



## COMPLEX STUDY OF THE LACUSTRIAN ECOSYSTEMS OF MOHOȘ SWAMP

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### Abstract:

Mohoș Swamp is an oligotroph swamp, formed in a volcanic crater on the site of a former lake, which permanently changes. Using a series of modern methods such as ultrasound bathymetry, we want to set up a reference base so that in the future one can be able to determine the rhythm and direction of the development of this complex ecosystem, both in terms of morph metrics and chemical hydrology parameters point of view. Bathymetry and geomorphological study represents the most important stage because it makes it possible to establish the concrete characteristics of the investigated lakes as well as their placement.

**Keywords:** volcanism, lake, swamp, bathymetric

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### 1 Introduction

Mohoș Swamp, "The lake with Moss" as translated from Hungarian, was formed 3,000 years ago into a volcanic crater located in Ciomadu (Ciomatu) massive near the famous objective Lacul Sf. Ana (St. Anna Lake).

Due to the existence of several particular flora species, the peat bogs was declared a flora reserve and a natural monument. On the carpet of moss (Sphagnum) there are several relict plant species such as the small bur-reed (Sparganium minimum), Reed Bent-Grass (Calamagrostis neglecta), moor grass (Eriophorum gracile), species of the insectivorous plant commonly known as the "Sundews" (Drosera obovata, Drosera rotundifolia), bushes of bog rosemary (Andromeda polifolia), of blueberries (Vaccinium axycoccos).

The vegetation is completed with downy birch species (Betula pubescens) and dwarf birch (Betula nana), dwarf pine (Pinus silvestris), their heights being

generally inversely proportional to the layer of peat on which they strive to maintain balance.

When it rains or the thick layer of snow melts, the peat layer (thick of about 20 m according to some accounts) becomes soaked with water and behaves like a huge sponge.

In the 1960's, an attempt was made to drain the swamp by digging several channels, that are still visible and active today, and the 80 acres were used as grassplot.

The beauty of Mohoş Swamp is complemented by several water meshes of different surfaces, shapes, depths and colors.

## **2 The study area**

Ciomadu is the only compartment of the Harghita Mountains developed in the east of the Olt River, whose work has ceased relatively recently. The last eruption was dated around 15 ka ago, during the upper Pleistocene (Schreiber, 1994; Szakács & Krézsek, 2006). The main attraction of this volcanic cone is the crater lake, the only one in the country which generated great interest over time.

The volcanic activity of the Ciomadu apparatus was a mixed one. There alternated explosion phases with lava outpouring phases, which began with an explosive phase whose products partly deposited over the flysch deposits of Cretaceous era, and partly in the Ciuc basin waters. During this first phase, the eastern slope of Ciomadu, including the eastern side of the Mohos, remained uncovered by lava.

There was a dacite lava outpouring phase with green hornblende, which generally covered the explosion products of the first phase, except the eastern flank of part of the southern one. Following these rises, the central and south-eastern parts of the massif were completed.

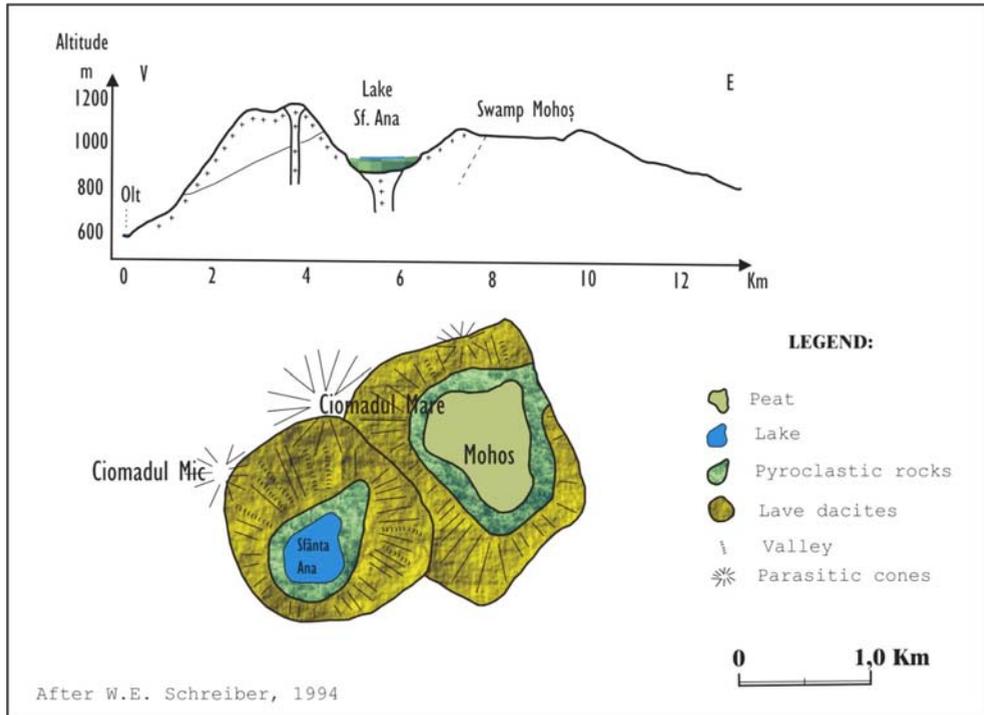
The latest effusion was the basalt hornblende dacites as lava. The forming of the secondary, parasitic cones of the north-western and northern slopes occurred during this phase. The Sfanta Ana (Saint Anne) crater was also completed, due to the collapse of the central area over the magmatic oven, emptied during this stage, but not through the central crater but through the intermediary of the peripheral secondary cones.

D.P. Radulescu (1973) states that here the volcanism has resulted into a higher explosivity due to more pronounced acidity of the lava. The amphibiol and biotite andesite are considered to be the most acid of the entire Căliman-Gurghiu-Harghita chain.

The topography of the Ciomadu volcanic cone distinguishes by its preservation status. The cone is not very high (Ciomadu Mare (Great Ciomadu),

1301 m with a diameter between 5,50-7,00 km) and displays complications on the north-western and northern parts, due to the parasitic cones, such as Ciomadu Mare (Great Ciomadu), Ciomadu Mic (Little Ciomadu), Mohos, Vf. Cetății, Surducu which, by their placing, outline several fracture lines.

The greatest attraction is exerted by the two twin craters: Sfânta Ana (Saint Anne) and Mohos (Figure 1).



**Figure 1. Profile through the Sfânta Ana (Saint Anne) and Mohoș craters**

The opinions on the genesis of the Sfânta Ana (Saint Anne) crater are contradictory. There are trends according to which the depression where the Sfânta Ana Lake (Saint Anne Lake) would not be a volcanic crater (Hauer and Stache, 1863, D. Slăvoacă and C. Avramescu, 1956 M. Ilie, 1964, C. Privighetoriță, 1970, W.E. Schreiber, 1972). Another trend states that indeed, it is a volcanic crater of the Ciomadu massif (H. Wachner, 1934, Aurel Lazar and Adela Arghir, 1964, WE Schreiber, 1972). An interim point of view was issued by P. Coteț (1969) considers it to be a special type of caldera, of subsidence, probably formed as a result of the vacuum created through the eruption of Harghita Mountains, settled west of the Olt River and the depression would be the result of the compaction process.

W.E. Schreiber (1972) considers that Mohoș is a blast and enclosure crater, and the Sfânta Ana (Saint Anne) depression is an enclosure and collapse crater.

The Mohoş crater was drained by Pârâul Roşu (the Red Brook), tributary stream of the Tusnad valley in a sector where the edge of the crater is exclusively made up of pyroclastic rocks.

The place where the draining occurred is the oldest part of the cone, as the erosion acted here for a long time.

Inside the cone, a peat bog was created. At some point, an attempt was made to drain it and use the land for agriculture purposes but later, after the original owners regained ownership over it, it was declared a nature reserve and correspondingly administered aiming at protecting it and developing low environmental impact travelling in this area.

Mohoş crater depth is currently estimated to be approximately 60.0 m. This value was and is constantly changing due to sedimentation processes that take place here.

The main processes can be classified as follows:

- Before draining, the collapses affect the steep crater edge, the convergent network and the washings lead to a broadening of the craters and also a reduction in their depth (due to the accumulation of eroded material).
- After draining, due to strong erosion of the hydrographical network, there is a discharge of crumbly materials, the widening of the crater continues and it strongly deepens.

Sfânta Ana (Saint Anne) volcanic cones and Mohoş also stand out because the first one is an intact un-drained crater while Mohoş is a poorly drained crater, keeping almost unchanged in the central area.

The most important climatic factors influencing the current shape and development of the vegetation are the air temperature, precipitations and not the least the wind and the duration of sunshine.

The area studied is characterized by a typical average height mountain climate where the average annual temperature is +6 ... +7oC and that of January below -6 oC and in the month of July below +15 oC, thus resulting an amplitude of the monthly average temperature of about 21 ÷ 22oC. Recorded rainfall is between 800 ÷ 1000 mm per year, with predominance in the hot season. The snow layer lasts for about 75 ÷ 100 days / year, and has an insulating character for the vegetation of the swamp. The number of days when frost is recorded total between 140 ÷ 180 days and at the other extreme we count the tropical days which do not exceed 2 days / year. Relative humidity of the warmest month, July, reaches 72 ÷ 80%. The number of clear days recorded here is 40 ÷ 50 days per year.

Prevailing winds come from the west and north-west, with a frequency above 50%.

### 3 Methodology

The research activities conducted within the lacustrian units of Mohoş Swamp covered two areas of study: on the spot and in the office.

The works on the field consisted in acquiring submerged data, done with an ecological drilling device, single beam SIMRAD CX 33, the number of radar beams emitted towards the lake sink being (1 to 10 seconds). The ecological drilling device must be set to receive GPS corrections from satellites (EGNOS or ARTEMIS), settings made in the Position menu.

At the same time, the standard speed of sound in water, which varies depending on salinity, water temperature or turbidity was set. It is worth saying that the standard values are 1470 m / s in salty water and 1430 m / s in fresh water. Settings for sound frequency (50 kHz) issuing are done depending on the depth and nature of the river bed; the frequency of 50 kHz is used in the areas with abundant vegetation.

Thanks to the computer system used within the HYPACK program, one can view jointly or independently on the GIS map or on the orthophotomap, the position within the lacustrian unit, the CSA mark and the reference points situated on the shores, possibly the profile lines used to maintain the direction of the boat, and any obstacles if they were entered into the system.

The borders of the water meshes were identified within the Mohoş Swamp were listed within the Stereo system in 1970 due to a GPS SR 20 with  $\pm 1$  cm error.

In order to determine the hydro-chemical parameters of the water of the lakes identified in situ, the HI 9828 kit (Hanna Instruments) was used which allowed measurement of all the necessary parameters in order to assess water quality: the percentage of dissolved oxygen saturation, conductivity, specific weight of water, pH, etc.

The office activity includes processing of raw data (topographic and bathymetric) using software applications for filtering and eliminating implausible values in order to compose the digital pattern of the ground, on the basis of which the interest elements of the lake being studied will be calculated.

After each profile was partly examined and processed (transverse, longitudinal and additional), a file containing the XYZ coordinates of all points mapped on the ground, be it on the lake shores or in the lake sink.

Using the HYPACK program, the digital pattern of the ground was carried out, on the basis of which the volume of the lake at different levels, maximum depth, surfaces depending on the level in the lake were calculated and text reports on all these elements are issued.

The digital pattern of the ground is created by making triangles between the nearest XY coordinate points, according to certain criteria defined in the HYPACK program.

Such a criterion is the maximum possible distance between 3 points and the points beyond this distance will not be used in realizing this digital pattern.

Given this criterion, it is preferable that on spot, depending on the size of the lake and the desired accuracy of the final results, the distance between the transverse profiles be as short as possible, realize at least three transverse profiles and diagonal profiles (if one wishes more accurate final results).

After realizing the digital pattern of the ground, the form of the lake sink is graphically represented in a 3D or 2D image and the bathymetric curves are mapped out depending on the desired spread.

The final results of a topo/bathymetry, the volume and surface of the lake area are automatically generated and presented in a text file, for the spread level defined by the user of the HPACK program.

The GPS points were positioned using the GIS applications of ArcGIS 9.2 computer program. Data on water temperature were transferred and read on a PC using the DLN 60 application.

## **4 Results**

17-20 water meshes were identified in the Mohoş Swamp they have different surfaces and depths, different colors and eutrophication degree (Fig. 2 - position, tab. 1). Most lakes are oval or round, with low sides and much vegetation. Within it, there is a rich vegetation composed of submerged and floating plants, which have as development limit the depth of 4.0 m. It can be said that this value represents the depth to which light reaches or there is a termocline whose value leads to restrictions on the development of aquatic vegetation at higher depths.

Paludous plants of the border area of the lake are part of the herbaceous layer but also of the trees and shrubs that grow in height as they move away from the water mirror of the lake. The high herbaceous vegetation shows the itineraries of the animals that come to drink here, bears and deers, which carefully avoid the misleading channels that can be life threatening.

The flotability of the peat layer is surprising. At a stronger pressure it vibrates, thus indicating the existence of water layer below it. The surveys conducted from close to shore and in the places where dwarf pins were knocked down, show that the thickness of the peat layer varies and its shape is the one of a cone trunk, the lake being positioned at the top of it (Figure 3). Making a comparison between the distance from shore water until the first trees that have a height of about 1.20 m and their rythms of growth, we can assume that the process of vegetation covering the gloss of water does not exceed 0,10 - 0,15 m per year as of the growth of the tree.

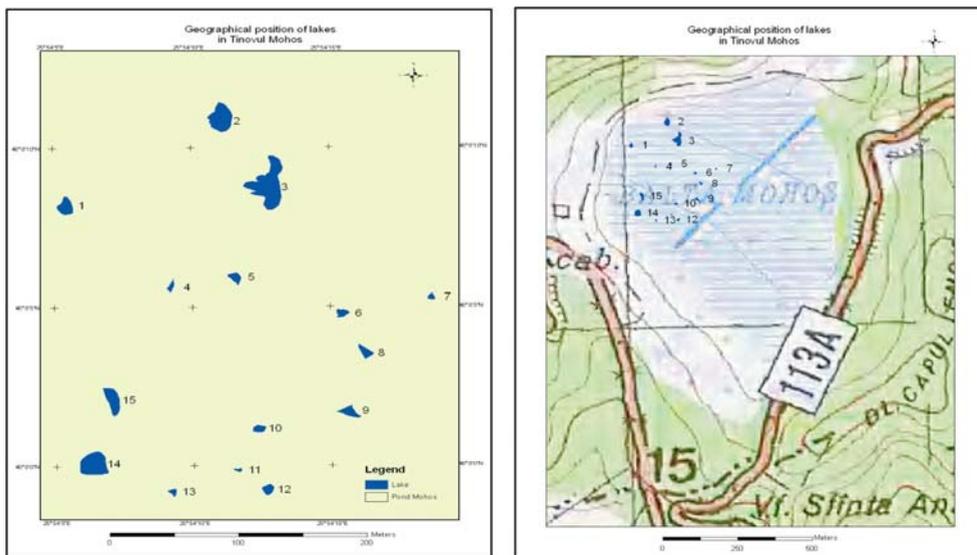


Figure 2 Position of lakes in the Mohoş Tinov

Table 1 Morphometric characteristics of the lakes identified in the Mohoş Swamp

No.	Name of the lake	Depth (m)	Volume (m <sup>3</sup> )	Surface (m <sup>2</sup> )	Observations
1	Mohoş 1	17	1050,94	139,47	pH - is between 3,1-6,5 transparency is 0.5 - 0.3 m water color between green and black turbidity 0-1,75
2	Mohoş 2	22	1876,25	177,93	
3	Mohoş 3	17	1935,54	341,85	
4	Mohoş 4	10	378,82	65,55	
5	Mohoş 5	14	512,21	65,33	
6	Mohoş 6	10	194,41	36,59	
7	Mohoş 7	10	137,15	23,82	
8	Mohoş 8	5	144,76	101,46	
9	Mohoş 9	7	399,58	137,48	
10	Mohoş 10	10	241,65	61,76	
11	Mohoş 11	5	19,48	12,14	
12	Mohoş 12	4	93,05	50,02	
13	Mohoş 13	10	89,40	27,37	
14	Mohoş 14	10	350,78	129,02	
15	Mohoş 15	10	1298,34	212,71	

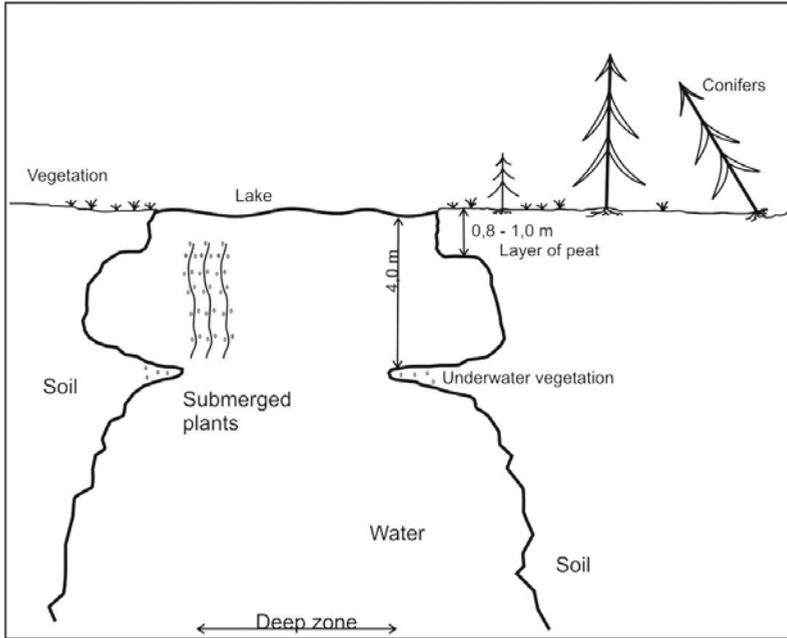


Figure 3 Morphological sketch of the lakes located in Mohoš Tinov

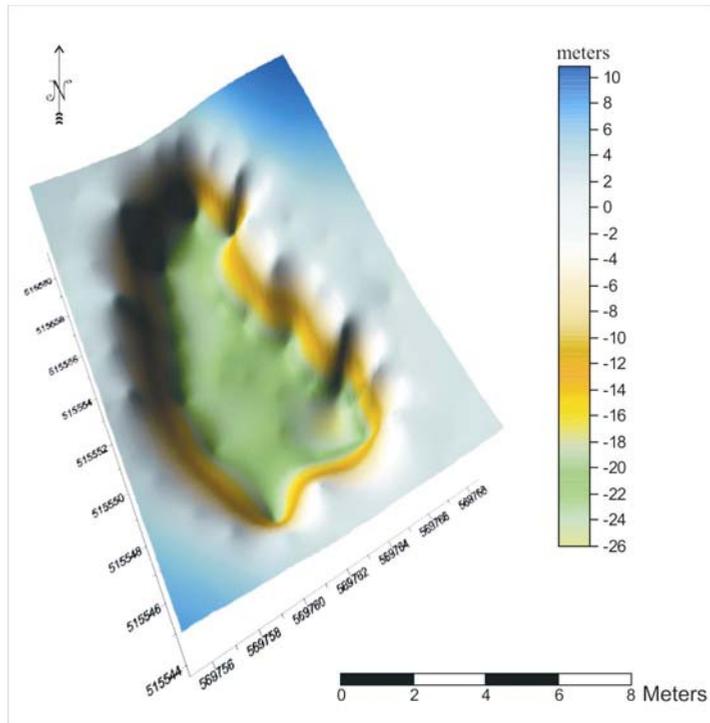


Figure 4 Bathymetric sketch of lake no. 2

## 5 Conclusions

The lakes identified within Mohos Swamp show morphological and morphometric characteristics which differentiate them among the other natural lakes at mountain or depression levels. Elucidation of their formation and evolution is the main purpose of researches and this article aims to mark the beginning of the study of these lakes.

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