical-chemical parameters in Tasaul Lake is strongly influenced by the permanently input from tributaries (mainly the Casimcea River). Nevertheless, the concentrations of nutrients in the lake are relatively low as they are consumed quickly by intense phothosyntetically processes that carry on during whole year.

Tasaul Lake is not stratified; temperature shows homogeneous distribution in the water column due to permanent and complete mixing as a result of strong wind action. Also, due to frequent winds, the lake is well-oxygenated within the water column and also the nutrient vertical profiles are rather uniform. This relative homogeneity of vertical distribution of physical-chemical parameters is very useful in order to select the best management alternatives that would be implemented for Tasaul rehabilitation.

ACKNOWLEDGEMENT

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