# P 9. ASSESSMENT OF WATER QUALITY IN THE DIFFERENT DEPTH OF OHRID LAKE (ALBANIAN PART) BASED ON DIATOM INDICES

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**ABSTRACT:** Since many years, the siliceous algae (diatoms - *Bacillariophyta*) are used to evaluate the ecological state of surface fresh water. Lake Ohrid is the deepest lake of the Balkan, with a maximum depth of 288 m and a mean depth of 155 m. The data about water quality in Ohrid Lake, which are presented in this paper, are based in diatom composition in different depth. The diatoms communities were collected like epiphyte in macrohytes, in different depth of three sampling sites (Hudënisht, Gur i Kuq and Mëmëlisht) during yrs. 2011. Most of the species in Ohrid Lake are oligotraphent, growing up only in clean waters with low nutrients, like: *Achnanthes minutissima*, *Navicula cryptotenella*, *Cymbella microcephala*, *Nitzschia denticula*, *Fragilaria capucina*, etc. Other species of highest vitality in stronger mesotrophic to eutrophic waters were observed, like: *Amphora pediculus*, *Cocconeis pediculus*, *Gomphonema pumilum*, *Gomphonema olivaceum*, *Cymbella minuta*, *Diatoma vulgaris var. vulgaris*, etc. The ecological preference groups of diatoms reflect the chemical character of different streams. Such changes in diatom community structures suggest a change in environmental conditions such as, for example the deterioration of trophic status observed in Ohrid lakes. From a rough estimation of diatom species based on two standards: EN 13946:2003 and EN 14407:2004, we have calculate the Shannon Index, which gave evidence of biodiversity variations over the seasons and some differences between sampling sites. The Saprobic Index oscillated within a small band, indicative for oligo-β-mesosaprob to β-mesosaprob conditions. The Trophic Diatom Index ($TI_{DIA}$) and the Saprobic Index (SI) follow similar trends. The structures of the diatom communities reflect real environmental changes. These states are confirmed also by relative activities, such as: from mine and from agriculture land in to the watershed area.

*Key words: Ohrid Lake, diatoms indices, epiphyte in macrophyte, ecological assessment*

## 1. INTRODUCTION

Lake Ohrid has 87.5 km of shoreline and covers an area of 358.2 km$^2$. The average depth of the lake is 164 m; it has a maximum depth of 289 m. The watershed of Lake Ohrid includes steep mountains, as well as both Macro and Micro Prespa Lakes. The total area of the watershed is about 3,921 km$^2$. A little less than half of the water in Lake Ohrid comes from its tributaries. On the Albanian side, river flow is substantially less, but the Pogradeci and Verdova Rivers are the largest contributors. The remaining inflow comes from the springs that flow into the southern part of the lake, at St. Naum, Drilon and Tushemisht. These springs are fed by water flowing out of the porous karst mountains (Mali i Thate). Over thousands of years, holes and channels have formed within the mountain rock. These channels carry water that originates in the Prespa watershed to Lake Ohrid. The farmland in the basin is likely a significant source of pollution to Lake Ohrid as fertilizers, soil particles, and pesticides wash into rivers and streams and eventually to the lakes. Much of the farmland in the watershed is irrigated, which increases the load to the lake. In Albania, human waste and wastewater is currently not treated in the watershed. In Pogradec, the waste generated by about 30% of the town is collected but it is simply discharged into Lake Ohrid near Tushemisht. In addition to eutrophication, Lake Ohrid also shows metal pollution near the sites of the old chromium, iron, nickel and coal mines outside Pogradec (in Gur i Kuq and Memelisht). Long-term exposure to elevated levels of chromium, copper, cobalt, nickel, and other metals have been shown to have harmful effects on human health. The shoreline around Pogradec is also the prime area for tourism on the Albanian side of the lake, so the water pollution from sewerage has significant economic, as well as ecological impacts. Evidence of the ecological impacts of human activities is apparent in both the aquatic plant community and the phytoplankton in the near shore waters. In the region of Pogradec, phytoplankton densities are much higher than elsewhere along the shoreline, and the submerged plant community has high densities of pollution tolerant taxa. In the mining area of Memelisht and Guri i Kuq, these plants show evidence of metal contamination and stunted growth. The population in the Pogradeci areas has been growing rapidly, and as this growth continues, the pressures on the lake will continue to increase. To accommodate this growth, and the economic development necessary to improve the quality of life in the region, aggressive management actions will be needed. A coordinated approach that manages urban growth, agricultural impacts, and industry must be developed. Diatoms are the main primary producers and chemical modulators in freshwater aquatic ecosystems (Kupe L. et al., 2008, Wu et al., 2012; Bere et al., 2014; Mangadze et al., 2015, Dalu T. et al., 2016). The diatoms are very sensitive to environmental change. Moreover diatoms have distinct ecological tolerances and short generation time (Zalack et al., 2010, making them suitable indicator organisms for water quality changes over short time scales. Diatoms have been used as water quality indicators in Europe (Kelly et al. 1998; Prygiel et al., 1999, Sládeček V., 1986, Willén E., 2000). Most of the indices employed are based on Zelinka and Marvan's (1961) approach, which considers weighted averages of taxa's sensitivity to nutrients and organic degradation, as well as pH and salinity (Dalu T. et al., 2016). We evaluated that changes in water quality resulting from different depth would be reflected in diatom community structure.

## 2. MATERIAL AND METHODS

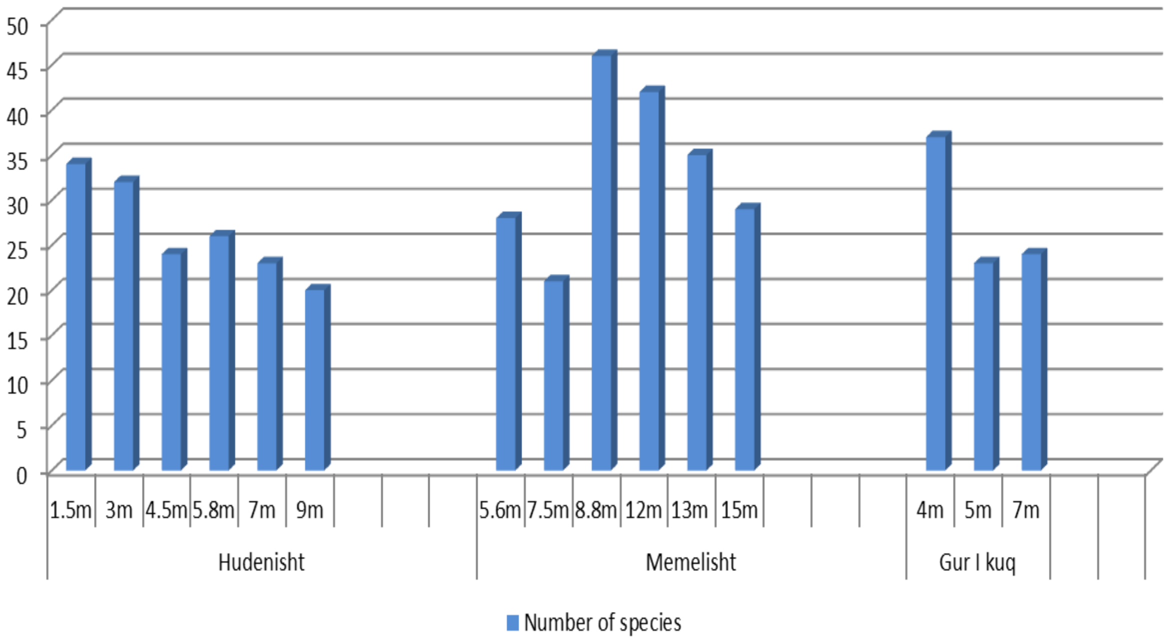
Lake Ohrid is a tectonic and the deepest lake of the Balkans, with a maximum depth of 289 m and a mean depth of 164 m. It covers an area of 358.2 km², containing an estimated 55.4 km³ of water. Lake Ohrid is special as such; by far the most spectacular quality is its impressive endemism. He has more endemic species covering the whole food-chain, from phytoplankton to fish. Sampling and monitoring of the diatoms were performed on July 2011. The samples are collected in three sampling sites and for each sampling sites we have collected samples in different depth from shoreline: Memelisht (5.6m, 7.5m, 8.8m, 12m, 13m, 15m); Hudenisht (1.5m, 3.5m, 4.5m, 5.8m, 7m, 9m) and Gur i Kuq (4m, 5m, 7m).


**Figure 1.** Sampling sites in Ohrid Lake in different depth

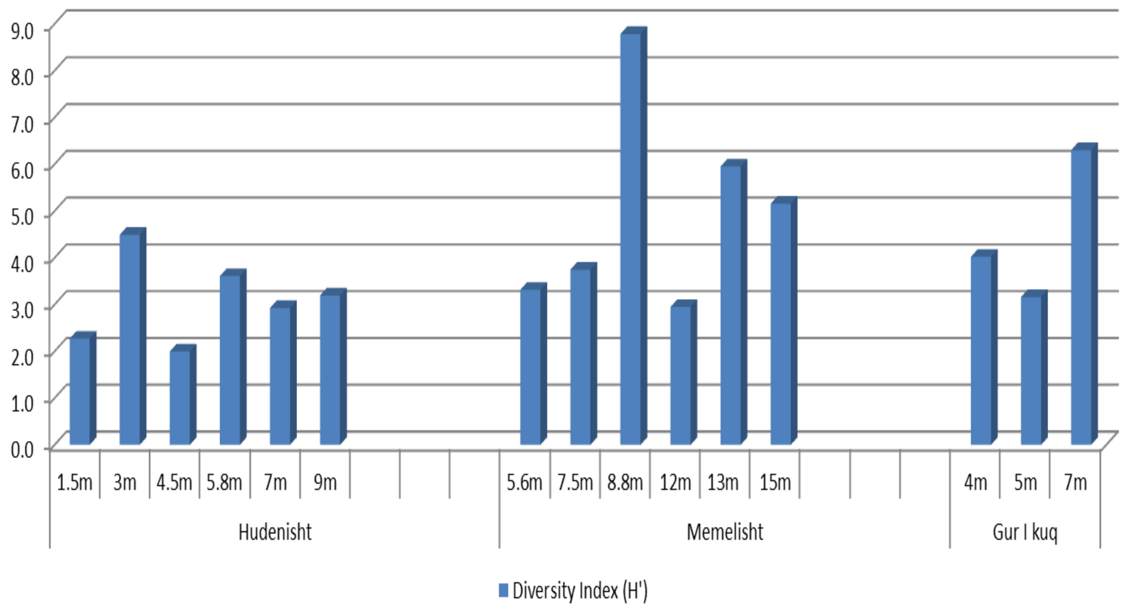
In this paper in total we will present 15 samples, in which sample we have calculate the Diversity Index (H'), trophic Diatoma Index ($TI_{DIA}$) and Saprobic Index (SI). The diatom community are collected like epiphyte in different macrophytes in different depth from shoreline; the resulting suspensions collected in small bottles and preserved in 4% formaldehyde (Kelly et.al., 1998; Prygiel et. al., 2002; Kupe L., 2006; Kupe et. al., 2013). The cleaning of diatom frustules was done boiling the material, first with HCl*cc* and then, after washing, boiling them again with $H_2SO_4$*cc*, adding during the last procedure some crystals of $KNO_3$, as described by Krammer & Lange-Bertalot 2001 (standards of EN 13946: 2003). About 500 valves per slide were counted using 100 oil immersions, yielding a 95% confidence for the data on species composition (Lund et al., 1958; Kelly et al., 1998; Prygel et al., 2002). Diatoms were identified using standard literature (Cleve – Euler 1955; Pascher 1976; Krammer & Bertalot 1996-2001), (EN 14 407: 2004). Several studies have clearly demonstrated that diatom community's change with increasing concentrations of both organic and inorganic load of substances, making them the preferred organism group for in situ biomonitoring studies in Europe, the USA and Asia (Cox 1991; Kovacs et. al., 2006; Kupe et al., 2012).

## 3. RESULTS AND DISCUSSION

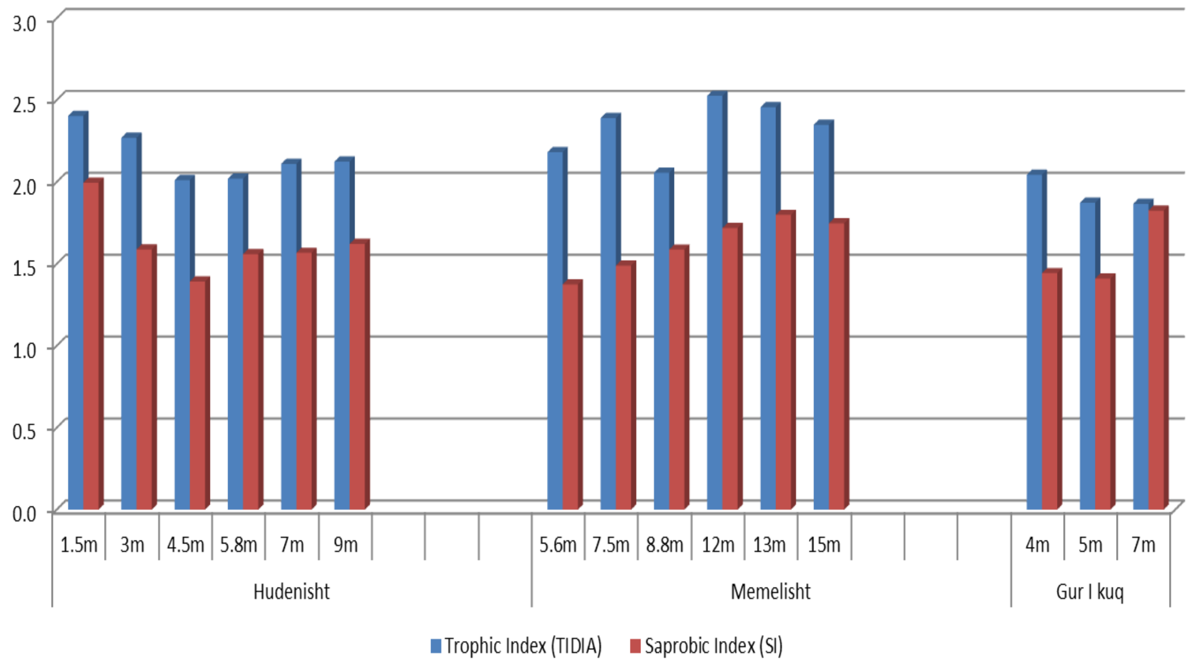
In 15 samples of 3 sampling sites we have determine in total 88 species in Hudenisht; 94 species in Memlisht and about 60 species in Gur i Kuq. The dominant species in our samples are presented by: *Cyclotella ocellata, C. fottii, Aulacoseira ambigua, Cocconeis placentula, C. robusta, Denticula tenuis, Epithemia ohridana, Gomphnema olivaceum, Navicula cryptotenella etc.* Each species is characterized by an ecological value, which have indication in trophy level of water. The Ohrid Lake is also very rich with endemic species. For them didn't determined the ecological value but their presence though high in some cases is not taken into account in calculating the trophic and saprobic index due to lack of that their ecological values. Among the endemic species we determination: *Placoneis macedonica* Levkov, *Amphora ohridana* Levkov, *Encyonema macedonicum* Levkov, *Encyonema ochridanum* Krammer, *Placoneis juriljii* Miho, *Planothidium lanceolatum* Lange- Bertalotti, *Hippodonta costulaiformis* Lange-Bertalot (Miho & Tase 2004; Miho Witkovskii 2005).
The high number of species was found in Memelishti station, in 8.8m depth. The low number of species was found in Memelisht (7.5m) and Hudenisht 9m. If we compare three sampling sites, the average number of species belong Memelisht station, especially in 8.8m and 12 m, which show the high value of nutrient and organic matter.




We have identify tolerant species that are dominant and grow in a wide range ranging from oligotrophic to eutrophic waters, such as: *Neidium dubium, Nitifolia amphibia, Nitzschia angustata* etc. Some others species like as: *Achnanthes lanceolata, Amphora pediculus, Cocconesi pediculus, Cymbella minuta,* *Diatoma vulgaris var. vulgaris, Epithemia adnata, E. sorex, Fragilaria capucina var. mesolepta, Gomphonema minutum, Gomphonema pumilum, G. olivaceum, Gyrosigma accuminatum, Meridion circulaire, Naviculadicta atomus, N saprophila, Navicula cryptocephala, N. menisculus var. grunowii, N. reinhardtii, Nitzschia dissipata, N. linearis, N. palea, Rhoicosphaenia abbreviata, Surirella angusta*, etc. The politrophic and polyhypertrophic species of diatoms species such as: (*Amphora lybica, Cymatolpeura solea, Fragilaria ulna, Navicula cuspidate, Gomphonema olivaceum, Navicula cryptotenella* are not very dominant in Lake Ohrid. Most of species in Ohrid Lake belong to endemic species. The highest values of the variability indicator are found in the Memelisht (depth 8.8m) which indicates a variety present, is related to the various trophic levels, which determine the quality of the waters. Diatom indices have been used extensively for water pollution and trophic status assessment. These indices like as: trophic indices ($TI_{DIA}$) were significantly correlated to (nutrient) ammonium, nitrate and phosphate concentrations. But saprobic indices (SI) were significantly correlated to organic matter.




$TI_{DIA}$ oscillated from 1.9 Gur i Kuq to 2.5 in Memlisht, show a moderate level of inorganic mater in water. They come from domestic matters and agricultural land. SI oscillated from 1.4 (oligosapro) to 2 (ß – mesosaprob). In general, the value of saprobic index shows low level of organic matter.




In all sampling sites and in all depth, trophic values are very high if we compare with saprobic index. The high values of trohic index are the results of high level of inorganic matter (nitrogen and phosphorous) have a strongly influence to growth the macrophytes. The trophy levels in Ohrid Lake oscillated from mesotroph in Gur i Kuq to eutroph in Hudenisht and Memelisht. The caused by the impact of the inhabited of villages like as: Hudenishti and Memelishti.

## 4. CONCLUSION

The Pennat diatoms are the most dominant species in the waters of Lake Ohrid because samples were accumulated as epiphyte in macrophytes dominated by: *Cocconeis placentula var. lineata* (show a moderate pollution of water), *Cocconeis robusta* (endemic species), *Gomphonema pumilum* (show a good quality of water), *Navicula cryptotenella* (from moderate to high pollution which is low presence), *Gomphonema minutum* (modearte pollution, high presence in all depth and in all sampling station), *Cymbella ohridana* (endemic species of Ohrid Lake). However, in Ohrid Lake, we have identify tolerant species that are dominant and grow in a wide range ranging from oligotrophic to eutrophic waters, such as: *Neidium dubium, Nitifolia amphibia, Nitzschia angustata* etc. Some others species like as: *Achnanthes lanceolata, Amphora pediculus, Cocconesi pediculus, Cymbella minuta, Diatoma vulgaris var. vulgaris, Epithemia adnata, E. sorex, Fragilaria capucina var. mesolepta, Gomphonema minutum, Gomphonema pumilum, G. olivaceum, Gyrosigma accuminatum, Meridion circulaire, Naviculadicta atomus, N saprophila, Navicula cryptocephala, N. menisculus var. grunowii, N. reinhardtii, Nitzschia dissipata, N. linearis, N. palea, Rhoicosphaenia abbreviata, Surirella angusta*, etc. However, in littoral habitats, there have been observed tolerant species as dominant that grow up to a wide range, from oligotrophic to eutrophic waters, like: A. *biasolettiana, N. minima, Neidium dubium, Nitzschia amphibia, Nitzschia angustata, Gomphonema truncatum, G. parvulum, Fragilaria brevistriata*, etc. Other species of highest vitality in stronger mesotrophic to eutrophic waters were observed. High presence of *Cyanophytes* has been observed in planktonic samples near Pogradeci. Some more considerations about trophy state of Albanian habitats were reported in a previous publication (Miho et al., 2006)

The politrophic and polyhypertrophic species of diatoms species such as: (*Amphora lybica, Cymatolpeura solea, Fragilaria ulna, Navicula cuspidate, Gomphonema olivaceum, Navicula cryptotenella* are not very dominant in Lake Ohrid. The composition of the diatomes in Ohrid Lake oscillated from oligosaprobic to oligo- β-mesosaprobic state, ie a medium to moderate contamination with organic matter and a little more contaminated with inorganic matter from mesotroph to eutrophic.

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