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Biological and Physico-Chemical Evaluation of the Eutrophication Potential of a Highly Rated Temperate Water Body in South – Eastern Romania

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Abstract

The natural depollution mechanisms often reach a low impact level in the case of lakes situated close to major urban settings. We are presenting the assessment of the eutrophication potentialities of Lake Brates, situated in Galati County (Romania). The results may be considered a case study, as the Lake Brates receives an estimated 800 visitors/month for recreational, aquacultural, domestic and industrial purposes. Experimental measurements in order to determine the contamination of Lake Brates, which incurs an enormous social and economic potential. Low oxygenation, high alkalinity, water hardness, organic content, and increasing values of the nitrate and phosphate ions place this endorheic lake in a eutrophic-hypertrophic limnic ecosystem. The presence of *Metopus ovatus*, *Caenomorpha medusula*, and *Vorticella campanula* reveal a high pollution status, while the high abundance of the resistant forms of *Cryptosporidium* spp., *Entamoeba histolytica*, *Gairdia spp.*, *Cyclospora cayatenensis*, *Ascaris lumbricoides*, *Diphyllobutum latum*, *Tenia* spp., *Strongyloides stercoralis* re-affirms the sanitary risks associated with the applicability of this limnic ecosystem. The results may help selecting the most efficient sustainable water treatment methods and environmental protection remedial strategies to be used to re-enforce the hydro-ecological capacities of this highly rated temperate water body.

Keywords: Eutrophication, Biological, Physico-chemical contamination, Humans, Lake Brates

1. Introduction

Aquatic eutrophication is the enrichment of natural waters with plant nutrients, which results in the stimulation of an array of symptomatic changes (Wu et al. 2011). According to Jin et al. (2005), in the studies of the middle and lower reaches of the Yangtze River and Yungai plateau, the water quality decreases and a declination of the ecosystem is noticed. The effects include an increased production of algae and other aquatic plants, process that is affecting the quality of the water and the balance of organisms present within it. Such changes may be undesirable and interfere with water uses. The nutrient status of any natural water is determined by the supply of nutrients from its catchment, which in turn is influenced by the pedological and anthropological realities of the region in question.

Lake pollution and consequential impacts can occur if there are changes in the nature of the catchment, the feeding rivers or the biocenotic qualities of the overlying basin (Lu et al. 2010). This becomes a concern when human activities accelerate the enrichment process and it is this artificial nutrient input that warrants much attention (Yu et al. 2011). The growth of plants in natural waters is influenced by the supply of nutrients, light, temperature, flow regime, turbidity, and zooplankton grazing and toxic substances. The properties of the catchment and the water body and the impact of human activities affect the impact of these factors. In temperate freshwater systems, phosphorus is generally the key limiting nutrient. However, silicon may limit blooms of diatoms in spring. In areas where phosphate levels are naturally high because of the underlying geology, the water bodies may be nitrate-limited. However, the common occurrence of suspended sediments in estuaries with resulting turbidity often means that light limits algal growth and the consequent productivity of the ecosystem.

Nutrient sources which play a crucial role in lake functioning can be broadly segregated into two categories: readily identifiable point sources (such as sewage effluents), and diffuse sources (such as the run-off from agricultural land), with the relative contribution of each varying between catchments. The contributions (in percentage terms) of the main sources of phosphorus entering surface waters in some European countries have been estimated as: agricultural (43%), human and household waste including detergents (43%), industry (8%), and background source (6%) (Morse et al. 1993). Eutrophication can have both temporary and long-term effects on aquatic ecosystems. Large fluctuations in dissolved oxygen concentrations can occur between day and night. Low oxygen levels, the result of plant respiration, may lead to the death of invertebrates and fish. This process can be compounded when algal blooms, through their decay, further reduce the oxygen content of water. The growth or decay of benthic (bottom-dwelling) mats of macro-algae can also lead to the de-oxygenation of sediments.

Lake pollution ultimately detracts from biodiversity, through the proliferation and dominance of nutrient-tolerant plants and algal species. These tend to displace more sensitive species of higher conservation value, changing the structure of ecological communities. This can also adversely affect a wide variety of water uses such as water supply, livestock watering, irrigation, fisheries, navigation, water sports and nature conservation. It can give rise to undesirable aesthetic impacts in the form of increased turbidity, discoloration, unpleasant odors, slimes and foam formation (Soller et al. 2010).

We are presenting in this paper the results obtained during the evaluation of the biological and physico-chemical properties of the water and soil sediments of Lake Brates, situated in Galati County (Romania). The lake is located on the eastern border of the European Community, i.e. on the border (River Prut) between Romania and the Republic of Moldova. As a result, the quality of its water constitutes an issue of cross border concern. Previous studies on the water bodies of the region, performed by teams including scientists from Romania and the Republic of Moldova, have indicated that the quality of the water on both sides of the border (i.e. River Prut, Lake Stanca-Costesti, Lake Dubasari) is still far from the desired level, although the European environmental directives have been progressively implemented in the Romanian legislation since more than 10 years ago (Cioroi et al. 2012; Zubcov et al. 2012). As a result, the water of the Danube River and of the Danube Delta Biosphere Reserve is consequently affected (Ene et al. 2010; Pantelica et al. 2012; G. Ajeagah et al. 2012).

In this study, the biological and physico-chemical properties of the water and soil sediments of Lake Brates were evaluated in order to determine the eutrophication status, the compounds responsible for the variation in the environmental gradient, and the pathogenic organisms such as protozoa and helminthes that may generate sanitary risks in the ecosystem. Based on these findings, we are also suggesting sustainable solutions for the proper management of this water system that is very important eco-economically, as it attracts a lot of children and elderly people for leisure activities. The lake is also a veritable giant structure for aquaculture, hydraulic activities and a prioritized natural laboratory for environmental engineering.

2. Materials and Methods

The map of Galati County (Romania) indicating the location of Lake Brates is presented in Figure 1. The ecological and biological variables were assessed by the standard methods for the examination of water and wastewater recommended by APHA (1995).The analysis of the biological and physico-chemical parameters were performed during the period of 2010-2011 as presented in Table 1.

The biological parameters were analyzed by centrifugation, and then coloration by Lugol, basic Fuchsine, and Hematoxyleine, Methylene bleu, before observation in the optical and electronic microscope. The statistical analysis was carried out by SPSS correlations and PCA analysis between the biological and physico-chemical parameters of water and soil samples of Lake Brates. Sampling took place at three different points (A, B, C) of the lake, at a distance of 300m each, and the points were sampled at the surface and at the bottom layer (50-1m).

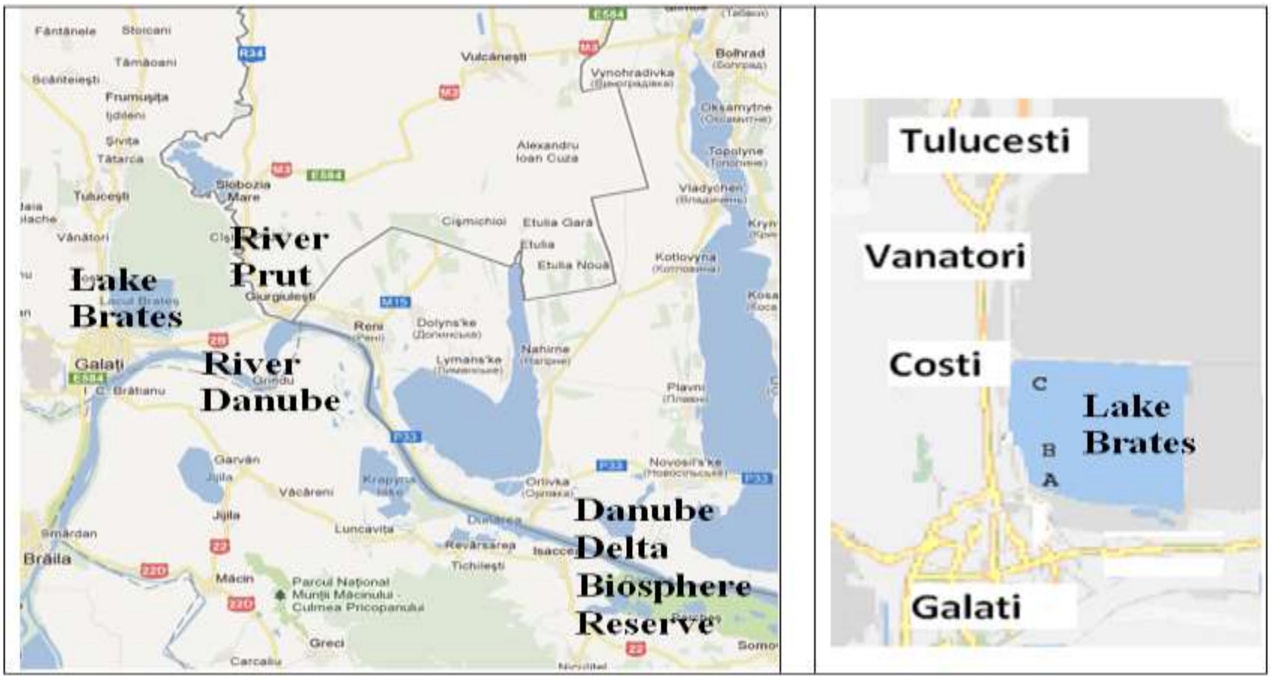


Figure 1. Map of Galati county (Romania), indicating the location of Lake Brates and the sampling points (A, B and C)

Table 1. Analysis of the physico-chemical parameters

Parameter	Apparatus or Main reagent	Units
Temperature	Thermometer	˚C
pH	pH metre	CU
Conductivity, TDS	Conductimeter	µS/cm, mg/L
Electric Potential, Salinity	Conductimeter	mV
Turbidity, SS, color	Spectrophotometer	FTU,mg/L, Pt-Co
Oxygen, Carbon Dioxide	$MnCl_2$, KI + NaOH, $Na_2S_2O_3$ NaOH, + HCL	mg/L
Cl	$AgNO_3$	mg/L
Ammonia, Nitrates	Nessler reagent, sulphanilic acid, alpha napthylamine	mg/L
COD, Oxydability, BOD	H_2SO_4, $KMnO_4$, oxalic acid, $KMnO_4$	mg/L
Ca, Mg	Buffer, Erio T, NaOH, Murexid EDTA	mg/L
Alkalinity	Phenolfthaleine, Methyl Orange, HCL	mg/L
Mn	HNO_3, HNO_3, $AgNO_3$, NH_4	mg/L
Al	H_2SO_4, EDTA, Ascorbic acid, Buffer, Erio R	mg/L
Phenol	Folin Ciocaltau, Na_2CO_3	mg/L
Phosphates	Ascorbic acid, Molibdate	mg/L
Fe	Chlorihydrat-Ho-Amine, R-nitrozo, Tampon CH_3COOH	mg/L

H_2S	Cd (CH_3COONa), I_2, HCl, Starch, $Na_2S_2O_3$	mg/L
Heavy and trace metals	Environment and Meteorological laboratory of the Galati Municipality, Romania	mg/L

3. Results and Discussion

The results presented in Figures 2-13 reveal the dynamics of the biological and physico-chemical properties of the water of Lake Brates. Tables 2, 3 and 4 indicate the values of the soil properties, trace and heavy metals and the dynamics of free living ciliates, of resistant forms of enteropathogenic protozoa and of helminthes. The correlation coefficients obtained for the biological and physico-chemical parameters were calculated for the water bodies and the bottom sediments by Principal Component Analysis (PCA). The SPSS statistical formulae are presented in Table 5 and Figures 15-16. This lake ecosystem is effectively used for recreation activities; the number of visitors who attend Lake Brates on monthly basis are presented in Figure 17. The analysis was carried out for samples collected at three different stations (A, B, C – see Figure 1) that are 500m apart in the lake. Each station has been sampled at the surface (0m) and at the bottom (1m).

Figures 2 reveals that the dissolved oxygen values are generally lower in the bottom layers of Lake Brates, the highest value (7,58mg/l) being recorded at point C. The permanent alkalinity was remarkable in the month of August, with maximum concentrations attending 8,5mg/L (see Figure 3 and Figure 4). Chlorine and total hardness could attend 300 mg/L in this limnic aquatic ecosystem, as shown by Figure 5 and Figure 6. The pH was largely basic, with values of 8-9 conventional units (see Figure 7). The dynamics of the temperature of the water during the analyzed period of time is presented in Figure 8. Temperature varied between 20 and 30˚C, a range that is characteristic to temperate ecosystems during the summer period. The conductivity varied around 1500 uS/cm and the total dissolved solids could attend 1000 mg/L (see Figure 9). Lake Brates reached a higher tenor in the Magnesium ion (60mg/L) with respect to the calcium ion (20mg/L), as shown by Figure 10. Turbidity ranged from 100 to 300 FTU, while electronegativity could reached -200mV. The values of these parameters were higher at the bottom of the water body, as presented in Figure 11. Oxydability reached 100mg/L in August (see Figure 12), while dissolved carbon dioxide increased to 200-250mg/L in the months of August and September (see Figure 13). Suspended solids were higher at the bottom of the three points sampled for the physico-chemical assessment, with values ranging between 200-1700 mg/L (see Figure 14).

Nitrates and phosphate ion were analyzed in Lake Brates at all points and throughout the sampling period. Other ions identified at substantial proportions were iron (18,88mg/L), manganese (09.5mg/L), phenol (15.89mg/L) and aluminium (0.333mg/L). The ammonium iron (14.56 mg/L) was identified at the point C in the month of September, and NO_3-N (0.886 mg/L) in the month of August.

The values recorded for pedological variables in Lake Brates revealed that pH is slightly basic, the electric potential varies from -88mV to -50mV, the conductivity may reach 1531uS/cm and the salinity is about 0,8 CU. There is a remarkable hardness of the soil samples and alkalinity may reach 27,04 mg/L. The evaluation of trace and heavy metal component elements indicated the preponderance of Sr, Rb, Pb, Zn, Cu, Fe and Mn (see Table 2 and Table 3).

According to the biological results presented in Table 4, thirty one ciliated protozoa were identified in the water of Lake Brates. Those that were present throughout the sampling period were *Colpidium campylum*, *Colpoda cucullus*, *Hyprotriche*, *Paramecium* sp and *Prorodon ovalis*. Other more prominent ciliates were *Frontonia leucas*, *Oxytricha chlorelligera*, *Pleurotricha lanceolata* and *Vorticella campanula*. *Caenomorpha medusula* and *Metopus ovatus*, which are indicators of acute pollution, were enumerated in our samples. Resistant forms of enteropathogenic protozoa were also identified. These are *Cryptosporidium* sp (63 kysts /l in August), *Entamoeba histolytica* (14 kysts/L in September), *Giardia* sp (20 kysts/L in September), *Chilomastix mesnili* (10 cysts/L in August), *and Cyclospora cayetanensis* (15 kysts /L in August). Other pathogens isolates were *Isospora belli*, *Entamoeba coli* and *Retortamonas intestinalis*. Major helminth eggs that were identified were *Ascaris lumbricoides, Clornochis sinensis, Diphyllobothium latum, Enterobius vermicularis, Heterophy heterophys, larva of strongiloides stercoralis* and *trichiura trichiura*. *Hydra viridis* and *Rotaria rotaria* were also present in the water samples of this lake.

The relationships between the biocenose and the biotope in Lake Brates are presented in Table 5 and Figures 15-16. There is an important positive correlation between the physico-chemical variables and the biodynamics of ciliates, resistant forms of protozoan and helminthes. The oxygenation of the medium is highly correlated to some *Amoebae* in the milieu, while the organic content was found to be correlated with the load of pathogenic protozoa and helminthes present in the system. The indicators of eutrophication such as phosphates and nitrates were found to be strongly related to emerging enteropathogenic and opportunistic pathogens such as *Entamoeba*, *Ascaris*, *Cryptosporidium* and *Giardia*. These values are in line with the high correlation components substantiated for *Metopus ovatus*, *Caenomorpha*, *Vorticella campanula*, which are indicators of very high water contamination. The PCA carried out is in line with these statistical data and with the results obtained for other water bodies in the region (Ene et al. 2010; Cioroi et al. 2012) and the results are represented in Figures 15 - 16. The statistical variables calculated for the soil content present total alkalinity, total hardness, electric potentialities, conductivity, total dissolved solids and the organic content as determinant factors of the pedo-environmental properties of soil from Lake Brates.

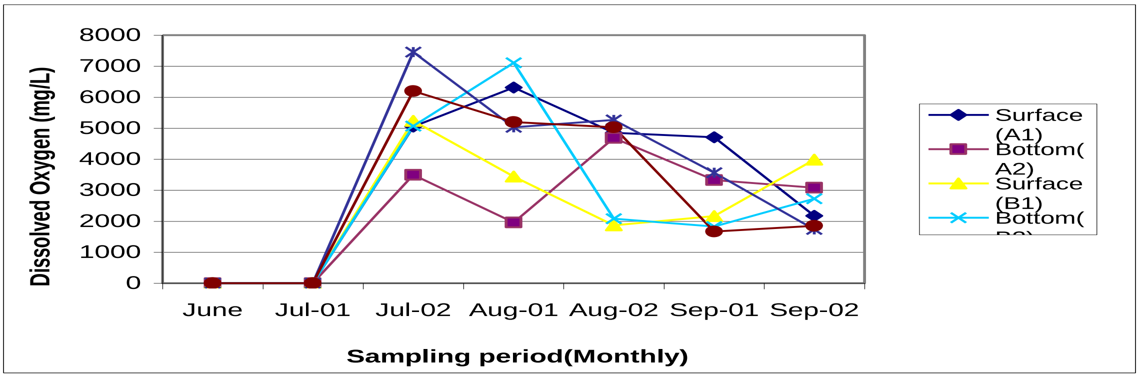


Figure 2. Dynamics of dissolved oxygen (mg/L) in Lake Brates

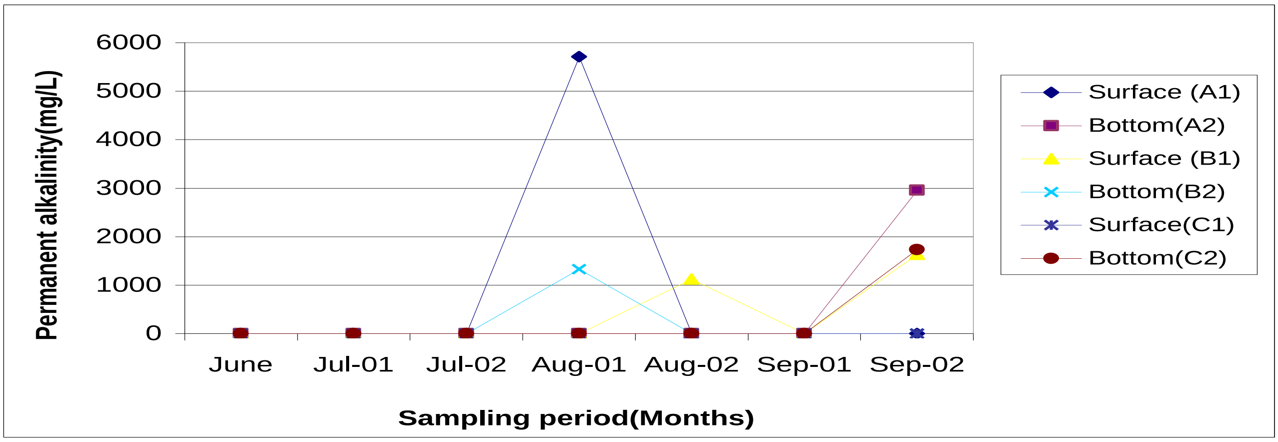


Figure 3. Dynamics of permanent alkalinity (mg/L) in Lake Brates

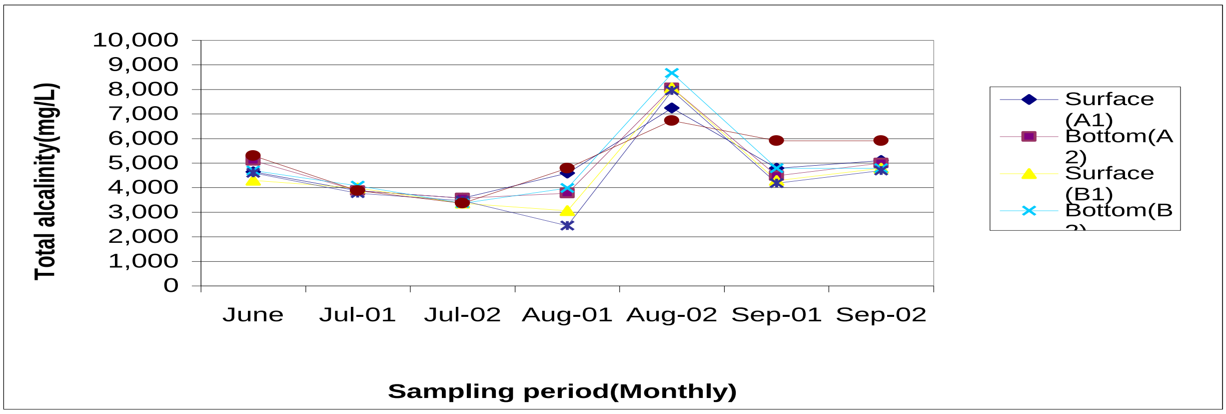


Figure 4. Dynamics of total alkalinity (mg/L) in Lake Brates

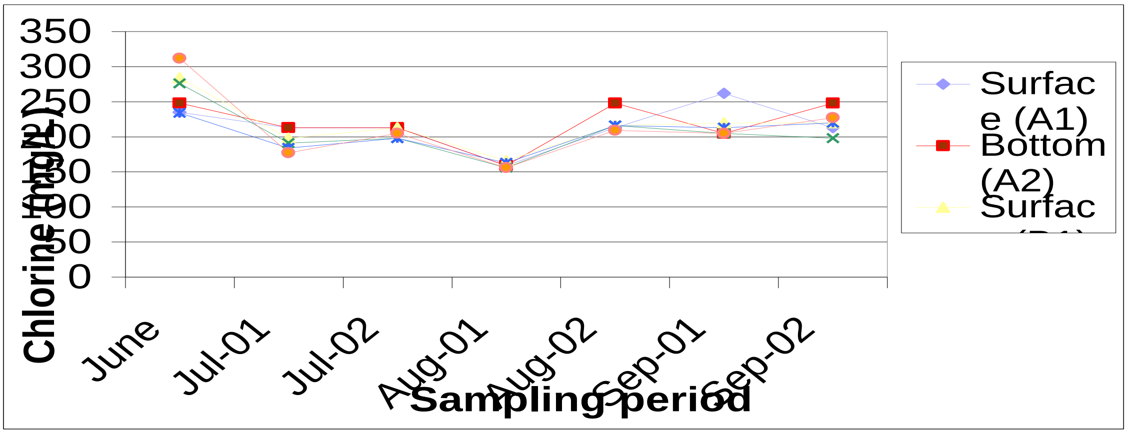


Figure 5. Dynamics of chlorine (mg/L) in Lake Brates

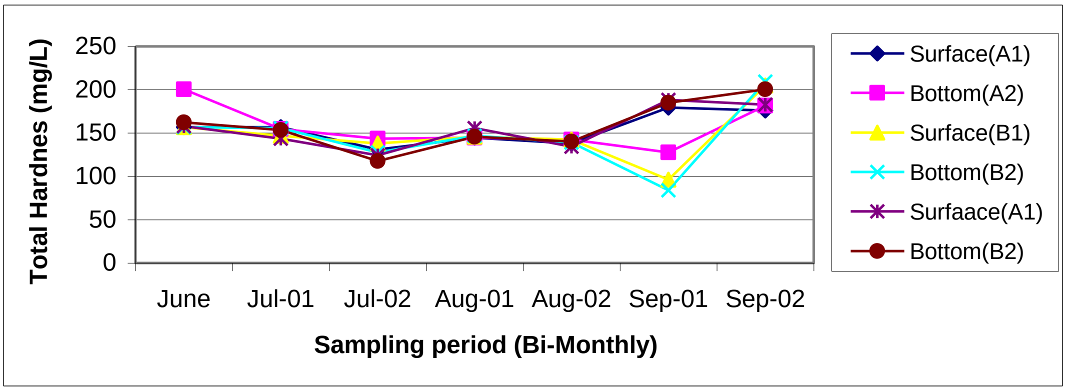


Figure 6. Dynamics of total hardness (mg/L) in Lake Brates

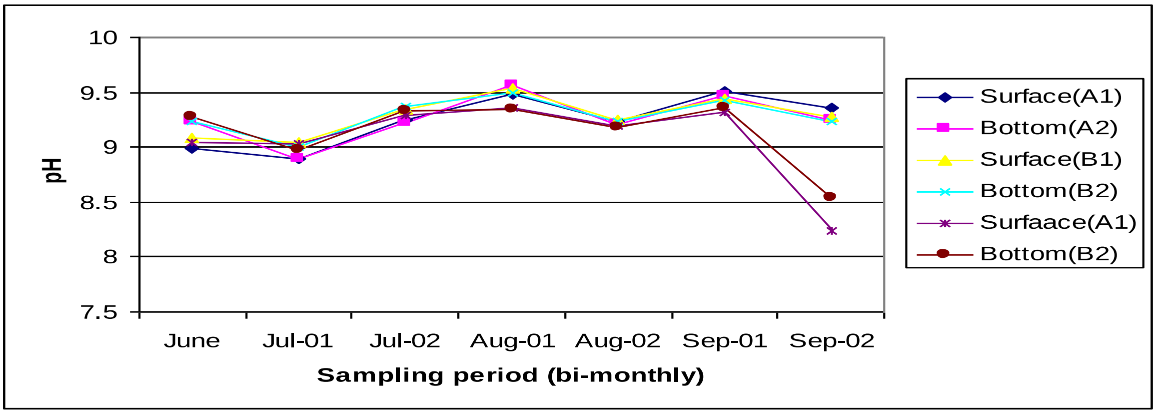
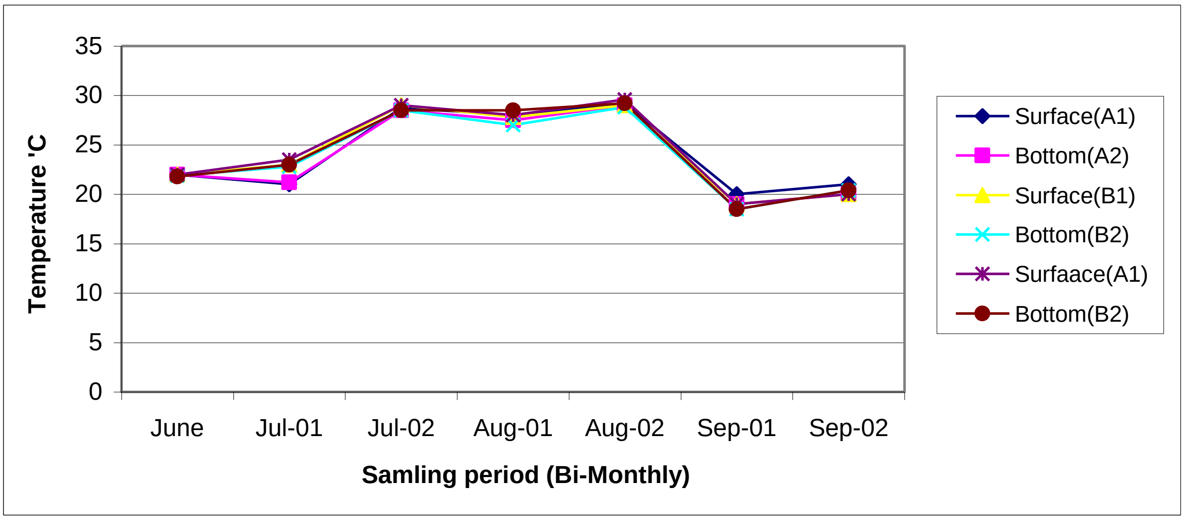


Figure 7. Dynamics of pH in Lake Brates



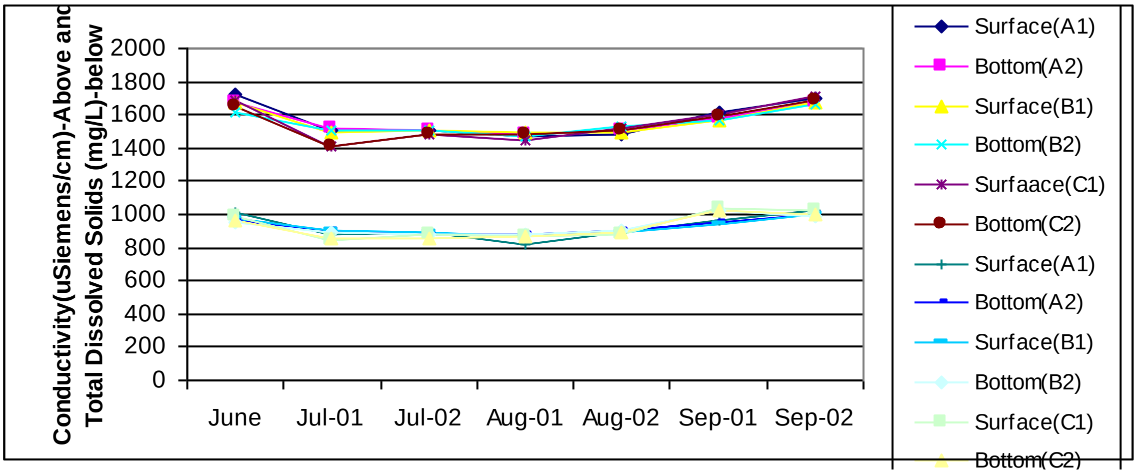


Figure 8. Dynamics of temperature in Lake Brates

Figure 9. Dynamics of conductivity (uS/cm) and total dissolved solids in Lake Brates

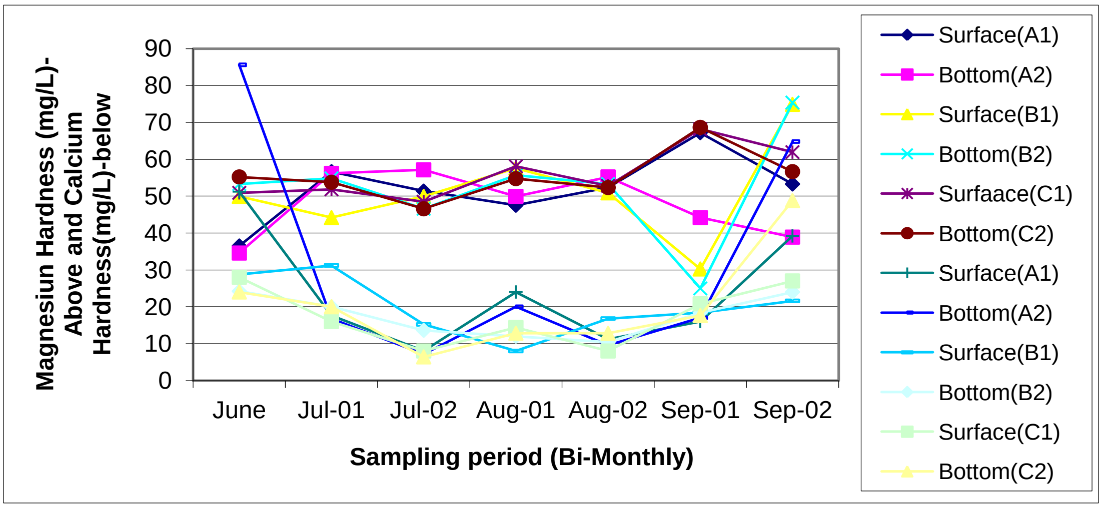


Figure 10. Dynamics of Magnesium (mg/L) and Calcium (mg/L) in Lake Brates

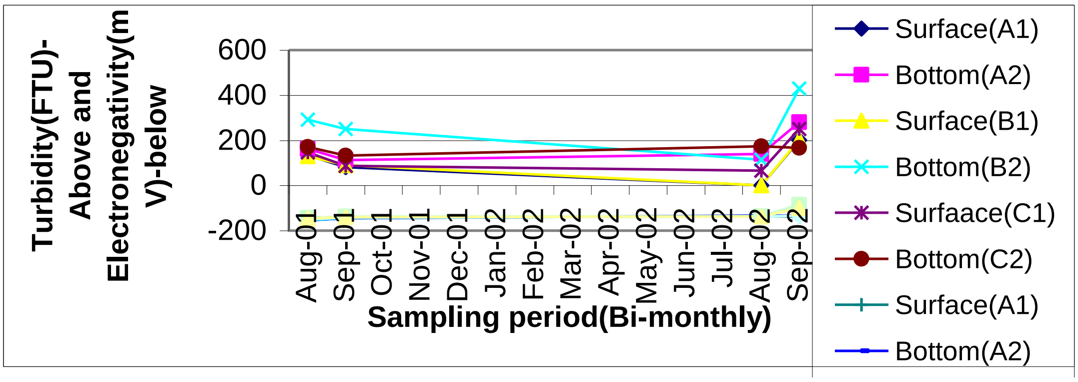


Figure 11. Dynamics of turbidity (FTU) and electronegativity (mV) in Lake Brates

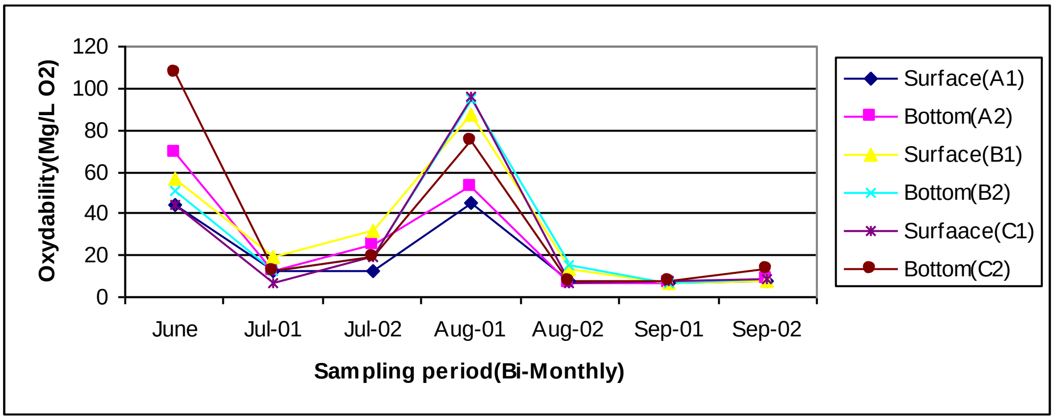


Figure 12. Dynamics of oxydability (mg/l KMnO4) in Lake Brates

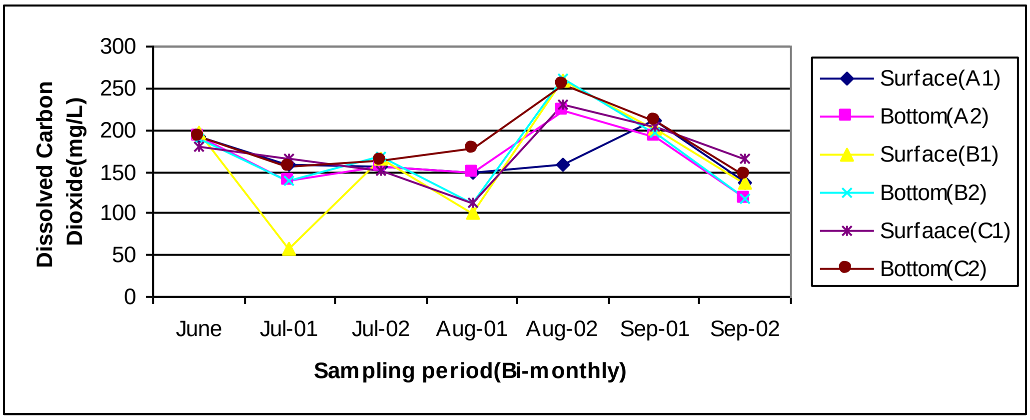


Figure 13. Dynamics of dissolved carbon dioxide (mg/L) in Lake Brates

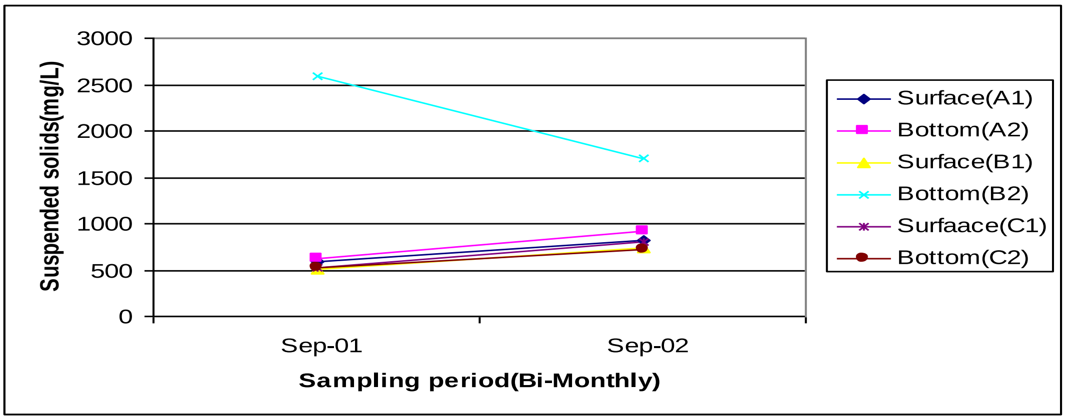


Figure 14. Dynamics of suspended solids in Lake Brates

Table 2. Pedological properties of Lake Brates

Soil properties / Month	July	Aug-01	Aug-02
pH	7,66	8,31	8,22
Electric potential (mV)	-50	-88	-83
Conductivity (uS/cm)	794	1484	1531
Salinity	0,4	0,8	0,8
TDS (mg/L)	466	878	890
Cl^- (mg/100g)	42,60	13,49	17,75
Ca^{2+}+ Mg^{2+} (mg/100g)	28,00	41,44	28,30
Ca^{2+} (mg/100g)	11,20	14,00	8,40
Mg^{2+} (mg/100g)	7,20	11,76	6,60
Humidity (%)	24,46	14,90	35,40
Perm alcalinity	0	5,2	5,2

Total alcalinity	15,60	27,04	5,20
Sr (g/100g)	0,009	0,010	0,012
Rb (g/100g)	0,003	0,002	0,003
Pb (g/100g)	0	0,001	0,001
Zn (g/100g)	0,008	0,006	0,007
Cu (g/100g)	0,008	0,007	0,007
Fe (g/100g)	0,84	0,63	0,81
Mn (g/100g)	0,020	0,027	0,025

Table 3. Physico-chemical properties of some trace and heavy ionic components found in Lake Brates

	A				**B**				**C**			
	June	**July**	**Aug**	**Sep**	**June**	**July**	**Aug**	**Sep**	**June**	**July**	**Aug**	**Sep**
Iron (mg/L)	0.094	18.750	2.500	2.180	0.083	18.750	18.880	3.875	0.063	12.500	2.000	1.162
NO^- (mg/L)	0,165	0.138	0.198	0.313	0,119	0.113	1.1826	0.065	0.440	0.092	1.967	0.088
PO^{4-} (mg/L)	1.321	0.479	0.808	1.395	1.043	0.564	1.494	0.944	1.120	0.724	1.149	1.538
Mn (mg/L)	0.333	0.917	0.583	9.500	0.417	0.333	1.250	3.875	2.250	0.625	4.000	4.625
Phenol (mg/L)	15.890	0.672	1.468	1.269	12.440	0.199	2.514	1.568	18.670	0.324	1.692	1.170
Al^{3+} (mg/L)	0.039	0.025	0.011	0.345	0.011	0.013	0.008	0.333	0.009	0.019	0.010	0.039
$NH4^+$ (mg/L)			3.646	6.070			2.585	2.428			3.692	14.568
NO_3-N (mg/L)		0.100	0.443	0.400		0.100	0.400	0.500		0.700	0.886	0.600

Table 4. Distribution of Ciliate dynamics and pathogenic organisms (protozoa and helminthes) in Lake Brates

BRATES	June	Jul-01	Jul-02	Aug-01	Aug-02	Sep-01	Sep-02
CILIATES							
Amphileptus quadrinucleatus		1		4	3	1	1
Caenomorpha medusula		6	1	1	9	1	3
Chilodonella uncinata		2			6		2
Coleps hirtus		5	1	1	2	3	4
Colpidium campylum	14	4	1	16	10	4	23
Colpoda cucullus	1	7	3	8	2	18	
Frontonia leucas		1			10	3	4

Frontonia sp		1		1	7		
Glaucma frontalis				1	3		1
Histriculus histriculus		1		1	2	1	27
Hypotriche	1	1	4	20	1		10
Lembodion leucens		1		3	1	4	3
Litonotus sp	1	2					
Loxodes kahli	7			5			1
Loxodes rex			1			2	2
Metopus ovatus				2		5	9
Oxytricha chlorelligera			12	32			
Paramecium sp	1	1	1	5	6	2	4
Pleurotricha lancelata		1	3	23	1	3	2
Prorodon ovalis	1	7	4	9	4	3	2
Spirostomum ambigum						2	
Strombidium meganucleatum	1	4			1	4	6
Trachelius ovum				1	2	1	
Urocentrum turbo		3		4	1		2
Uronema acutum		6		3	3	4	4
Vorticella campanula		6	25	156	1		30
Stentor magnum							2
PROTOZOAN							
Chilomastix mesnili		3	3	3	10	5	4
Cryptosporidium sp	14	13	53	46	63	42	25
Cyclospora cayetanensis		7	1	3	15	15	11
Endolimax nana		7			1	2	1
Entamoeba coli	3				5	7	3
Entamoeba hartmanni				1		2	
Entamoeba histolytica		4	11	5	2	14	4
Enteromonas hominis			2		1		1
Giardia intestinalis	8	41	15	12	18	20	25
Iodamoea butschli		1	1	2	2	3	3
Isospora belli	2		1	1			
Retotamonas intestinalis					1		1
Sarcocystis hominis		1	3	1	1		
Dientamoeba fragilis				1			
HELMINTHES							
Ankylostome duodenalis		2					
Ascaris lumbricoides	14	14	6	15	6	6	12

Cercaria or metacercaria			2				
Clonorchis sinensis	2	4	2		4	2	
Diphyllobothium latum	1	11		3		2	
Enterobius vermicularis			37	4	10	4	1
Fasciola hepatica				1			
Heterophrys heterophrys		3	1	2	3		1
Hymenolepis diminuta	1		1			1	
Hymenolepis nana		2					
Metagonimus sp	1						
Paragonimus sp				2	1	1	
Strongyloides stercoralis	1	2		1	5	1	
Tenia sp	7	9	3	1	4	8	
Tichostrongylus sp					1	2	1
Trichiura trichiura		2	1				
Shistosoma mansoni				1			
Opisthocis festinas							1
OTHER							
Hydra		1				1	
Rotaria rotaria				1			

The spatial and temporal patterns of heavy metals such as Sr, Rb, Pb, Zn, Cu, Fe and Mn in aquatic systems have been linked to industrial and agricultural setups as the case of lake Geneva and Lucerne in Europe and could be similar to the lake Brates as presented on Tables 2 and 3 (Thevenon et al. 2011, Zubcov et al. 2012). Climate sensitive processes such as catchment erosion and melt water runoff could also influence the high concentrations of Pb and other components in the soil and water (Liu et al. 2012) of Lake Brates. Water pollution is defined as a change in the chemical, physical and biological health of a waterway due to human activity and is exemplified by the concentrations of numerous organic and inorganic components (see Figures 2-13).

Ways that humans have affected the quality of lakes, over the centuries include sewage disposal, toxic contamination through heavy metals and pesticides, overdevelopment of the water's edge, runoff from agriculture and urbanization and air pollution. This results in a transformation of the metabolic activities of the lakes from aerobic to anaerobic, as it is the case of Lake Erhai in China, which records a similar dissolved Oxygen content of 7mg/l (Zhao et al. 2010), similar to the concentration determined for Lake Brates (see Figure 2).

Under the belief that water could dilute any substance, industries and individuals often used rivers and lakes as garbage cans. Industrial effluent, raw sewage and animal carcasses would often be dumped into waterways, without much thought of contamination and acute pollution of downstream neighbors.

Table 5. Significant correlations between physico-chemical and biological parameters (p>0.01)

Physico-chemical parameter	**Biological parameters**			
Oxygen	Enteromonas (0.92656)	Paramecium (0.920)		
Permanent alcalinity	Chilomonas (0.940)	Sarcocystis (0.9318)		
Alkalinity	Hypotriche (0.969)	Paramecium (0.9244)	Spirostomum (0.937)	Dientamoeba (0.9683)
BOD5	Paramecium (0.9244)	Strombidium (0.97707)		
Total harness	Oxytricha 0.922			
Temperature	Hypotriche (0.9191)	Oxytricha (0.9099)	Strombidium (0.9853)	Ascaris (0.9412)
pH	Histriculus (0.9530)	Oxytricha (0.9228)	Pleurotricha (0.9310)	Spirostomum (0.9537)
	Chilomonas (0.9327)	Cyclospora (0.9075)		
Phosphate	Strombidium (0.9559)	Entamoeba (0.9879)	Ascaris (0.9412)	
Nitrate	Lembadium (0.9309)	Loxodes (0.9223)	Oxytricha (0.9705)	Strombidium (0.9130)
	Entamoeba (0.97047)			

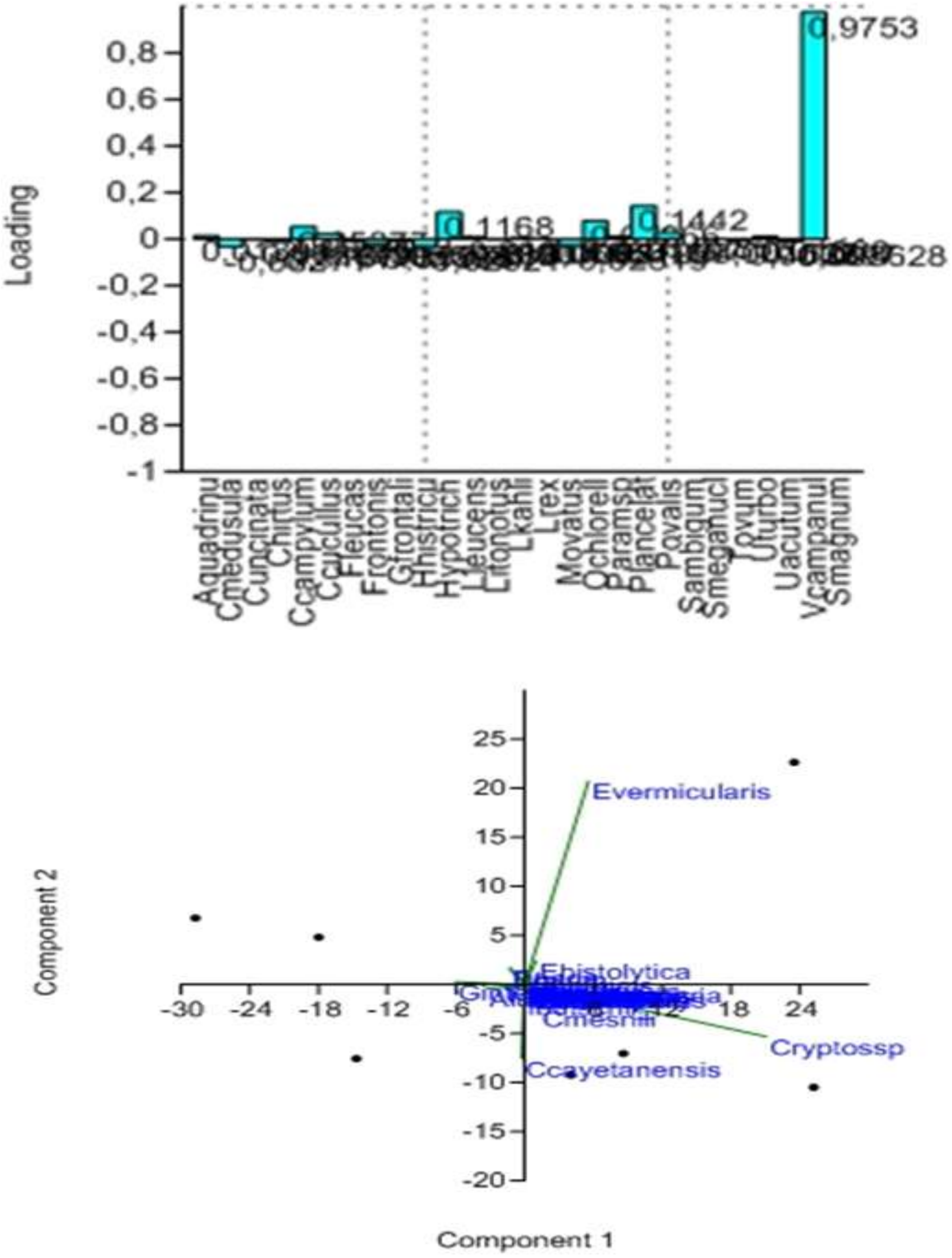


Figure 15. Principal component analysis of the main pathogens with respect to the ecological conditions in Lake Brates

This could be possible in our study site, if appropriate sewage and garbage recuperation measures are not carried out after intensive camping activities take place in the lake site. This lake is one of the major recreational areas in Galati, Romania with an estimated 800 touristic attractions on monthly basis, who exploit the lake water for recreational activities, fishing and nautical sports activities as presented in Figure 17.

The main three entryways of pollutants into aquatic systems are point sources, nonpoint sources and atmospheric pollution as revealed by Klecka et al. (2010). The assurance of water quality for human consumption is essential for public health policies. The exchange of materials between the terrestrial and hydro-system affects the proportion of suspended and dissolved components in water and its physical-chemical characteristics and consequently the quality of the water used by local people (Affonso et al. 2011).

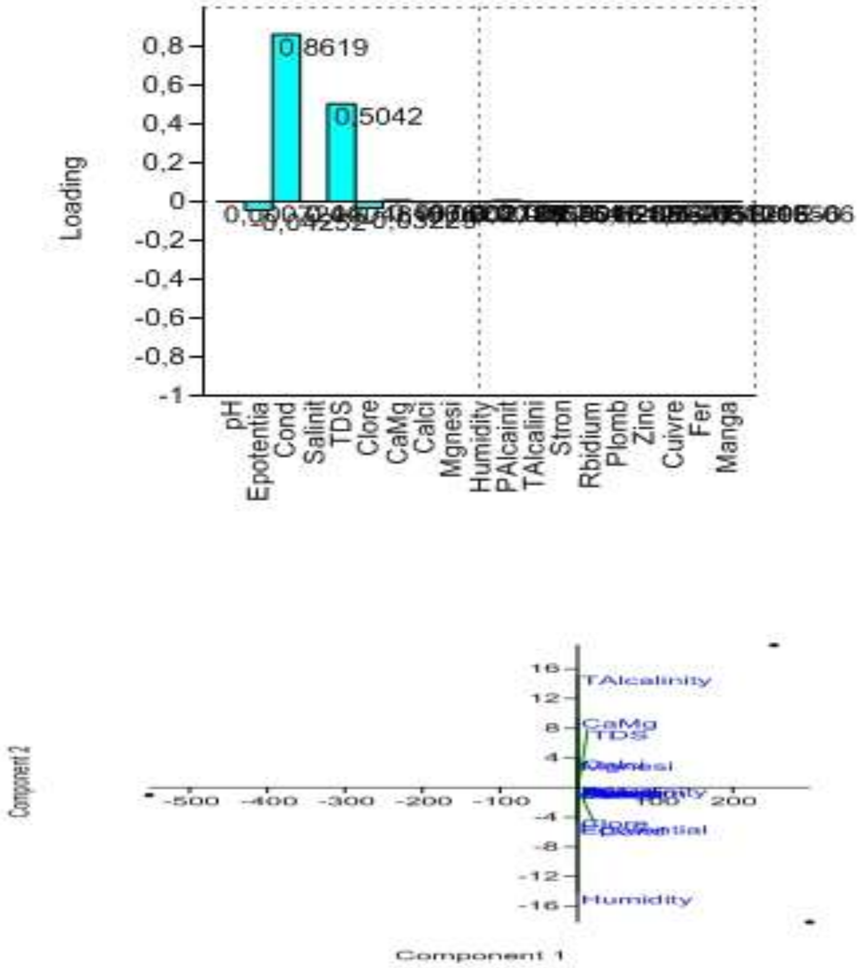


Figure 16. Principal component analysis of soil samples from Lake Brates

Point source pollution can be traced to a specific discharge point and owner; therefore, it has been the easiest source of pollution to control and regulate. In contrast to point source pollution, nonpoint source (or NPS) pollution comes from many different diffuse sources and is extremely difficult to regulate and control. Therefore, many experts believe that NPS pollution is the top hazard that most lakes are facing. NPS pollution is mainly caused by: runoff, when rain and snowmelt move over the land, picking up pollutants such as oil, grease and salt from highways; sediment from construction sites and eroding shorelines; and animal and human waste along the way; dumping the pollutants into rivers and lakes as it is the case of the winter / summer meteorological phase of Lake Brates, which is localized in a temperate region. The high statistical correlation determined for nitrates and phosphates and the biological indicators of the lake contamination reveal a useful exploration for the quantitative and qualitative evolution of inorganic and organic components in our study site (Pam et al. 2011)

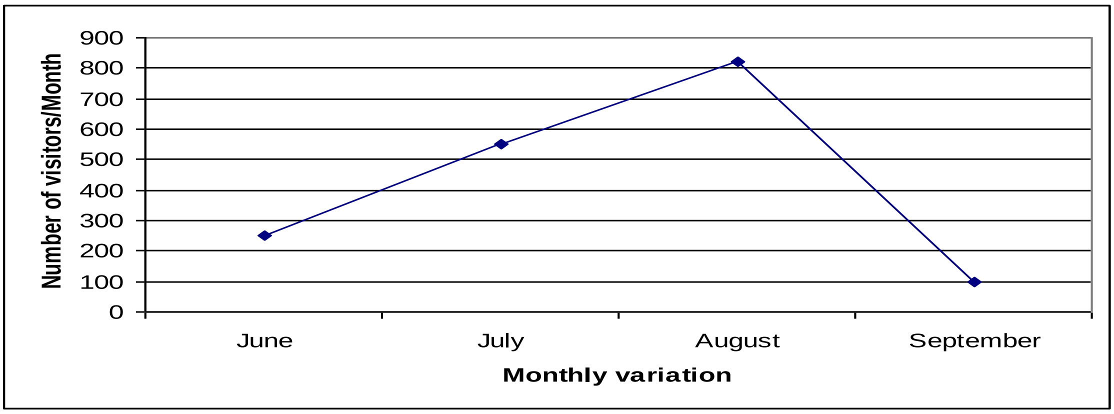


Figure 17. Number of visitors/month exploiting the economic potential of Lake Brates

Water pollution affects the health of the waterway, the health of the organisms living in and around the waterway and eventually the health of humans. The effects of water pollution can range from aquatic deformities to contaminated fish to "dead" lakes. Heavy metals such as mercury and lead, and human-made organic chemicals such as pesticides, bio magnify as they move up the food chain, resulting in tumors and death for predatory animals, such as lake trout, herring gulls, and even humans. Toxic pollutants can also alter the genetic makeup of an organism, resulting in either death or extreme deformities. Surface water must undergo careful quality assessment before being exploited for recreational or industrial purposes so as to detect the concentrations of elements and compounds present in it (see Figure 2-14 and Tables 2-4).

The contamination with wastewaters, whether treated, untreated or partially treated is a risk to public health (Aulicino et al. 2005). According to the biological results presented on Table 4, thirty one ciliated protozoa were identified in our analysis of the water in Lake Brates. Those that were present throughout the sampling period were the indicators of polysaprobity, such as *Oxytricha chlorelligera*, *Pleurotricha lanceolata*, *Vorticella campanula*, *Caenomorpha medusula* and *Metopus ovatus*, which proof the depreciating characteristics of the water quality. Resistant forms of enteropathogenic protozoa were present in our samples, as analyzed by parasitological procedures (Justine et al. 2012). These are *Cryptosporidium* sp, *Entamoeba histolytica*, *Giardia* sp, *Cyclospora cayetanensis*, Entamoeba *sp, and Enterobius vermicularis*. They reveal the possible domestic, industrial and anthropogenic contamination of this lake on the one hand and the precise sanitary risks linked to an unregulated exploitation of this vital hydric resource by the population of Galati-Romania and its environs. According to Engel et al. (2011), the integrations of biological diversity, climatic mitigations and the geodynamical specificities of the medium are important goal for integrative ecosystem management.

Human health issues due to organic pollutants can persist in the environment and bio-accumulate through the food web, thereby causing sickness and diseases in humans, who are at the end of the food chain (Purdy et al. 2010; Mircean et al. 212). While scientists are still studying the effects of high chemical levels in humans, studies have suggested that toxic chemicals can lead to reproductive problems, cancer and neurological disorders (Hanson et al. 2011). People who are most at risk of health problems due to contaminated fish consumption are those with weakened immune systems, including children, pregnant women and the elderly. Those in the "high-risk" category should either abstain from eating fish or swimming in the lake water (IDPH 1990). A reduction of phosphorus entering Lake Brates and an estimation of maximum allowable level for some contaminants can greatly reduce the pollution status of the lake. The recorded and high correlative value of total hardness, Mg and Ca hardness, organic matter, suspended solids and other variables such as turbidity, color and the immobilization of physico-chemical and biological elements in the sediments (see Figures 15-16) participate in the regeneration and the definition of the trophic status of the ecosystem (Istvanoviss and Somlyody 2001).

An excess supply of organic, mineral, trace and heavy metals with subsequent losses to the aquatic environment can lead to adverse effects on both the ecology and uses of receiving waters as presented in Tables 2 and 3 and substantiated by the findings of Hanson et al. (2011) and Gazzaz et al. (2012). The process of accelerated enrichment and its impacts, arising from human activities, is termed cultural eutrophication and has been recognized internationally as a significant environmental problem/challenge for a number of decades, particularly since the influential reports and cooperative environmental programmes have been initiated (Vollenweider and Kerekes 1982). There is often a large amount of accumulated organic matter on the bottom of Lake Brates, probably due to a low turnover that could exists between the surface and bottom waters, as substantiated by the disparity that exists between these water layers (see Figures 2-14, Tables 2 and 3). This could lead to a high primary and secondary productivity of this water body and the acceleration of the mesotrophic, eutrophic and hypereutophic transformation sequence that is in process in this limnic ecosystem.

Eutrophic lakes are susceptible to oxygen depletion in the hypolimnion and a relatively lower value in the mixolimnion and epilimnion, as the case of Lake Brates that has a relatively low depth. The variation in pH and mineral contents can play a primordial role in the succession patterns of zooplankton and phytoplanctonic communities, as it is the case of some mining lakes in Austria that could be compared to the fluctuations in the ciliated protozoa determined in Lake Brates (Moser and Weise 2011). There is a polimicticity that probably does not involve the regeneration of the bottom sediments. The basicity of Lake Brates remains unstable due to the agro-technical inputs activities that comprise an important component adjacent to the ecosystem and the climatic variability, as postulated by Engel et al. (2011). In this case, monitoring of potential toxic algae and the application of nutrient reduction strategies will be an efficient corrective aquatic resource governance policy (Smith 2003; Soaresa et al. 2011).

4. Conclusions

There is an acceleration of the mesotrophic, eutrophic and hypereutophic transformation sequence in process in this limnic ecosystem. These results proof the presence of organic and inorganic pollutants in Lake Brates (Galati-Romania) in quantities that impose the application of environmental securing measures to avoid the propagation of communicable diseases at proportions that can cause waterborne outbreaks to the community exploiting the lake water for domestic and industrial purposes. The isolation and identification of *Metopus* sp. and *Caenormorpha* sp is an indication of acute pollution. *Cryptosporidium, Giardia, Cyclospora, Entamoeba* and the larva of *Strongyloides strongyloides* are indicative of the presence of the environmental forms of emerging, entero-pathogens at proportions that can signal outbreaks to immuno-compromised hosts (children and elderly) who might use the lake for hydro-economic purposes. Some accommodating measures include washing of hands thoroughly after bathing in Lake Brates, or before preparing or eating food such as fish at the lake site. Ingesting contaminated and untreated lake water can result in the dispersal of infectious agents. Measures to decrease risks associated with recreational activities in water should be directed towards reducing the likelihood of faecal contamination and the installation of appropriate hygienic and water treatment rules to maintain lake quality equilibrium and reduce the transmissivity of pathogenic protozoan and helminthes.

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