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THE MORPHOBATHYMETRIC FEATURES OF THE CUCIULAT LAKES (SĂLAJ COUNTY) AND THEIR WATERS' PHYSICAL CHARACTERISTICS

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Abstract

The lake units analyzed in this study are located in the Purcăreţ-Boiu Mare plateau, specifically in the formerly Cuciulat quarry (Salaj County). To the origin of the two lake basins, have contributed mostly anthropogenic factors and to a smaller extent natural ones. The lakes formed next to the quarry are significantly influenced by the spoil bank: this can be seen in the lakes' form, in their bathymetry and also in some of their physical characteristics. The identification of the lakes' morphobathymetric features and of the waters' physical characteristics relied on measurements taken in the summer of 2009 (August 17). In the field, we used a Hannah HI 9828 multiparameter instrument to measure the waters' physical characteristics and a GPS to pinpoint the measurements' position. Also for the depth measurements, because they are shallow lakes, besides the GPS, we used a Seechi disk. To capture the best possible spatial variation of the mentioned characteristics, we used interpolation as modeling method.
Keywords: lake bathymetry, Cuciulat quarry, waters' physical characteristics

1. Introduction

The two lake units (Cuciulat I and Cuciulat II) are situated in the area of the lime quarry from Cuciulat, in between the localities Cuciulat and Băbeni (Sălaj County), 250 m away from the railroad connecting the localities Dej and Jibou. As geographic unit, they are located in the north of the Plateau of Someş, in the subunit known as the Purcăreţ-Boiu Mare Plateau.

The origin of the two lake units is largely anthropic, the lakes' basin resulting after the depositing of the sterile material produced during the lime processing. It seems that the Cuciulat I Lake appeared largely naturally, yet the origin of the lakebed cannot be identified with precision, and its origin may be both natural and anthropic.

The determination of the lakes' bathymetric elements and of their waters' physical features was achieved on the basis of the measurements carried out on August 17, 2009. In order to measure the depth and the physical characteristics of the lakes' waters we used a Hannah HI 9828 multiparameter instrument, and in order to pinpoint the measurements' position, we used a Magellan Explorist 600 GPS.

2. Morphobathymetric features

The analysis of the lakes' morphometric features was carried out by interpolating the punctual depths measured using the Esri ArcG.I.S. soft groups. So, the measurements' positions were pinpointed using the GPS, and the depths were determined through punctual fathoming using a lead weight tool.

The geoinformatic programs included, for the interpolation, a series of specific functions. In the spatial analysis modules of the ArcG.I.S. program are included the following interpolation functions: Spline, Kriging, IDW. In order to choose the interpolation function, we took into account the number of points for which there were available values, and also their distribution in the lakebeds. Taking into account these two elements, we reached the conclusion that the best function for interpolation is the *Spatial Analyst* IDW, namely the space analysis module of the ArcG.I.S. program.

Interpolation is the process by means of which the value of certain features in some unknown points is calculated based on the values in the known points. From a mathematical viewpoint, the interpolation consists in the obtaining of a function f(x) approximating another function, for which only certain values from an interval considered correct are known. The IDW (Inverse Distance Weighting) spatial interpolation function relies on the hypothesis that the influence of the value of a certain point on another point is inversely proportional with the distance between them (Bilaşco, 2008).

So, after the creation of the lakebeds' digital model, it was possible to calculate the area and other morphometric features (Tab. 1), the characteristic curves and last but not least the lakes' volume (Pandi & Magyari, 2003).

Analyzing the lakes' transversal profiles, one can highlight the anthropic impact on the lakebeds' shape. The waste dumps from the nearby quarry ended up in the lakebed, so one can notice in the case of Lake Cuciulat I, that on the left border, the depths grow fast, the slope being very steep, as here is located the waste dump that was introduced in the lake, while for the Lake Cuciulat II on the left shore the slope is gentler: being situated further away from the waste dump, the form of the lakebed is less influenced by it. The significant slope on the right shore is due to the natural abrupt slope cut out in calcareous stones from this area.

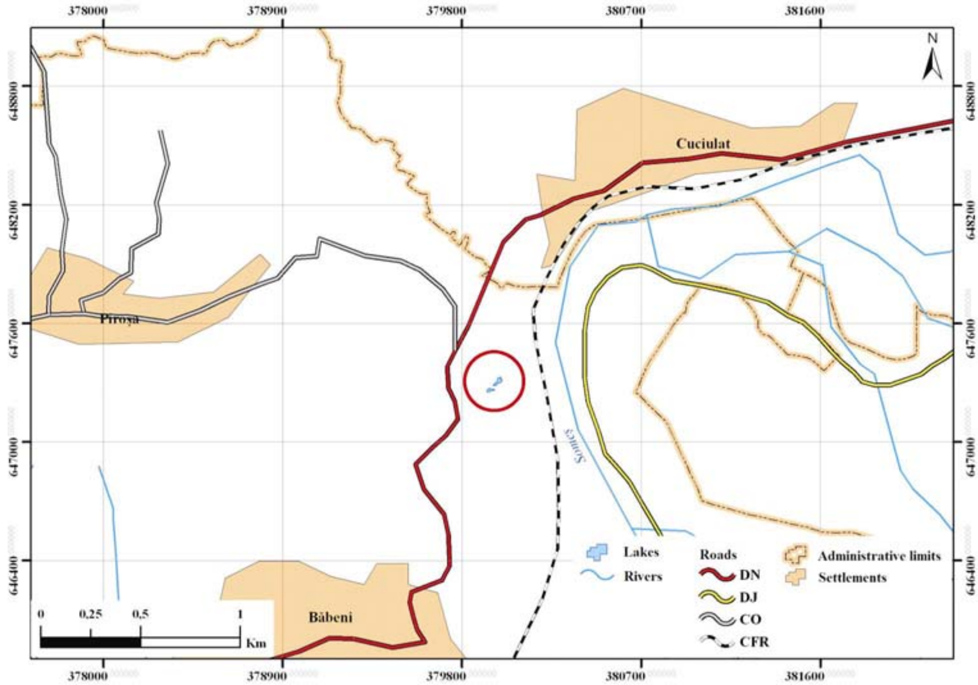

Fig. 1. Lakes' location

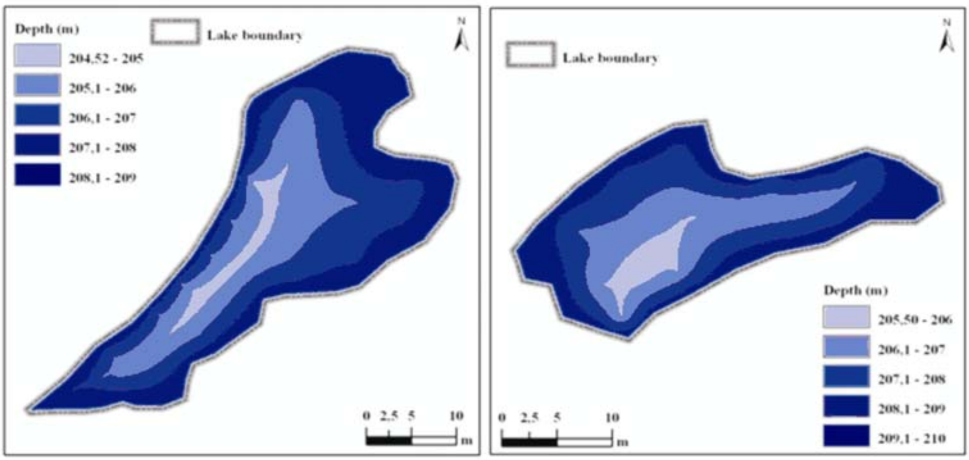

Fig. 3. Bathymetric map of the lakes Cuciulat I and Cuciulat II

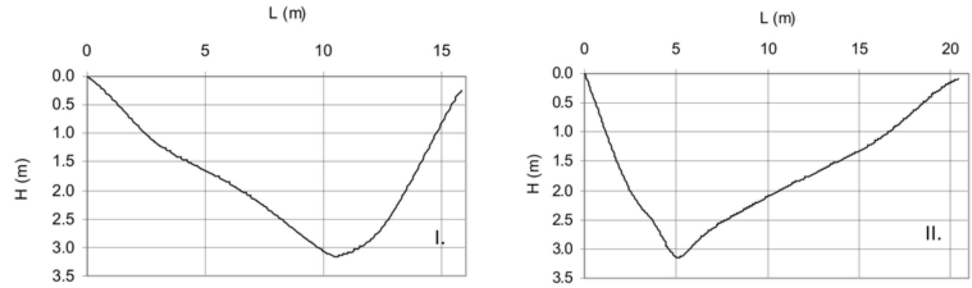

Fig. 2. Transversal profiles of the Lakes Cuciulat I and Cuciulat II

From the transversal profiles and at the same time from the bathymetric maps, it results that the depths are similar for both of these lakes, reaching a depth of maximum 3.5 m. The analysis of the lakebeds' digital model, using ArcG.I.S., has highlighted the following morphometric features (Table 1) (Horváth, 2008) .

Table 1. Morphometric and hydric features of the Lakes Cuciulat I and Cuciulat II

Lake's name	Area (m^2)	Average depth (m)	Maximum depth (m)	Maximum width (m)	Maximum length (m)	Volume (m^3)
Cuciulat 1	759.95	1.36	3.4	22.4	53.2	1038
Ciciulat II	400.22	1.49	3.55	13.4	35.6	597.33

We should mention the fact that due to their differentiated altimetric position, as the lake Cuciulat II is situated 28 cm higher than Cuciulat I, when the quantity of precipitations is significant, there appears a self-regulation phenomenon, the surplus volume from lake Cuciulat II overflowing into Lake Cuciulat I. Following this phenomenon, in time there appeared an active overflow channel, which is active only during the periods when the volume of Lake Cuciulat II goes over the maximum retention capacity of its eastern shore.

3. Physical characteristics of the lakes' waters

An essential lake property, transparency is determined by: the climatic conditions of the area, the morphometric properties of the lakebeds, hydrochemical regime, biological processes, etc. (Burian, 2002). The lakes' transparency was determined using a Secchi disk. Given the low depths, we have concluded that the entire lakes' volume is situated in the photic area, as the disk was visible for all the measurements until it reached the lacustrine bed.

The lakes' waters thermal regime is especially interesting, as it explains some phenomena related to the stagnation or to the circulation of the water masses, which in their turn determine their physico-chemical and biological structure. One can notice, due to the lakes' low volume, a close connection between the air and the water temperature (Baranyi, 1980; Pandi 2004).

The analysis of the water's physical features was carried out using the *spline* geostatic interpolation method integrated in ArcGIS. Spline is a deterministic interpolation method, locally stochastic, which can be considered the mathematical equivalent of the "matching" of a flexible bidimensional surface over several points with an irregular distribution.

The analysis of the waters' temperature and Ph was carried out both in a vertical and in a horizontal profile. In each depth profile or each profile measured with the Hannah HI 9828 multiparameter instrument, the values of the temperature and of the pH were measured every half meter. After their recording, these values were introduced in a vectorial format in ArcGIS, which made it possible to interpolate each depth in turn (Fig. 4).

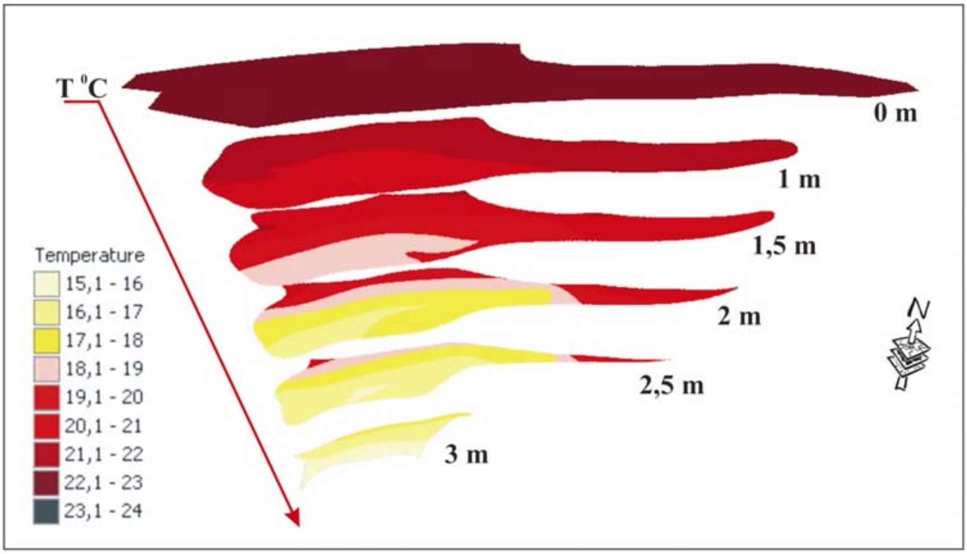

Fig. 4. Analysis of the temperatures' spatial variation for Lake Cuciulat II

The temperature differences between the surface and the deeper levels are low, and the variation of these values can be followed considering the characteristics of the lakebed. So, in the case of the Cuciulat II Lake, it appears that the temperatures are lower as the depth grows, and the abrupt slope in the area of the southern shore makes this area cooler (Fig. 4). The impact of the depth on the temperatures' variation in space can be noticed by superposing the temperatures found at different levels: in the deeper areas, the temperatures are lower. The temperatures' variation in space was highlighted using the values of the temperatures from each vertical profile in turn.

The vertical temperature variation for both of these lakes covers a 10 °C range (Fig. 5). In order to follow the temperature and pH variation vertically, we have chosen the longest profiles, which also cover the greatest variation. Given the small temperature difference, the hypolimnion cannot be highlighted very well, and the epilimnion becomes generalized for the entire depth (Sorocovschi, 2004). A not very obvious thermocline appears because of the not very significant depth (Fig. 5).

The pH value expresses the concentration of the hydrogen ions, which determine the waters' reactivity. It is inversely proportional to the quantity of carbon dioxide, one of the main indicators of the biological production of the water environment. Its variation is influenced by photosynthesis, respiration and nitrogen assimilation.

In the Cuciulat I Lake, the pH values have a tendency of decrease with the depth, yet they remain alkaline throughout the vertical line. In the Cuciulat II Lake, the pH records a slight tendency of increase, from 7.67 to 7.76. Due to the low depths of these lakes, the pH values are relatively uniform, the values measured ranking between 7.6 and 8.2, indicating weakly alkaline waters. This situation can be explained by the direct contact between the lakes' waters and the limes that form their lakebed, and by the rocks washed up from the slopes situated in the vicinity of the lacustrine units. The small pH difference in the case of the Cuciulat I Lake can be explained through the existence of the lacustrine vegetation from the surface and through the photosynthesis process that can lead to the increase of the pH value.

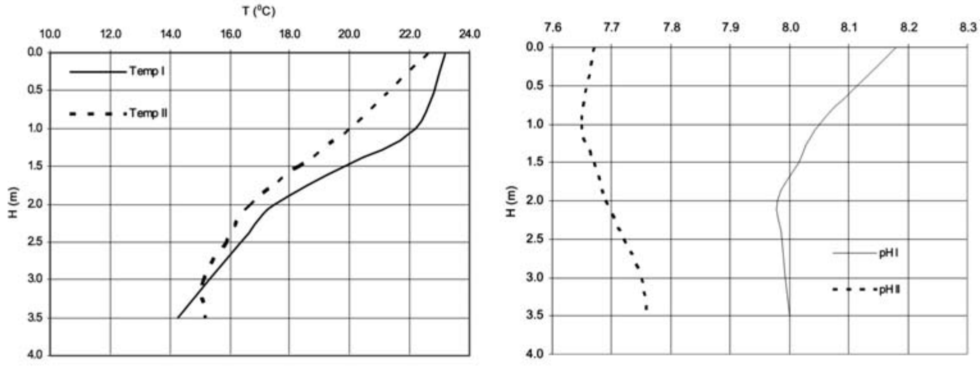

Fig. 5. Variation in the vertical profile of the temperature and pH for the lakes Cuciulat I and Cuciulat II (August 17, 2009 – the longest vertical profiles continuous line - Lake Cuciulat I., interrupted line - Lake Cuciulat II.)

Conclusions

The origin of the lakebed of the lakes under analysis is largely anthropic, resulted following the depositing of the spoil bank from the lime quarry of Cuciulat, Sălaj County, their water supply being exclusively pluvial.

The morphometric dimensions of the two lake units are moderate, a fact reflected as well in the relatively uniform spatial repartition of the water's physical characteristics, so the temperature does not record significant variations in the vertical profile, the thermal stratification being direct, with higher temperatures toward the surface and lower temperatures deeper under water. The higher temperature recorded in the south-west of the Cuciulat I Lake can be explained as well through the existence of the self-regulation process of the water volume and through the low depths correlated to a gentle slope of the lakebed in this sector. As far as the pH is concerned, in the case of both of these lakes, a generalized pH of over 7.6 can be noticed, indicated weakly alkaline waters within the entire lacustrine volume.

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