

## **HYDRO-ECOLOGICAL QUALITY STATUS ASSESSMENT IN DIFFERENT LAKES OF DANUBE DELTA – ROMANIA. CASE STUDY: UZLINA, ISACOVA, MATIŢA, BABINA AND ROŞU LAKES - 2010**

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### **Abstract**

The aim of this study is to provide a precursory estimation regarding the water and sediment quality of some lakes in the framework of the Danube Delta. The region of Danube Delta is a peculiar land, being crossed by many canals, streams, swamps and including many lakes which represent unique ecosystems which provide and sustain habitats for plant and animal communities. Due to the upstream anthropogenic activities, delta lakes are subjected to susceptible pollution, taking into account that Danube River is receiving considerable quantities of industrial, agricultural and urban wastewaters. In order to assess the hydro-ecological status of deltaic lakes, two sampling campaigns were performed during 2010 and the following measurements were fulfilled: water physico-chemical parameters (oxygen concentration, pH, electrical conductivity, total dissolved solids, nitrates, nitrites, phosphates and sulfates), main lithological parameters of sediments (total organic matter, carbonates and siliciclastic fraction) and biological assay (identification of benthic communities). The basic results show that the analysed aquatic systems are actually controlled by external factors as: lake morphology, variation of climatic parameters, and lake position within the deltaic hydrological network (directly influenced by the Danube River input or located farther on the fluvial input). Physico-chemical measurements performed on lakes and connection canals indicate small variations ranges. In some samples were incidentally noted lower concentrations of oxygen content and pH fluctuations from slightly alkaline to alkaline domain. Chemical recorded data does not present high concentrations for nitrates, nitrites and sulfates. Regarding the phosphate content, some higher values have been investigated. Generally, the physico-chemical records report normal values which are in accordance with surface water quality standards. The lacustrine sediment cores exhibit uniform profiles, display a homogenous color (from light grey brown to dark grey brown) and sometimes with evidence of layering. Sedimentologically (textural and structural), these bottom sediments correspond to the group which diverge from silty to silty clayey (fine and very fine), alternately sometimes with sandy deposits. Distribution of the main lithological components noted a similar trend for every studied core, meaning a high percentage of organic matter at the top, a subsidiary low content of carbonates and a complementary siliciclastic sediment fraction. The biological findings show some sensitive sectors (small number of taxa) which may suggest a degradation of the aquatic environment (poor growth of some species). Overall, the implemented study fulfilled in 2010 shows a normal status for such aquatic systems with undetectable contamination evidences.

**Keywords:** Ecological, Assessment, Sampling, Quality Standards, Total Organic Matter, Biological Assay.

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### **1. INTRODUCTION**

The objective of this research is to assess the water and sediment quality of five lakes located within the Danube Delta. This study consists of a preliminary characterization of water samples collected from various lakes and some connection canals in order to acquire a database regarding the seasonal changes of physico-chemical parameters and an evaluation of the inputs and outputs due to climate change (floods or droughts, rainfalls, etc.). Simultaneously, this study deals with the assessment of sediment samples regarding the distribution and interconnection of organic material, carbonates and siliciclastic material with depth; furthermore, it aims to set up the environmental involvement of the future trends of organic matter, carbonates and siliciclastic fraction. In addition, biological investigations have been performed. The character of the lake sediments, the physico-chemical water parameters and biological assay could contribute to the knowledge and understanding of aquatic environment and medium-long term variations that occur in a water basin.

## 2. MATERIALS AND METHODS

### 2.1. Geomorphological context

Danube Delta is the second largest delta in Europe (5.800 km<sup>2</sup>) after the Volga Delta. Danube Delta is located mostly in Romania, and partly in Ukraine, being considered the best preserved among other European deltas. Danube Delta is part of the vast system Danube River-Danube Delta-Black Sea, being the natural interface between a large drainage network (817.000 km<sup>2</sup> including more than 15 countries) and the Black Sea. Considering the genesis, hypsometry, aquatic connections between the Danube River branches and inland areas, climate differences and landscape variations, the Danube Delta is composed from two main sectors - fluvial delta plain and fluvio-marine delta plain, separated by the Letea-Caraorman initial litoral ridge (Panin, 1996).

### 2.2. Study area

This study is based on analyses of superficial sediments samples and water samples collected from five different lakes of Danube Delta. Matița (652 ha) and Babina (338 ha) lakes are included in the Lopatna-Matița-Merhei Unit, belonging to the category of lakes with large aquatorium and relative active changes of waters, also having a secondary hydrographic network. Roșu lake (1445 ha) belongs to the Puiu-Roșu-Roșuleț Unit, being situated in the fluvio – marine area; Roșu Lake is located far enough from the Danube distributaries being in free regime of water circulation (Gâstescu, Știucă, 2008).

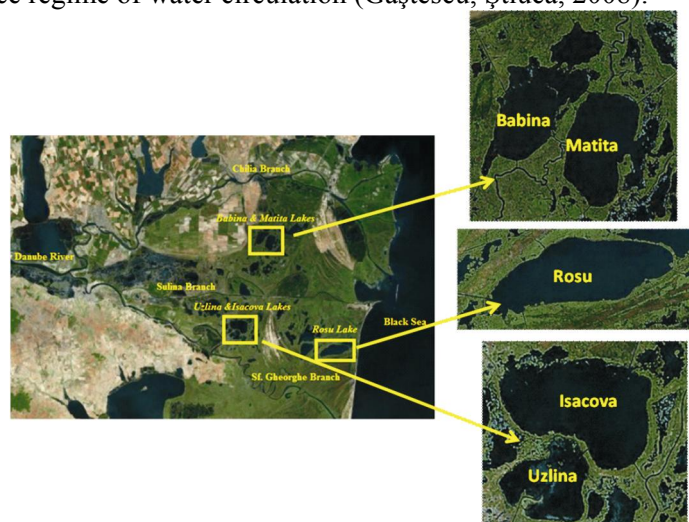


Figure 1: Satellite images of investigated perimeters in the Danube Delta

The couple of lakes Uzlina (468 ha) and Isacova (1101 ha) is comprised into the Rusca-Gorgova-Uzlina Unit, which stand into the fluvial area. In Uzlina Lake there are active changes of waters (due to direct contact with St. Gheorghe Branch through Uzlina canal). Isacova Lake is characterized by relatively stagnant conditions with low water circulation. In this area there is a rich hydrographic network, about 110 small lakes, many canals and streams. Here, the most important are: Litcov Canal, Uzlina Canal, Perivolovca stream, Isac 1, 2, 3 Canals, etc.

### 2.3. Field Methods – Sampling

The investigation of physico-chemical water parameters and sediment characteristics were accomplished into the framework of two different sampling campaigns which were held into the summer and autumn of 2010. The GPS coordinates, water depth, main climatic parameters (air temperature, humidity, atmospheric pressure, wind speed & direction) were registered for every water and sediment sampling stations.

*The water physico-chemical parameters.* A series of water samples (approximately 72 sampling stations) have been collected near the water surfaces (0, 5 – 1 m) in five lakes and several connection canals, in order to assess the water quality. The physico-chemical parameters (dissolved oxygen, pH, temperature,

conductivity, redox potential and total dissolved solids) were measured *in situ* on board, using WTW Multiline P4 Multiparameter device, well-equipped with adequate sensors.

**Chemical parameters** - The nitrates ( $\text{NO}_3^-$ ), nitrites ( $\text{NO}_2^-$ ), phosphates ( $\text{PO}_4^{3-}$ ), sulphates ( $\text{SO}_4^{2-}$ ), were determined on board of R/V "Istros", using Hach 5000 –UV-VIS –Spectrophotometer. Sampling and laboratory analyses have been performed according with the rules and procedures stated by Normative 161/2006 (Standard on surface water quality classification for determination of the ecological status of water bodies). It has been respected and fulfilled all sampling protocols, taking into consideration all the measures and proceedings in order to not contaminate the water samples.

**The sediment samples** were collected with a Hydro-Bios gravitational corer. Overall, six short gravity cores were extracted from the bottom of the investigated lakes.

The cores were sub-sampled on board, at different levels (1-3 cm intervals); the sub-samples have been placed in sterile plastic boxes and preserved in cold condition until their transportation to laboratory. Regarding the determination of the bulk sediment properties (% water, % total organic matter, % total carbonates, % siliciclastic material) approximately 100 g sediment was extracted from sliced sediments in order to be used at laboratory. The percentage determination was done by *Loss on Ignition Method*.

**The biological samples** were collected using a Van Veen grab sampler, and from the entire sediment was retained a sub-sample with a hand corer of 10 cm inner diameter, to a depth of 5 cm. The storage and conservation of biological material was performed with 4% neutralized formaldehyde. Technical laboratory processing of biological samples was as follows: washing the material on a set of particle size sieves with 1.000 mm, 0.500 mm, 0.250 mm and 0.125 mm, opening diameters in order to set apart macro-, meio- and microfauna, followed by ranging, classifying and numbering benthic forms (through binocular magnifying glass and microscope). Regarding the macrobenthic species biomasses were evaluated by weighing the organisms on analytical balance, and in terms of meio- and microbenthic forms were calculated in function of average weight tables which have been related to.

### 3. RESULTS AND DISCUSSIONS

#### 3.1. Characteristics of surface waters

The physico-chemical indicators present values which are situated within normal limits in accordance with the maximum allowable values. Some lower values for oxygen content and some pH fluctuations from normal to slightly alkaline have been recorded only incidentally. Transparency, odor and color have not been detected inadequate in any surface water sample. The chemical assays carried out from all examined lakes does not reveal increasing levels for nitrates ( $\text{NO}_3^-$ ), nitrites ( $\text{NO}_2^-$ ), sulphates ( $\text{SO}_4^{2-}$ ). In regard to phosphates ( $\text{PO}_4^{3-}$ ) content, we found out some higher values.

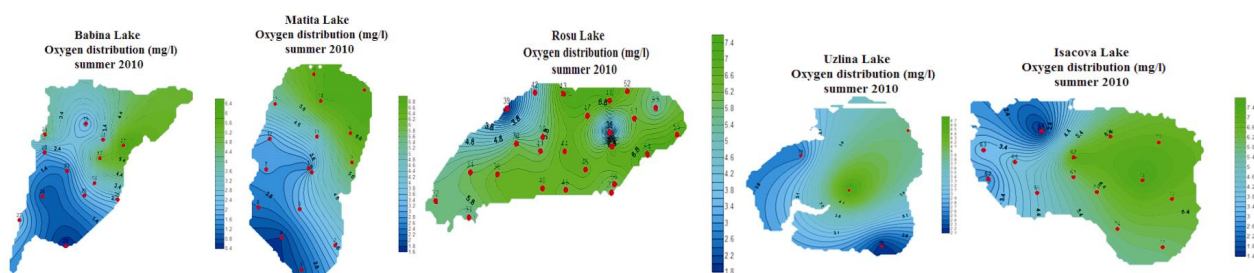


Figure 2: Oxygen distribution (mg/l) in Babina, Matita, Roșu, Uzlina and Isacova Lakes (summer 2010)

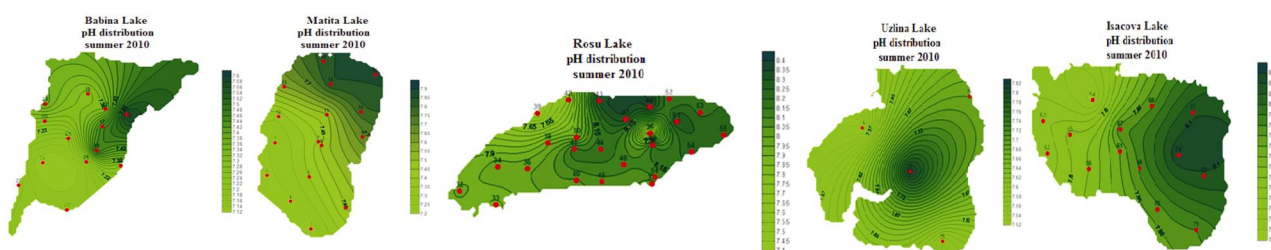


Figure 3: pH distribution in Babina, Matita, Roșu, Uzlina and Isacova Lakes (summer 2010)

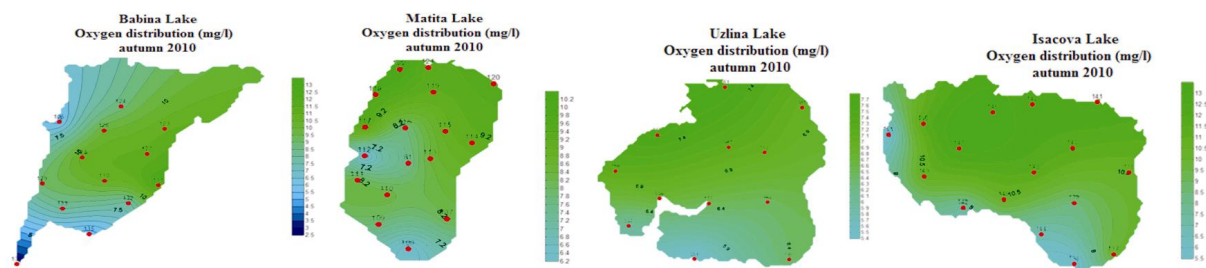


Figure 4: Oxygen distribution (mg/l) in Babina, Matita, Uzlina and Isacova Lakes (autumn 2010)

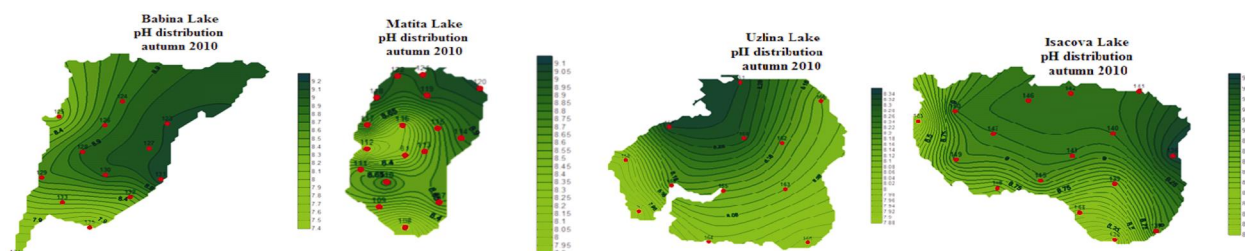


Figure 5: pH distribution (mg/l) in Babina, Matita, Uzlina and Isacova Lakes (autumn 2010)

### 3.2. Sediments characteristics

The core sediment samples were mainly collected in order to assess the bulk sediment characteristics (% water, % total organic matter, % total carbonates, % siliciclastic material). The organic matter derived from two main sources - allochthonous (geological substrate of the water ways, plant and animal detritus or other kind of materials carried by wind or rainfall) and respectively, autochthonous (microbial-bacterial decomposition and recycling of plant and animal remains). Generally, the carbonates may have biogenic origin or may come from chemical precipitation processes. During the laboratory proceedings, it has been tried to not take into account the fragments of shells. Analyses of sediment cores performed by LOI Method (Dean, 1974) do not present a uniform distribution of organic matter, carbonates and siliciclastic material, all cores showing some characteristic maximal or minimal peaks. *Lithological composition of lake sediments* - all the investigated sediment cores present uniform profiles, being homogenous in color, varying from light grey brown to dark grey brown, showing sometimes gradual colored particular layers, the sediment cores from two different lakes (Babina and Isacova) which are distinguished by color, alternating from light grey to dark grey and black, suggesting high contents of organic matter.

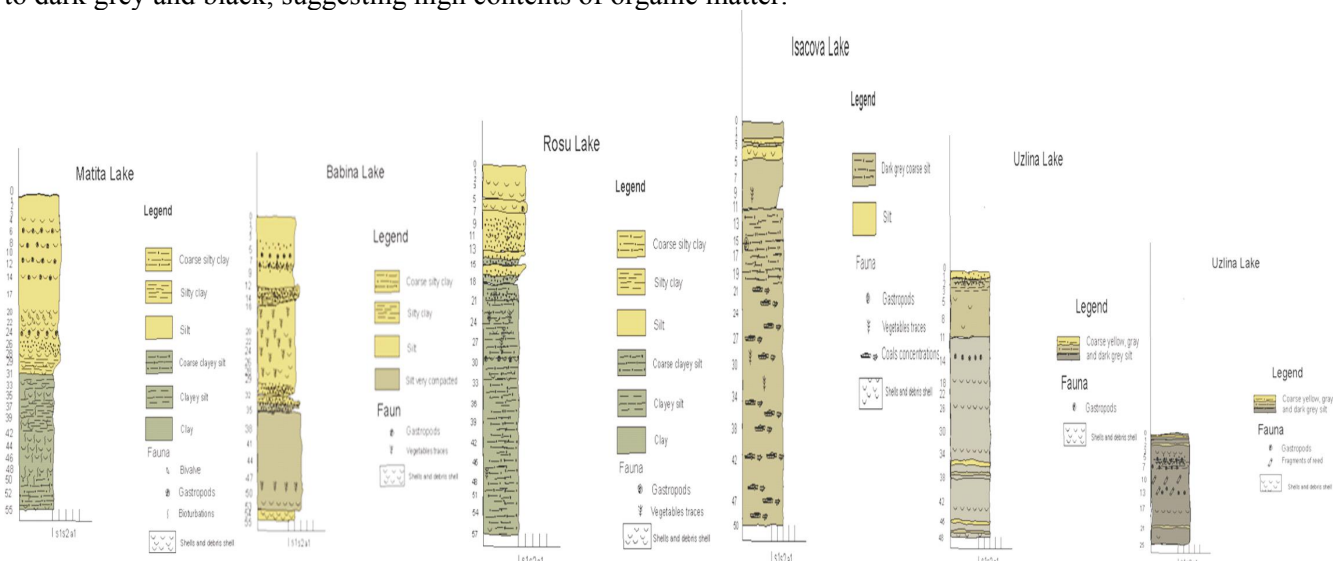
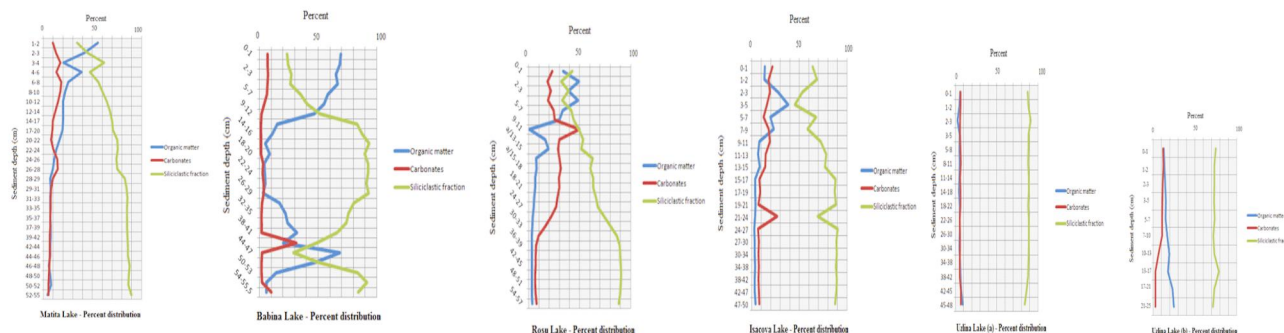


Figure 6: The synthetic core lithology of lacustrine sediments – Matita, Babina, Roșu, Isacova and Uzlina Lakes



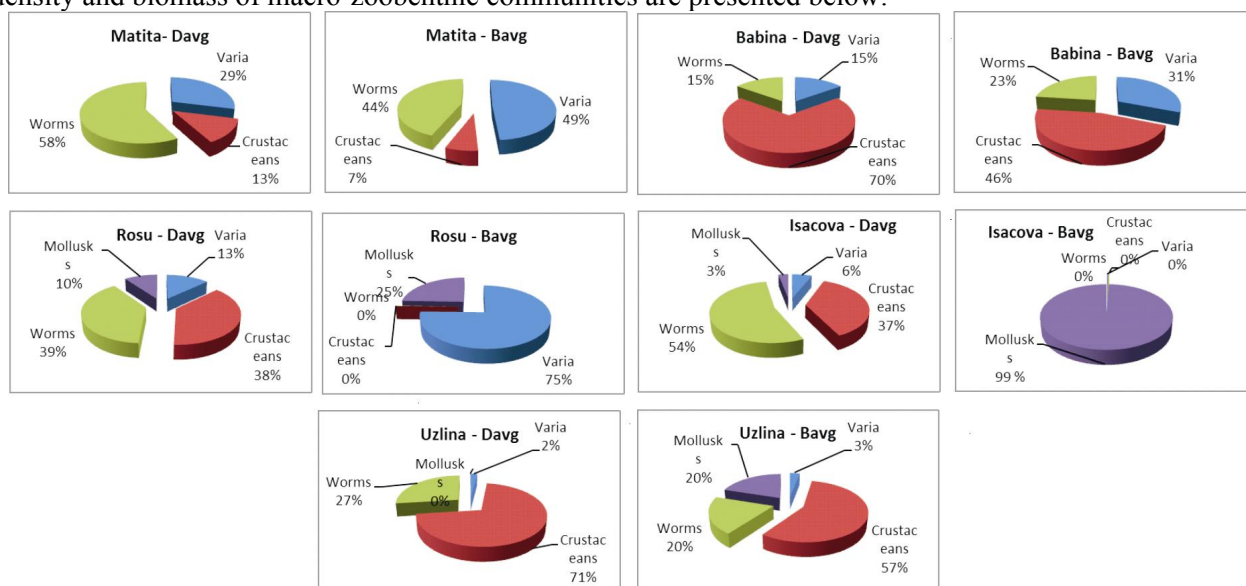
The highest content of organic matter was found out in Babina Lake (percentage average value 31 %) and the lowest content in Uzlina Lake (percentage average value 6 %). In most cores more or less fragmented plants residues, shells remains and visual traces of bioturbation have been identified. The water content indicate a general decrease with depth, all cores having a high content of water in the top (fluffy sediments) which decrease downcore, where the sediments become more compact. Sediment samples acquired from the investigated lakes are almost similar in terms of sedimentology (textural and structural). Macroscopic description from grain-size point of view, include these lacustrine sediments in the category which range from silty to silty-clayey (fine and very fine) and sometimes sandy deposits. Generally, the sediment profile expose three zones: a top horizon, rich in organic material, a middle silty horizon and a bottom clay-rich horizon. The evaluations made on all analysed sediment cores do not present a uniform distribution of organic matter, carbonates and siliciclastic material. Each examined core presents an individual high percentage of organic matter at the top, a corresponding low content of carbonates, and the rest being represented by siliciclastic material. High average values for organic matter are recorded, and these are present further on: Babina Lake (31 %), Uzlina Lake (17 %), Matița Lake (16 %), Roșu Lake (14 %), Isacova Lake (10 %) and Uzlina Lake (6 %).



**Figure 7: Percentage distribution of organic matter, carbonates and siliciclastic fraction in lacustrine sediments – Matița, Babina, Roșu, Isacova and Uzlina Lakes**

### 3.3. Biological assay

During this study it was performed an assessment of macro-zoobenthic communities in all the investigated lakes. From the biological point of view (structure, populations and growth rates) we can say that there were separated some susceptible sectors (Matița and Babina Lakes) and there could be a degradation of environment (poor growth of some species). Information concerning the number of taxa, density and biomass of macro-zoobenthic communities are presented below:



**Figure 8: General taxonomic structure concerning zoo-benthos populations of all investigated lakes**

## CONCLUSIONS

Predominantly, the physico-chemical characteristics of the lakes and connection canals show a small variation. Physico-chemical lake survey measurements made in summer and autumn of 2010 reveal in general normal values accordingly with environmental normative and regulations for surface waters. However, in some survey sampling stations were incidentally observed low concentrations of oxygen content. The registered data also confirmed the differences of seasonal characteristics. Oxygen content is directly dependent of air temperature (depletion content as temperature increases), pressure and biological activity. For some water samples we noticed a changeability of pH from slightly alkaline to alkaline, especially in the autumn period. The chemical analyses performed on water do not reveal increasing levels of nutrients. These values are within normal limits being in conformity with the maximum allowable values. Chemical analyses executed on several samples from the all five lakes do not expose high values for nitrates, nitrites and sulfates. In regard to phosphates content we found out some higher values. In this respect, in the future, we have to perform other detailed chemical analyses in order to establish their origin in water (from waste waters, derived from organic substances mineralization, fertilizers, detergents, etc.).

***Lithological distribution of recent superficial sediments from investigated lakes*** - The results of sediment cores show that organic matter and carbonate amounts have values between 12-36 %, and the siliciclastic matter quota is around 64-88 %, from the entire sediment mass. We can notice that siliciclastic sediments dominate in all analysed cores, versus organic rich sediments. Regarding to the sedimentation processes we can estimate that these investigated lakes are mainly supplied with allochthonous material transported through the hydrological network, mainly from Danube River and subsequently by different canals or streams. These lakes are not only interconnected by canals, but by submerged macrophyta beds or reed beds as well. We can say that were not observed significant variations in sedimentary organic matter, carbonate content and siliclastic fraction within and between the investigated lakes. The distribution of sediment bulk components (organic matter, carbonates and siliciclastic material) depend on numerous factors as: local geological background, hydrogeology, lake depths and morphology, climatic parameters (temperature, light, humidity, winds, storms, rainfalls, floodings, etc.), fluvial sedimentary input, etc. Biological assay (structure, populations and growth rates) present some susceptible sectors (Matița and Babina Lakes) which may lead to the idea of environmental degradation (poor growth of some species). More detailed chemical analysis is needed to argue the origin and mineralogical composition of organic matter, carbonates and siliciclastic fraction which were found out in these investigated lakes. The basic assessments performed in summer and autumn 2010 indicate that all five investigated lakes presents a normal status for such water systems without evidence of contamination.

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