

PATTERNS AND TOURIST ACTIVITIES INDUCED BY THE UNDERGROUND RIVERS AND LAKES IN THE ARIEȘ BASIN UPSTREAM OF BURU

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ABSTRACT. - *Patterns and tourist activities induced by the underground rivers and lakes in the Arieș basin upstream of Buru – The presence of carbonate deposits in the Arieș basin, upstream of Buru induced certain organization of groundwater resources. Depending on local genetic factors – geological, climatic, biotic, temporal, etc – the extension and characteristics of karst aquifers engenders exploitable hydro units in terms of tourism: underground rivers and lakes. Identification and analysis of morphometrical, morphological, quantitative, qualitative, dynamic and biotic characteristics have provided the approach to ranking the hydro entities. Forms and tourism activities are subsumed to the established typological categories: recreational and pleasure tourism and multipurpose tourism.*

Keywords: karst aquifers, recreational and pleasure tourism, cave river trekking, multipurpose tourism

1. General considerations

Groundwater bodies have emerged in the Triassic and Jurassic deposits of limestone belonging to Gârda Seacă Basin, and there are three important karst aquifers outlined: Zgurăști – Poarta lui Ioanele, Ocoale – Cotețul Dobreștilor and Coibe – Tăuz.

Also correlated with carbonate deposits – Paleozoic crystalline limestone – are two major bodies of groundwater located in Poieni Plateau and Vulturese Ridge. In the Jurassic limestone of Bedeleu Massif from Trascău Mountains we can find Vânățara – Huda lui Păpară, a karst aquifer (fig. 1).

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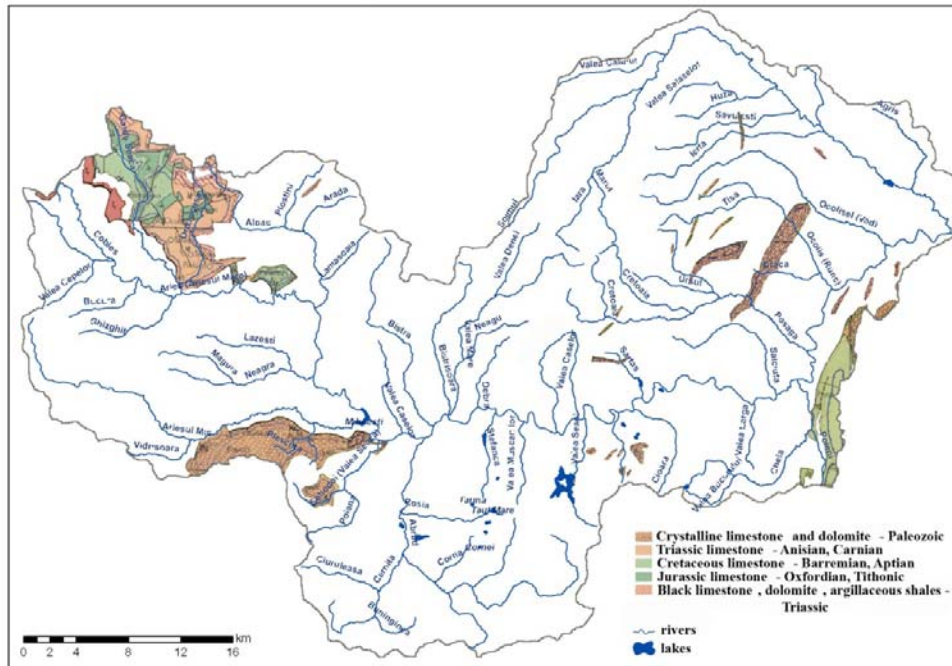


Fig. 1. Carbonate areas distribution map – limestone and dolomite – in the Arieș basin upstream of Buru (modify after Geological map of R.S. Romania, sc. 1:200000, Geological Institute, Bucharest, 1967)

2. Underground rivers and lakes

Analyzing the hydro-geological systems there were identified several underground rivers, accessible (completely or partially) through the related goals network: Bulz underground river (Huda lui Papară), Coiba (Coiba Mică - Coiba Mare), Hoanca Apei (Hoanca Apei Cave), and Huda Orbului (Huda Orbului Cave).

Observations and measurements in Huda lui Papară Cave targeted quantitative aspects (flow), quality (physic-chemical spectrum), morphometric (length, width, depth, fall's height) and morphological ones (bed configuration in plan and longitudinal profile, deposition of the bed). Qualitative and quantitative data cover one year - 2009, sampling for determining physic-chemical parameters and flow measurements was performed downstream from the cave's entrance.

Higher density of underground rivers in the Gârda Seacă catchment area is explained by the favorable conditions for large underground drainage systems, karst aquifers discharge achieved by springs (Tăuz, Cotețul Dobreștilor, etc.) (fig. 2).

The main criteria in the tourism recovery are accessibility, both in terms of access roads to the caves with underground rivers, and an easy underground way. Except for the inventoried and described cavities, the underground rivers can be intercepted by networks with endokarst important uneven. To explore them, thorough knowledge of alpine caving techniques is required as well as great physical abilities. The main morphometric and morphological parameters are summarized in Table 1.

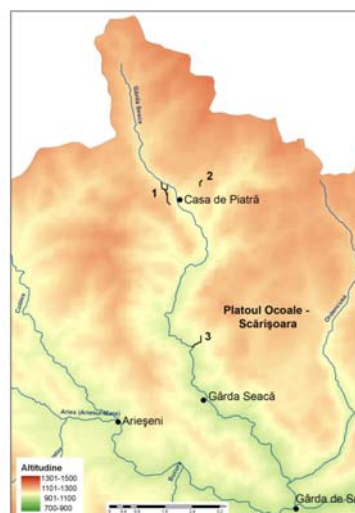


Fig. 2. Underground rivers from Gârda Seacă basin (1 Coiba; 2 Orbului; 3 Hoanca Apei Cave)

Table 1. The main features of underground rivers in the Arieș basin upstream of Buru

Under-ground river	Location			Length (m)	Q _{med} (l/s)	Waterfalls		Accessi-bility
	Cave	Massif	Catchment basin			No.	Height (m)	
Bulz	Huda lui Păpară	Trascău	Cheia	1200	354	2	2, 2,5	III
Coiba	Coiba Mică/Mare	Bihor	Gârda Seacă	800	200	2	12, 3	IV
Huda Orbului	Huda Orbului	Bihor	Gârda Seacă	190	5 - 10	1	8	III
Activul de Vest	Hoanca Apei	Bihor	Gârda Seacă	150	0,5 - 3	1	20	IV

The criteria for the classification of underground rivers on the accessibility concern: the presence of waterfalls and lakes, flooded sectors or siphons, the length of the river, underground bed morphology (Table 2.).

Table 2. Classification of underground rivers as accessibility

Accessibility degree	Characteristics of underground rivers	
	hydrologic	Morphometric and morphologic
I	Low flow, no waterfalls and lakes	There are no major unevenness, easy access
II	Moderate flow with important fluctuations, there are waterfalls and small lakes	There are thresholds, but overcoming them can be made without technical means
III	High flow, waterfalls and large lakes, flood hazard, siphons (galleries completely blocked during floods)	There are thresholds that require TSA equipment (speleological alpine techniques), narrow passages (overcome by crawling), large blocks
IV	High flow, waterfalls and large lakes, flood hazard, siphons and semi-siphons	Major unevenness (tens and hundreds of meters) that can be overcome only by TSA technique, labyrinth morphology, major cracks

According to these criteria, degrees of accessibility conferred to underground rivers are 3 and 4, their full overcome assuming major obstacles: waterfalls, lakes, rapids, siphons, etc. Therefore, tourism practiced in such hydro-forms organizations is selective, being represented by polyvalent tourism, with its specific forms (expeditions and scientific research). Only the risk-free areas are proper for recreation and leisure tourism.

The tourist potential of underground lakes is given primarily by the novelty of storage location. As far as the distribution of underground lakes in the Arieș basin upstream of Buru is concerned, the territorial disparities are clearly cut, this consequence being also attributed to the location of the major hydro geological systems. They focus on two catchment areas: Gârda Seacă (fig. 3) and Cheia. In Vânărtara - Huda lui Păpară

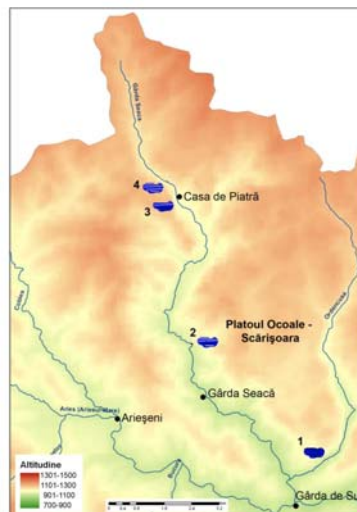


Fig. 3. Underground lakes from Gârda Seacă basin (1- Zgurăști; 2- Hoanca Apei; 3- Huda Oilor; 4- Coiba Mare)

karst system, on the subterranean river, several lakes succeed in marmites stationed at the base of waterfalls or behind sedimentation dams. Dimensional, Dorna Mare stands in the vestibular sector and Septelor Lake in the terminal part (sump). The largest underground lakes are hosted by the cavities from the Gârda Seacă catchment area: Gheţarul de sub Zgurăşti Cave, Hoanca Apei Cave, Huda Oilor Cave, Coiba Mare Cave.

Lakes from Gheţarul de sub Zgurăşti Cave concentrate the largest volume of water in Romanian karst. When stepping underground, on the Entrance Hall floor there is the largest lake basin, a temporary storage, their fluctuating level depending on the size of the supplies offered by the underground river and the infiltration rate of the basin bed. As for tourists' interest only in this lake, others are very difficult to reach.

Inventory of underground lakes in the Arieş basin upstream of Buru has taken into account several criteria: accessibility, morphometric, quantitative and morphological indicators (hydro touristic indicators). Accessibility shows the difficulties encountered on the route to intercept underground lakes, ranging from I - IV (Table 3).

Table 3. Classification of underground lakes in terms of accessibility

Accessibility degree	Morphological, morphometric and hydrological features of the access passages and morphology of lake basin
I	Easy access; does not require special equipment (TSA); fossil passages
II	Relatively difficult access; lowered ceiling passages which requires crawling; do not require special equipment and techniques (TSA); fossil galleries
III	Difficult access; there are vertical passages that require climbing or descending with special gear equipment – TSA - (shafts); low passages; the presence of large amounts of clay and mondmilch; is on the underground rivers passages; low or moderate flow
IV	Extremely difficult access; the shafts measure tens or more meters; they are on the track of big rivers and regularly flooded passages

Hydro touristic indicators of underground lakes in the Arieş basin upstream of Buru focused on morphometric features, morphology, degree of accessibility and landmarks for localization (Table 4).

Table 4. The main features of underground lakes in the Arieș basin upstream of Buru

Under-ground lake	Location			Morphometric features*			Morphological characteristics	Accessi-bility degree
	Cave	Massif	Basin	L (m)	l (m)	H (m)		
Dorna Mare	Huda lui Păpără	Trascău	Cheia	30	4	1,8	Gallery walls are nearly at least 2 m	I
Lacul Septelor	Huda lui Păpără	Trascău	Cheia	18	5	1,5	Gallery ceiling is close to 0.5 m mirror lake water (in the center) through a series of corrosion	III
Zgurăști*	Ghețarul de sub Zgurăști	Bihor	Gârda Seacă	65	38	14	Volumetry of the Host room is impressive (the ceiling height is over 30 m)	I
Lacul Sifonului Deschis	Huda Oilor	Bihor	Gârda Seacă	73	7	4	Winding path of the gallery; dam stalagmite in the middle, the upstream end of the ceiling descends to 0.5 m	II
Lacul Toboganelor	Huda Oilor	Bihor	Gârda Seacă	18	3,5	2	In the right wall of the lake there are three slides connected to teh gallery	II
Lacul Sălii Domu-lui	Huda Oilor	Bihor	Gârda Seacă	29	6,5	-	The host room	II

*L – lenght; l – maximum width; H – maximum depth; **temporary lake

The recreational, scientific and leisure characteristics of the lakes are undeniable. Navigating in the dark can provide a unique experience with an earthly primary and reversionary flavor. Feeling overwhelmed is amplified by the endokarst magnitude, forms of heated (collapse), speleothems (ensemble cave) forms of erosion and corrosion.

3. Types and tourist activities induced by underground water

In the category of underground water resources and aquifers we mention the deep underground rivers and lakes. The emergence of these aquifers to surface sources whose presence generates physical and chemical properties can provide multiple use possibilities. Perennial ice accumulations are reminiscent of some caves of Arieş basin upstream of Buru. However, due to the difficult access for possible tourist valorization, because of their position in the land surface, underground waters provide few opportunities in this regard.

The types of tourism sustained by these resources cover the entire spectrum typology: recreation and leisure, curative and versatile (Table 5).

Table 5. *Touristic forms and activities related to the underground waters (after Băţinaş, 2009)*

Tourism type	Tourism forms	Associated activities
Recreation and pleasure tourism	Sports, cruises	Black water rafting, cruises, visiting some objectives related to underground water resources
Curative	Balneal	Balneal
Polyvalent tourism	Scientific and professional	Research expeditions Visiting some specific touristic objectives

The tourist valorization of the underground water is limited to the cave spaces housing the waters: rivers and underground lakes. Instead, efforts to conduct planning and use of specific activities (water sports, recreational transportation, and visit) are discouraged from investing too much technical requirements necessary to resolve the morphology and hydrology underground water.

The caves across the Arieș basin upstream of Buru can provide a variety of recreational and leisure activities: cave-diving, cave-tubing, river cave trekking, swimming (pool or apnea), etc. (Table 6).

Table 6. *Forms and tourist activities induced by the underground waters from the caves of Huda lui Papară and Zgurăști glacier*

Cave	Water resources	Tourist form	Tourist activities	Observations
Huda lui Papară	Underground Rivers	Extreme water sports	Cave river trekking (crossing an underground river)	It combines different techniques: swimming, diving, free climbing or equipment (TSA-technical speleological alpine)
			Cave-diving (diving into caves)	Diving in the middle and terminal siphon
			Cave-tubing (Navigation craft with a rubber ring)	The middle sector of Bulz underground river
	Leisure transport	Light non-motorized boats navigation		
	Underground lakes	Leisure transport	Light non-motorized boats navigation	Dorna Mare lake is situated at the entrance of the cave
Zgurăști Galcier	Underground lakes	Extreme water sports	Cave-diving	
		Leisure transport	Light non-motorized boats navigation	Although they are the largest underground lakes in our country Zgurăști Lake is the only one available to the public

4. Conclusions

The valorization of underground water resources covers two organizational forms: rivers and underground lakes. Given the environmental features speleal (afotic, wet, cold), it reveals a side of restricting the practice of various forms and types of tourism. Some features of morphology underground and hydrological elements may encourage

particular forms of tourism and recreational versatility. Out of the forms of recreational tourism the most important ones are trekking cave and river cave tubing for underground rivers, inland lakes and sinking autonomous groundwater. Polyvalent forms of tourism means tourism exploratory and scientific, the latter being designed to elucidate the genesis and evolution of the karst systems.

As far as the underground rivers are concerned, there were taken into account a number of river indicators - morphometric, morphological, quantitative, qualitative and dynamic ones - and of lakes - morphometric, morphological, quantitative and biotic - that can quantify the attributes of these fluid forms of organization, so that encourage the practice of tourism activities mentioned (cave river trekking, cave - tubing, sailing). Such tourism activities require minimal facilities, resulting in little impact on the speleological environment. It is recognized that periodic flooding caves are faced with high energy cave. Enhancement of underground lakes in the practice of tourism activities (ground shipping) often requires infrastructure facilities (marked paths, stairs, railings, electric lighting).

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