MORPHO-BATHYMETRIC PARAMETERS OF RECESS CRUCII LAKE (STÂNIŞOAREI MOUNTAINS)

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ABSTRACT. - Morpho-bathymetric parameters of recess Crucii Lake (Stânişoarei Mountains). Crucii Lake from Stânişoarei Mountains was formed in 1978 as a result of riverbed dam Cuejdel after a landslide triggered on the western slope of Muncelul Peak. The event led initially to a small accumulation of 250-300 acvatoriu m, 25-30 m wide and 4-5 m maximum depth. In the summer of 1991 following the construction of a forest road in the flysch, and amid a high humid conditions, the slide was reactivated, leading to the formation of the largest natural dam lake in Romania. It has a length of 1 km, area of 12.2 ha, maximum depth of 16 m and a water volume of ca. 907.000 m^3. Morphometric and morpho-bathymetric measurements performed in the summer of 2011, with the help of the integrated 1.200 GPS of Station Leica System 1.200 surveying measurements and bathymetric measurements Valeyport Ecosounder Midas showed new values for the morpho-bathymetric parameters. Among them stands out: 13,95 ha area, perimeter 2801,1 m, maximum length of 1004,82 m, 282,6 m maximum width, maximum depth 16,45 m. To achieve the numerical model of the lake basin were more than 45.000 points bali reading, with equidistance of 0,25 m. The scale of detail work aimed to draw up a proper database to eliminate suspicions about the old analytical methods inaccuracies. At the same time was studied the evolution of the lake's basin in the context of relatively recent geomorphological changes.

Keywords: bathymetry, Crucii lake, morpho-graphical evolution, natural dam lake, topographic surveys.

1. INTRODUCTION

Crucii Lake dam is the largest natural aquatic surface of this type in Romania. It was formed following the outbreak of large-scale landslides that covered the upper stream Cuiejdel. The deluvial land slide comes left of Cuiejdel stream at a distance of 1 km from the valley.

The first attempt of morpho-bathrymetric analysis was done by Ichim I. (1996), but did not provide an overview of all morpho-bathymetric parameters.

Featuring a high precision technical support and a qualified team to do detailed measurements, in the summer of 2011 it was succesfully performed morphometric, and morpho-bathymetric measurements for hydrographic basin

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Cuejdel and aquatic surface from Crucii Lake. Although it is an lymnometric study, the methodology adopted is specific for land surface geomorphology.

The most important limnology and geomorphological studies that focused on Crucii Lake and also for the basin were developed by researchers at the resort Pangarati or "Alexandru Ioan Cuza" University of Iasi: Ichim, 1969, 1972, 1973, 1979, 1996; Mihu-Pintilie and Romanescu, 2011; Rădoane, 2002, 2003, Rusu et al., 2001, 2002, Rusu, 2004; Surdeanu, 1998, etc. For methodology see the following studies: Minea and Romanescu, 2007; Nicu and Romanescu, 2010; Romanescu and Stoleriu, 2010, etc..

It is a natural dam lake, with a total area of sliding mass of 35 ha . The forming process began in 1978 when there were the firsts slidings land. Due to weather, geomorphological and anthropogenic favorable conditions, in 1991 the sliding mass was activated and the entire valley was blocked (Rădoane 2003-2004).

In Romania there are many natural dam lakes, including Rosu (on Bicaz river), Iezerul Sadovei and Bolatau (on Sadova stream), Vulturilor (in the Siriu Mountains) etc. At this time Crucii Lake is the largest natural aquatic surface of its kind.

Originally this lake was called Cuejdel, after the neam of the stream that was blocked. Authorities have established that the official name is Crucii.

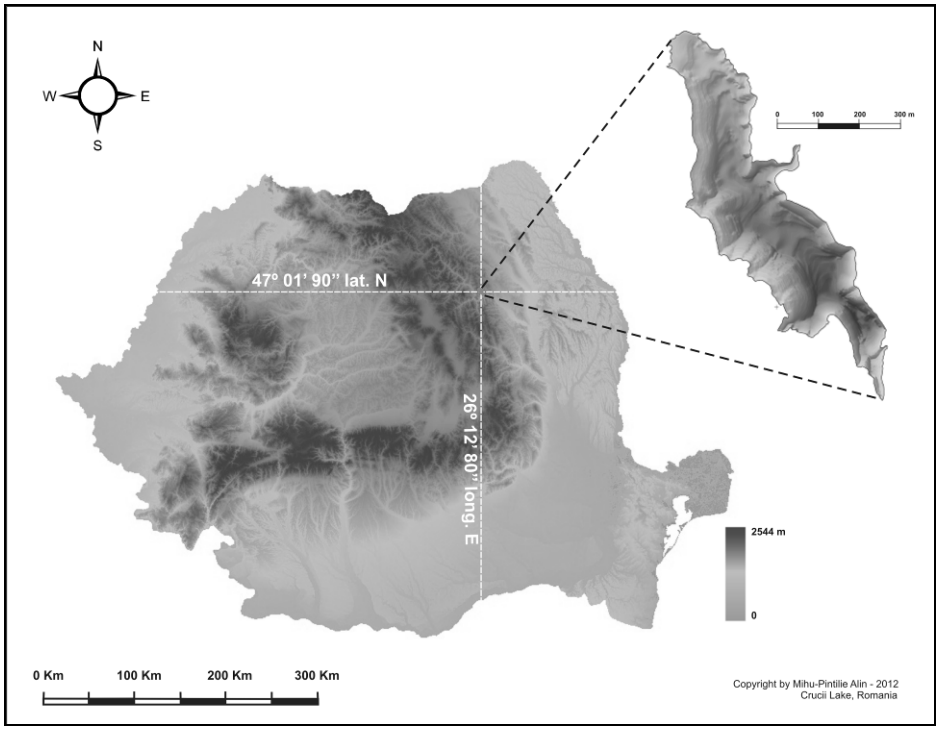

Fig.1 ***Geographical location of Crucii Lake in Romania***

2. LOCATION AND LIMITS

Crucii Lake is located in the Central Group of the Eastern Carpathians in the south-eastern of Stânişoarei Mountains (Fig. 1). It was formed on the upper river Cuiejd (middle sector of Cuiejdel, the main tributary). The main tributaries that the lake has are: Cuiejdel, Glodu, Făgetu and Piciorul Crucii.

Latitidinally the Crucii Lake it between 47 º 01' 54" lat. N and 47 º 02' 21" lat. N, and longitudinally between 26 º 13' 70" long. E and 26 º 13' 02"long. E.

3. RESEARCH METHODS AND TECHNIQUES

For precise delimitation of the lake basin perimeter and area of wetlands of Crucii Lake was used Leica GPS System 1.200. Validation of the results was performed by consulting satelit images and orthophotomaps.

Bathymetric measurements were performed using Midas Valeport Surveyor Ecosounder (Bathy-500DF Dual Frequency Hydrographic Echo Sounder) with resolution of ± 1 cm, and was use a GPS navigation system. The entire lacustrine area was swept systematically in several steps. There have been indexed over 45.000 points of reading depths. After removing errors were interpolated using specialized software, approximately 43.000 bathymetric points.

The main reading errors were caused by pitching carried by the waves. Corrections were applied by mathematical calculation, knowing the wave's height, the level at which the sole of the ecosounder was submerged and its operating principle.

Because in the lake there still are tree trunks, inherited from the old valley, some bathymetric points were read incorrectly. To avoid plugging in incorrect data were eliminated a number of gaps that have appeared frequently in measuring operation.

For processing bathymetric data and thematic mapping were used softwares like: ArcGIS vs. 9.3, TNT Mips vs. 6.9, Global Mapper vs.11 and CorelDRAW 4. They have allowed preparation of the numerical model of the land and its graphical conversion for various geographical utilities. Statistical processing and digital error correction was performed using Excel Office 2007 software.

4. RESULTS AND DISCUSSION

Tophobathymetric measurements of Crucii Lake showed the following values: 13,95 ha area (139.500 m2), the perimeter of 2801,1 m, 1004,82 m maximum length, maximum width 282,6 m, 19,25 m minimum width, average width 138,83 m, maximum depth of 16,45 m, average depth of 10,1 m, the total volume 1.413.255 m^3 (Table 1).

Table 1. ***Morphometric elements of Crucii Lake***

Nr. ctr.	Morphometric elements		Index	Value	Unit measure
1	Surface		S	13,95	ha
2	Surface of bottom lake		S_r	14,3	ha
3	Length		L	1004,82	m
3	Width	Minimum width	$l_{min.}$	19,25	m
		Average width	$l_{med.}$	138,83	m
		Maximum width	$l_{max.}$	282,6	m
4	Axis	High axis	-	973,76	m
		Small axis	-	299,53	m
5	Form factor (ratio of axes)		Cf	0,3	-
6	Perimeter		P	2801,1	m
7	Coefficient of shoreline sinuosity		Cs	2,11	-
8	Depth	Maximum depth	$H_{max.}$	16,45	m
		Average depth	$H_{med.}$	10,1	m
9	Volume		V	1.413.255	m^3
10	Volume development		D_v	1,84	-

Maximum altitude of north-western boundary, next to the outlets of Glodu and Cuiejdel streams, is 669 m. The output is situated at an altitude of 668 m, resulting in a difference of level between the outlet and the output about 1 m. The new measurements corrects the altitudinal value of the water level (665,5 m) that was circulated in the literature. The error was attributed to oscillations of level.

The lowest depths were recorded in the upstream at the outlets Glodu and Cuiejdel streams where there is formed a true fan-delta. This is due to relatively low solid transport of the streams feeding aquatic surface. Solid flow rate is reduced due to the high degree of afforestation of water catchment area. Extending these depths to the upper third of the lake it is also determined by the confluence,in this sector, of the two streams (Fig. 2).

Fig.2 ***Crucii Lake (left: area with maximum depths, right: northern sector with low depths)***

It should be noted that for small depths, light and higher temperature allowed the installation of a specific wetland vegetation. This contributes to clogging faster, leading to the formation of a typical soil lake basins called limnisol (Romanescu and Stoleriu, 2010).

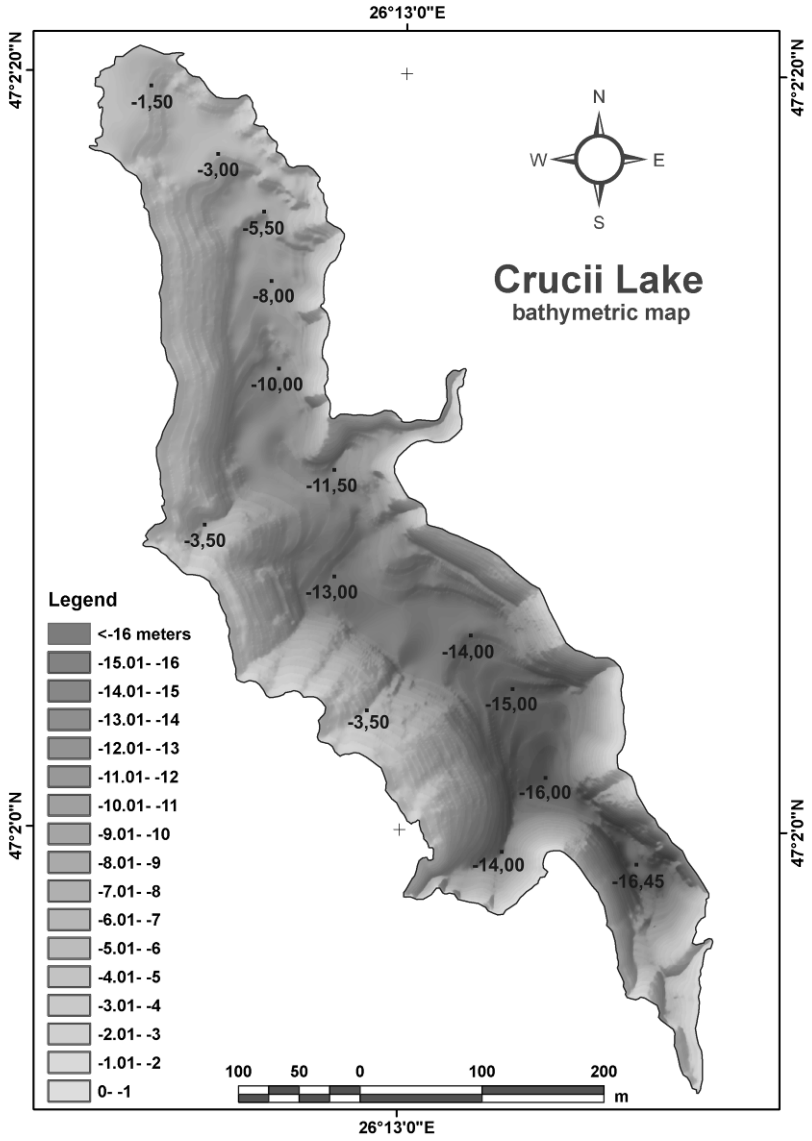

Fig.3 ***Crucii Lake – bathymetric map***

The greatest depths of over 10 m (maximum depth of 16,45 m), is recorded in the central-lower sector. The difference in level between the outlet and output of Cuiejdel leads to concentration of the most significant depths on this alignment. In

this complex, the submerged configuration is taken from the initial lake, that was much smaller in size, but also the liquid mass gained from the landslide of 1991. For this reason the maximum depth are concentrated in front of the deluvial slope and the outlet of the Piciorul Crucii stream (Fig.3).

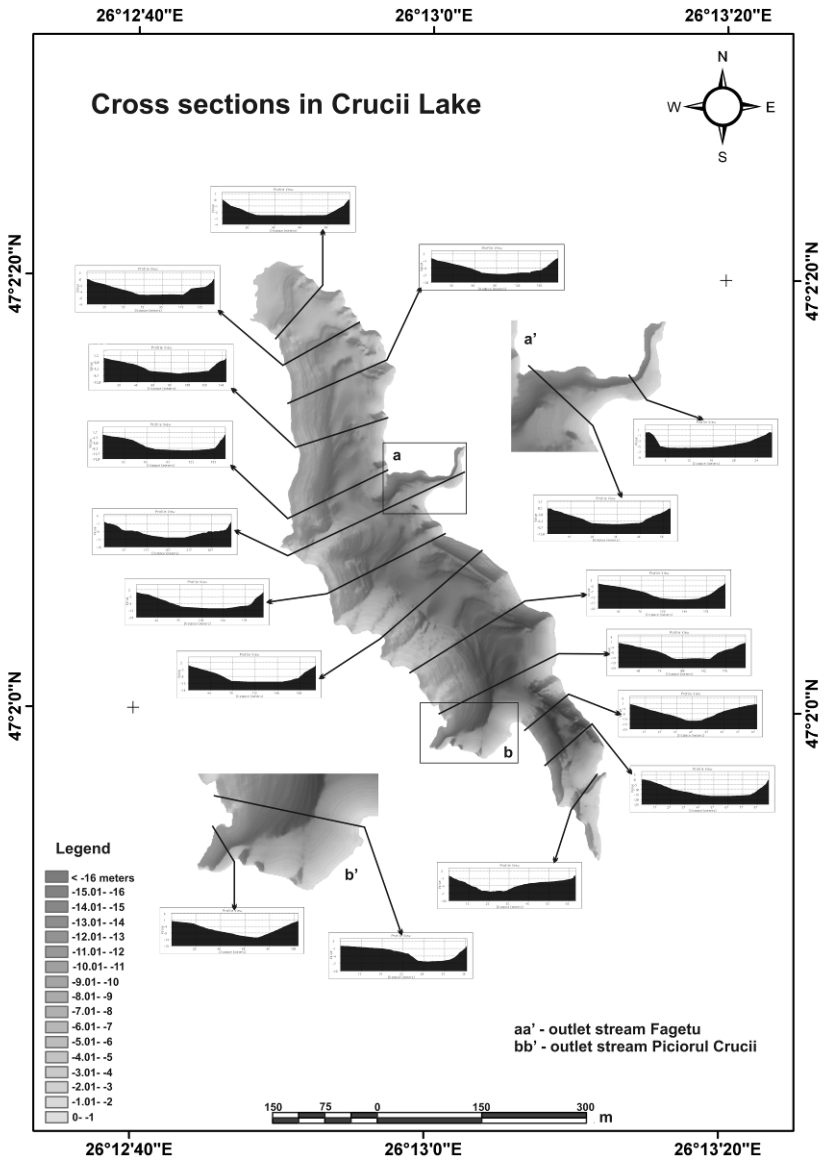

Fig.4 Cross *sections in Crucii Lake*

The transverse profile reveals a pronounced asymmetry of the slopes. Right bank, directed at Piciorul Crucii, has a relatively smaller and uniform slope. Opposite slopes are more fragmented and have a strong inclination. The highest

slopes are located on the eastern and southern shores, or on slopes affected by the outlets of Făgetu and Piciorul Crucii streams. The smallest slopes are found in western and southwestern areas of the lake (Fig. 4).

The steepest sectors are near the lakes output, where there is also the largest depths. Micromorphology of this area is directly influenced by the slide mass which crossed the old transverse stream. Slopes exceede here 50 degrees.

Microterraces bank erosion of lacustrine basin are extremely low. This shows that the lake level fluctuates very little. Therefore the lake basin is installed between the input and output a transfer balance.

The lacustrine basin is in form of an "S" leter due to Făgetu stream, on the eastern side and Piciorul Crucii, on the western side, which bring alluvial material and push the old course of Cuiejdelului otherwise. The current configuration inherits the lakes old flooded valley, taking sinuous appearance.

5. CONCLUSIONS

Crucii Lake is the largest natural dam lake in Romania and due to its relatively recent age (approx. 20 years) is one of the newest lacustrine surface of this type.

Most studies developed to present had a shallow character, avoiding the interdisciplinary character. The existing morphometric data (except the one developed by Ichim, 1973) were incorrectly recorded as a result of often rudimentary tools.

The ephemeral existence of these kind of lakes lead to studies performed in real time. Measurements and results achieved lead to a correct assessment of parameters morfobatimetrici and proper data interpretation hydrological, geomorphological, soil studies, etc.

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