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NEW ELEMENTS CONCERNING THE MORPHOLOGY AND THE MORPHOMETRY OF THE SLIDING LAKE OF CĂIAN (BISTRIȚA-NĂSĂUD COUNTY)

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Abstract

A spectacular lake, situated behind a sliding wave, was very well preserved near the Căianu Mic village (Bistriţa-Năsăud County). GPS technique used in topo-bathymetric measurements were facilitate the obtaining of some important informations and leded to the unit lake and its area GIS modeling. Comparison of previous measurements, maked with great rigor by surveyor and limnology specialists of our faculty, with measurements made by the authors of this study, made it possible a sharp dynamic of the lake area and its basin. In this sense, horizontal and vertical mobility of the sliding wave is evident, and also a small lake basin silting. Our predecessors considered important a pisciculture capitalization of the lake, because their communist society followed the maximal output in all domains. But, we consider opportune a touring capitalization of the objective, considering the beauty and spectacular landscape components, regardless of the season. Simultaneously it is necessary a lake protection by its framing into geomorphologic protected sites category, given the fragile specific ecosystem developed there and the highly dangerous access on the steep and friability slopes of the lake.

Keywords: sliding lake, "glimee" landslide, GPS and GIS technics, morphometric elements, protected area, capitalization

1. LOCATION AND NATURAL CONDITIONS OF THE LAKE AND SLIDING STRUCTURE EVOLUTION

The lake of Căian is located in the central-eastern part of Someş drainage basin to 3.6 km north-west of Beclean town, on the north-eastern slope of Cetățele Hill, component of the Suplaiului Hills *(Hognogi et al., 2012)* (fig. 1).

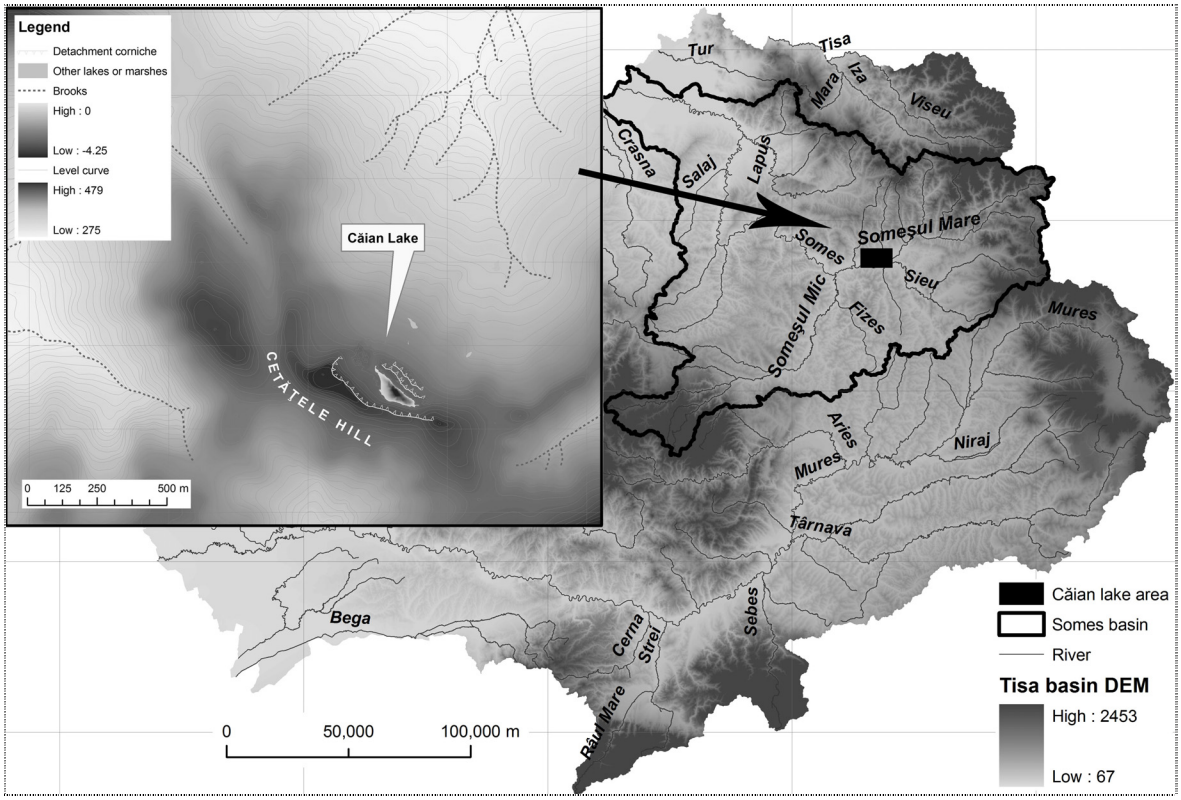

Fig. 1. Location of the sliding Lake of Căian across the Somes drainage basin

The Lake of Căian forming is related to glimee type landslides (fig. 2), developed on a monoclinic relief, which recorded a slight layers fall on the north-south direction *(Pânzaru & Rusu, 1973, Cocean & Danciu, 1994, Cocean et al., 2010)*.

Moreover, landslides generally and the "glimee" type of Transylvania, particularly, or water bodies located behind of sliding waves, have been studied or cited in the specialized geographical literature by the specialists in Geomorphology or Limnology: *Săndulache, 1963, Gâştescu, 1963, 1971, Tufescu, 1966, Pop, 1970, Gârbacea, 1992, Bălteanu, 1997, Grecu, 2009, Surdeanu, 1998, Irimuş, 2006, Surdeanu & Sorocovschi, 2003, Armaş, 2008 etc.*, in addition to the authors cited above. On this line, *Gârbacea,* in *1992*, made the first map of the "glimee" sliding type distribution from the neighboring natural unit - Transylvanian Plain, and also *Săndulache, 1963, Gâştescu, 1963, 1971, Pop, 1970, Şerban et al., 2004 etc.*, have done, or studies on the lakes classification or Transylvanian lacustrine units inventory, or studies of some lacustrine units appeared behind the sliding waves.

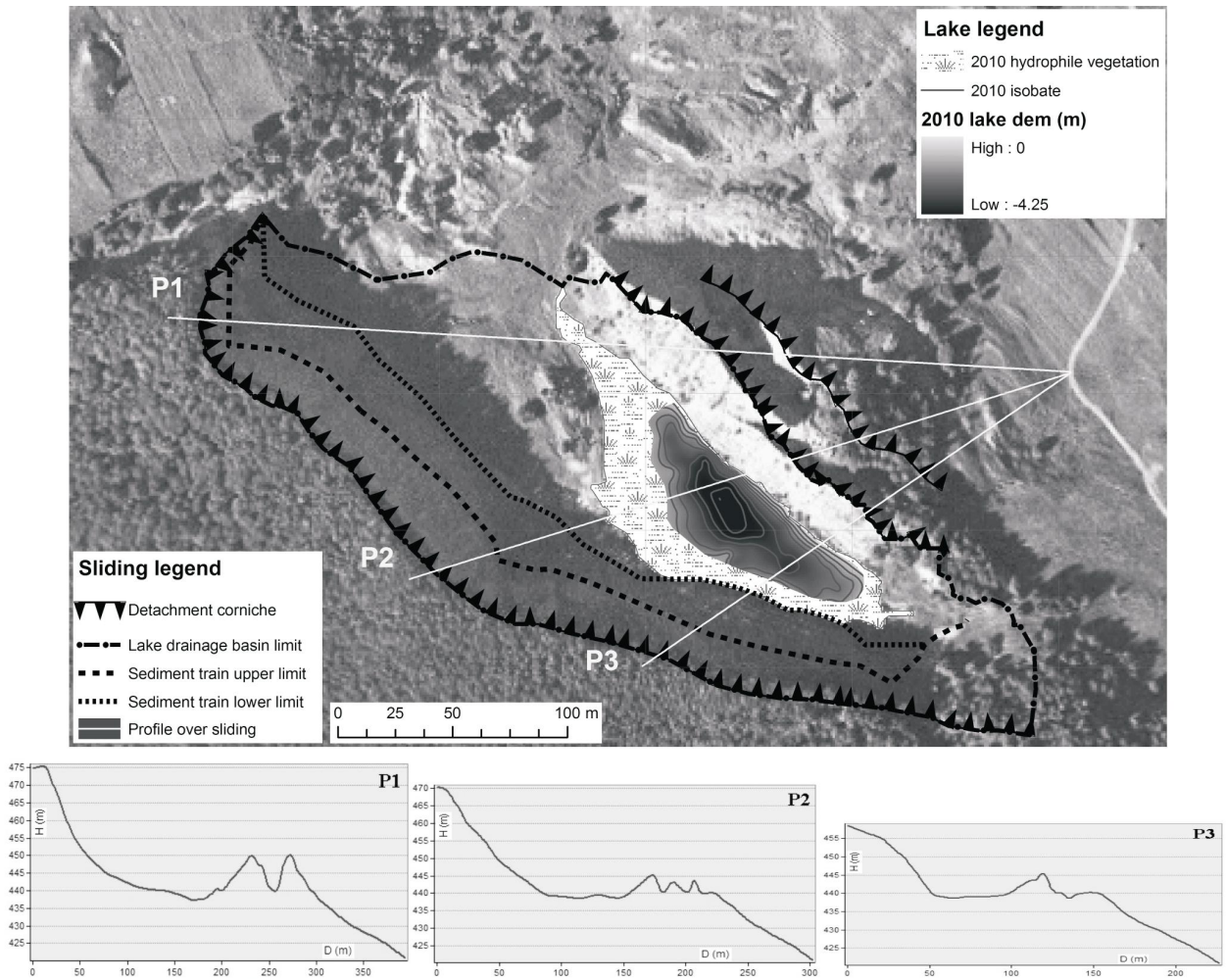

Fig. 2. The glimee landslide type from the north-eastern slope of the Cetăţele Hill. In the background an 2012 ANCPI image

After the studies published by *Bălteanu, 1997* şi *Surdeanu, 1998,* the southeastern part of Someşan Plateau (where is located our object of study) frame into the category of areas with an average frequency of the landslides, generally, and with a high frequency of the "glimee" landslides type, particularly.

The causes that led to the landslides starting are geological, geomorphological and climatic *(Pânzaru & Rusu, 1973*). *Stratigraphic*, the interest area is characterized by the Tortonian and Sarmatian formations, which have a special favorability for landslides; in the study area, the Dej Tuff supports marls breccia with lenticular salt massive, covered by the slate blackish-brown clays, with thin intercalations of dacite Tuff and with gray-open marl. Than they appear Sarmatian deposits of marls alternating, with rare intercalations of sandstones and conglomerates even. *Tectonically,* the area represents an anticline vaulting with salt up-to-date appearances between the Căian, Chiuza and Săsarm localities.

Towards the amount of the rainfall required to the significant moistening of the bed clay from the base, some authors believe that 90-100 mm over the annual average of the studied place would be enough *(Cocean et al.,*

2010, citing various sources). Some researchers which effectuated climate studies in the Transylvanian Plateau area estimated that the area analyzed frame within areas with high vulnerability to excess of precipitation *(Croitoru, 2006)*.

Diapiric disturbance of the Tortonian and Sarmatian formations, with subsequent character of the Ilişua River, caused a structural abrupt on the northeastern facade of the Cetățele Hill. To the construction of this abrupt contributed, further, the torrential brooks with obsecvent character, installed on the cuesta front (fig. 1, inset). Therefore, the slope with inclination between 13 and 60^0 became unstable, developing many landslides with ephemeral lakes and swampy areas, culminating with the landslide of "glimee" type under Cetățele Hill ridge, which is kept very well in relief and evolve faster, as we shall see below (fig. 2).

The slopes of resulted forms are subjected to an intense change through runoff, collapse etc. The sliding wave and the cornice of detachment lost from declivity, the first, also, from the height, because of erosion. In addition the sliding wave suffered fragmentations, the number of the resulting "monticles" increased to four. The principal "monticle" know an intense erosion and destruction in the central part, visible on the satellite image from figure 2 and, also, on the three-dimensional model from the figure 3, because of rainfall and underground water circulation.

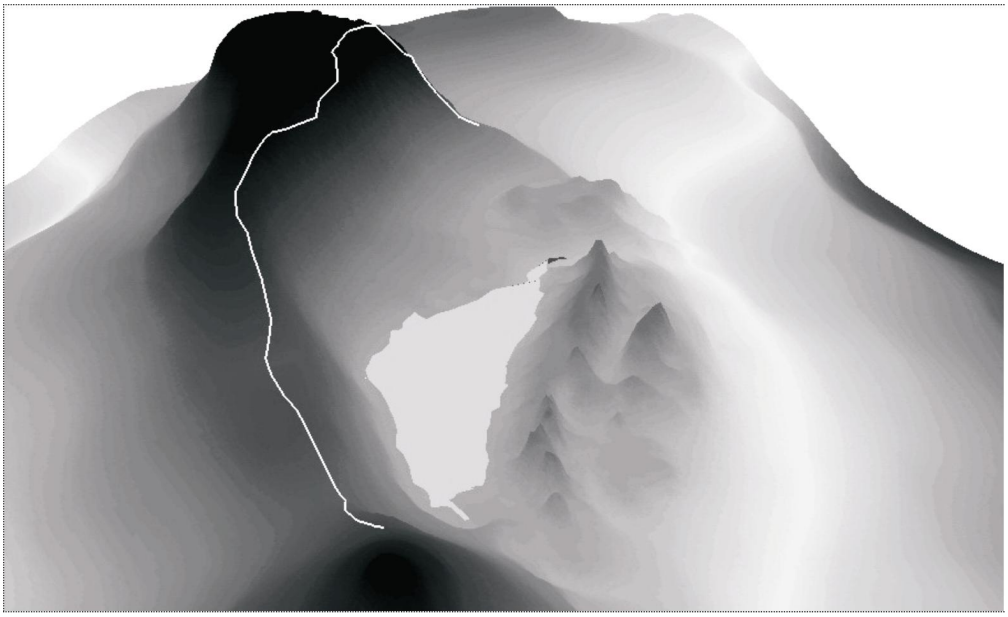

Fig. 3. The three-dimensional model of the sliding from the Cetăţele Hill. Image from East

The micro-basin groove suffered a widening visible with the naked eye on the images from figure 4, from 151 meters in 1969 to 165 meters (measured on the direction of profile 2), caused also by the erosion of the cornice of detachment, but especially by glide of the main wave sliding. Because of blocking of the terminations of the micro-basin with slope sliding material, inside the groove there is a lacustrine unit, whose appearance is a direct result of intersecting the groundwater by the slip plane, the characteristic of the lithology favoring water retention. The communication of the lake with the outward make also by underground mode and by a drain located at the northwest extremity of it; the crash from the "monticles" body prove it, as well as the swampy areas from the bottom side of the slope *(Hognogi et al., 2012)*.

2. SOURCES, INSTRUMENTS AND METHODS

During the documentations prior and further to the measurements were used cartographic sources, pictures and old articles *(Pânzaru & Rusu, 1973)*, but also a recent detailed cartographic base, consisting of detailed scale topographic maps (1:5000) and ANCPI satellite images.

If our predecessors ordered just from the levels and theodolites for topometric surveying and from the simple manual sounder for the bathymetry, latest technical endowment made by the Faculty of Geography facilitated the development of some faster and accuracy measurements campaigns.

For the topometry making were used GPS Magellan 600 terminals. For batimetry making was used a graded rod (very dense surveys), because the invasion of vegetation on the lake not allow use of ultrasonic sounder.

For other determinations (ex. – physic and chemical parameters) was used a portable Hanna kit for water quality, with a cable of 30 meters and sensors capable to measure the values of 12 parameters, including transparency, temperature, pH, conductivity, dissolved oxygen, salinity, resistivity, oxygen saturation etc.

The centralization, the processing, the modeling and the information analysis was done in computerized version using current and performance software: GPS Utility, Global Mapper, Microsoft Office, ESRI ArcView 3.x, ESRI ArcGIS / ArcInfo 9.x.

3. MORPHOLOGICAL AND MORPHOMETRIC ANALYSIS OF THE LAKE. CHARACTERISTIC CURVES

The form, the structure and the size of the micro-basin that house the lacustrine basin have changed significantly between the two topo-bathimetric surveys, therefore the effect on the lake basin was similar (fig. 4).

Fig. 4. Images of the sliding Lake of Căian – topo-bathimetric surveys from 1969 and 2010

By comparison with previous measurement, there is a reduction of the lake surface, a change of the appearance of the banks, the appearance of hydrophilic vegetation, the material loss on the northern side of the emersion slope of the micro-basin, recovered material in the submerged area of the lake, the advancement of a "monticle" from the west toward the lake basin and, also, the development of a peripheral lake basin "porch". This formation is due to the share by washing and hydraulic transport of the material from the circumference of slope, decanted to the contact with water, but also to the visible decrease/regress of the lake water level. The plan and the three-dimensional models confirm these aspects (fig. 5).

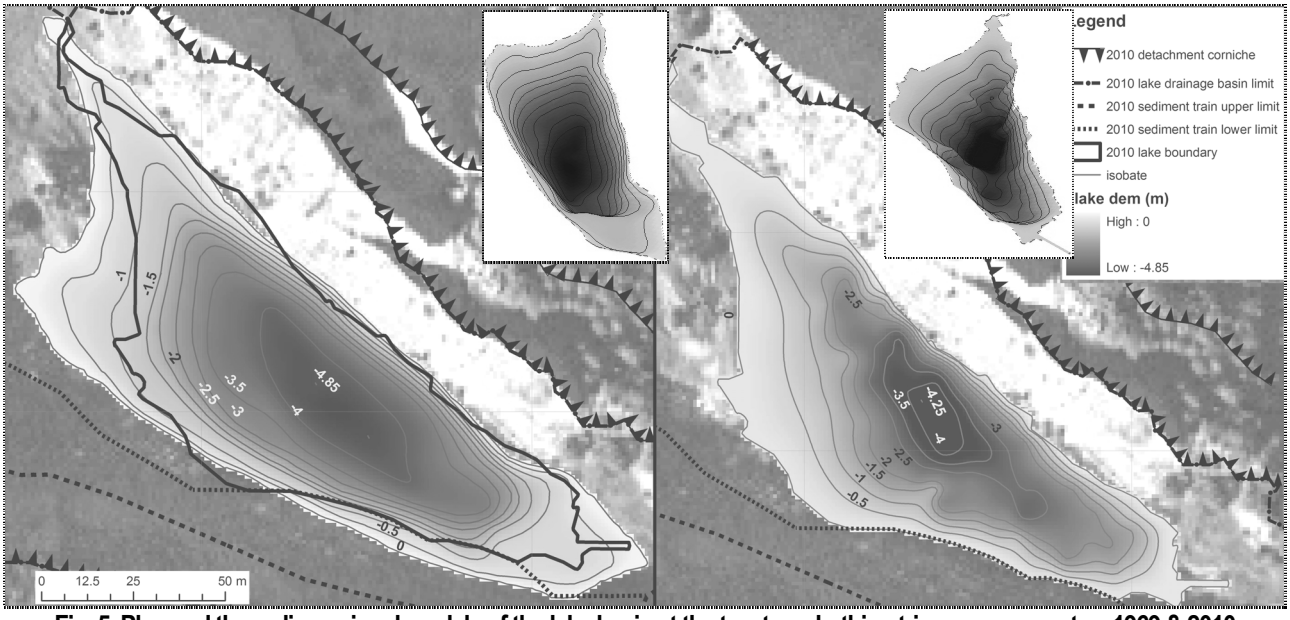

Fig. 5. Plan and three-dimensional models of the lake basin at the two topo-bathimetric measurements – 1969 & 2010

It can observe a peripheral "porch" development also in the submerged area in damage/with a collapse of the central pit, which also records the maximum depth. Undoubtedly, the reduction of the cuvette capacity cannot be explained only by the alluvial transport from the slope; the continuous sliding of the material from the slope toward the lake basin is the main factor that caused this reduction. Observing the areas with maximal charging of the lake basin, it can feel from which part of the slopes performed the most important material glides toward the lake. The hydrophilic vegetation development on 3436 m^2 (54% of the lake surface) represented a disturbing element for the lacustrine unit, accelerating the decantation of the warp and the lake basin silting (fig. 2).

Tabelul 1. The main morphometric parameters of the Lake of Căian at the two topo-bathimetric measurements

Absolute altitude of water level	Year of survey	Surface (S-m^2)	Lenght (L-m)	Medium width (B_m-m)	Maximum width (B_{max}-m)	Medium depth (h_m-m)	Maximum depth (h_{max}-m)	Maximal axis (A-m)	Minimal axis (a-m)	Perimeter (m)	Quotient of sinuozity	Volume (V-m^3)
441.00	1969	8787	227	38.7	61	2.12	4.85	220	64	517	1.56	18657
439.27	2010	6323.6	225.7	28.0	59.9	1.47	4.25	210.79	59.2	509	1.81	9322.08
1.73m/Δ (%)	41 years	28.03	0.57	27.65	1.8	30.66	12.37	4.19	7.5	1.55	-16.03	50.03

All these aspects are confirmed by the evolution of the Lake of Căian morphometric parameters (table 1) and by characteristic curves graph (fig. 6).

There are observed major percentage reductions to the parameters which defining the dynamics and the life endurance of a lake: area, average width, average depth and, especially, volume. The reduction of the latter by 50% reveals a clear evolution toward the lake silting and disappearance, through accelerated transformation into a swamp.

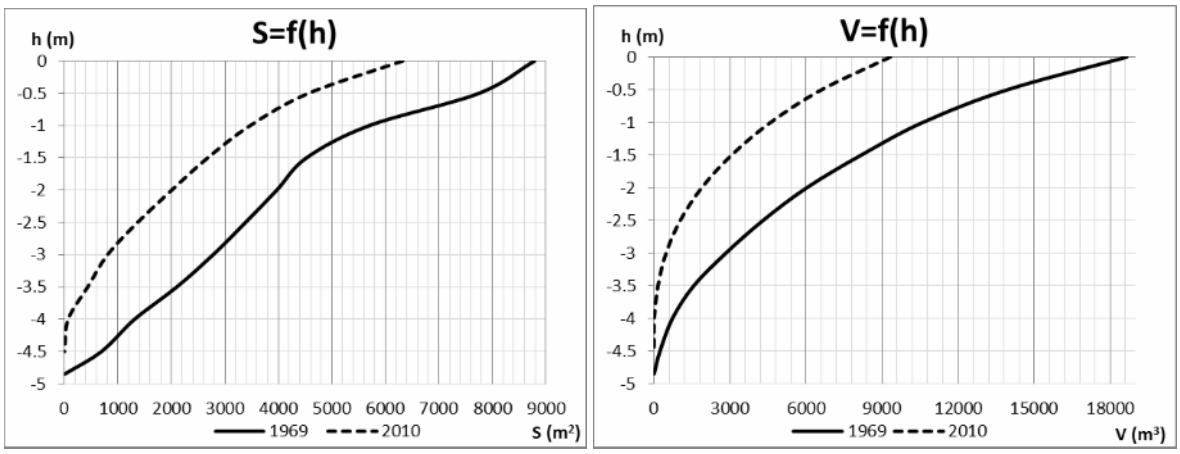

Fig. 6. The characteristic curves of the Lake of Căian

Given that currently, the lake is an ecosystem with free evolution also natural, insignificant influenced by man, would require its conservation measures, to lagging the evolution towards the final stage of silting; it is possible any this sliding lake and the "glimee" sliding declaring as nature reserve or protected geomorphological site.

4. ECOLOGICAL CAPITALISATION OF THE LACCUSTRINE POTENTIAL

The lack of reaction from the anthropogenic factor, concerning the future of this particular objective, is reprehensible, as is the lack of reaction or negative response concerning the other natural objectives that have the Carpathic & Danubian & Pontic area. Considering this aspect we have designed a plan of tourist routes organization toward this objective, starting from different Cetățele Hill peripheral points (fig. 7, table 2).

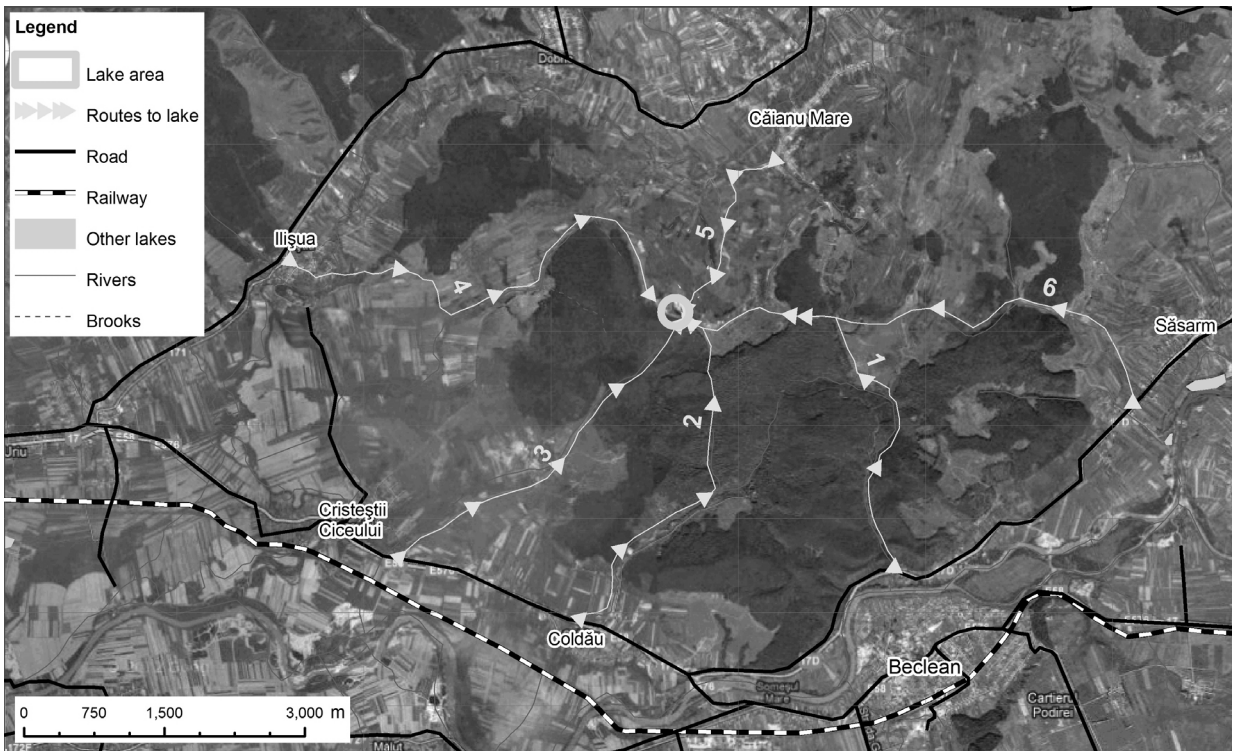

Fig. 7. Tourist rotes toward the Lake of Căian and Cetăţele Hill

All routes, starting from the immediate vicinity of the villages, respectively, from the access ways with traffic more or less intense: roads, railways, local roads, forest roads. In the table 2 are given the calculated distances need to be cover to achieve this objectives and the versions of possible locomotion.

The longest walking trail can be covered easily in two hours. The access from Căianu Mare locality is possible no more than an hour to go, on a forest road or directly on the field. The distances and the times seem quite inaccessible and appear to require a serious workout as a good physical condition, which is not at all, really. Any person, even less common with physical effort, can travel through these routes.

Tabelul 2. The lenght and the acces version of the touristic routes toward the Lake of Căian

Nr. of route	Direction	Length (km)	Acces
1	Beclean-Lacul Căianului	4.9	walk
2	Coldău-Lacul Căianului	4.2	walk
3	Cristeştii Ciceului-Lacul Căianului	4.1	walk
4	Ilişua-Lacul Căianului	5.3	walk
5	Căianu Mare-Lacul Căianului	2.2	with SUV
6	Săsarm-Lacul Căianului	5.8	walk

This effort would not be only an excursion for participant's health; once arrived near of the lake any tourist would be fully rewarded by the magnificent natural landscape met. Of course, there is no negligible the commercial aspect of the action, numerous tourists could opt for accommodation in the neighboring localities and for consumption of local traditional products.

CONCLUSIONS

The sliding Lake of Căian with the "glimee" sliding type structure, that houses it, represent one of the local morphological trait, a characteristic element of the landscape from the Someşene hills of the Suplai and Ciceu. Enchanting aspect of the lake and of the local natural landscape contrasts with their increased degradation rate. The lake evolution toward the silting was confirmed by its morphometric features. There are several limited opportunities of intervention to protect the lake, but also to capitalize its potential, by authorities involving, even with European funds and by arranging of several tourist visiting routes.

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