

**THE IDENTIFICATION AND EVALUATION OF THE HYDRO-TOURIST  
POTENTIAL OF THE ARIES BASIN UPSTREAM OF BURU**

*THESIS SUMMARY*

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**KEY WORDS:** hydro-tourist potential, identification, evaluation, hydro-tourist indicators

## INTRODUCTION

Preoccupations in this area, although generous and thorough, are still offering original ways of approaching as well as new directions in deepening the geographical study, namely tourism. Although the Aries River basin is a mountainous region often mentioned in the specialty literature, the complexity of local geographical factors still leaves time for other research, but also for the subtle nuance of topics already covered.

The complex hydrologic studies carried out for this basin are numerous. Therefore, as valuable works one may mention: *The Apuseni Mountains - Hydrological Study*, Ersilia Iacob's PhD thesis (1971), but also more recent and meritorious concerns made by Răzvan Horațiu Băținaș with a PhD thesis on water chemistry and pollution - *Study on Surface Water Quality in the Aries Basin* or Viorel Arghiuș with his PhD study related to floods - *Flood Study on the Rivers in Eastern Apuseni Mountains and Their Risks* - both works in 2008. One should also mention the pioneering work of Al. I. Maxim entitled *Ebb and flow springs. Intermittent Springs from us* (1941).

Regarding the hydrological studies that have sought to explain extension, dynamics, and physicochemical characteristics of the main karst aquifers of the Aries basin upstream of Buru, a relevant PhD thesis is Orășeanu's I. *Contributions to the Hydrodynamics Knowledge of the Karst Aquifer Systems in Apuseni Mountains* (2000), and published by the University of Bucharest publishing house.

But most references regarding river issues are covered in extensive studies of regional geography, geography or tourism guides, as shown in older or newer works: *Bihor-Vlădeasa Mountains*, M. Bleahu, S. Bordea (1981), *Key and Gorges in the Apuseni Mountains*, P. Cocean (1988), *Țara Moșilor - Study of Regional Geography*, C. Boțan (2008) PhD thesis.

Aries basin upstream of Buru includes a number of valuable tourist attractive attributes, primarily from natural resources category: gorges, canyons, caves, steep, intermittent streams and vauculian, waterfalls, etc. The aim of this paper is to analyze water resources (through identification and evaluation) in order to highlight the tourist potential of a taxonomic unit of this class, namely surface and underground water entities.

The impetus of addressing such an analysis is based on the extremely generous fund available to the Aries basin due to some favourable genetic factors: lithology, that covering a wide range (carbonate deposits, sand stones, metamorphic, igneous and volcanic rocks), complicated tectonics, climate characteristics, river network.

The morphometric, morphological, quantitative, qualitative, dynamic and biotic properties of the surface waters, generated by their natural endowment, represent analysis criteria of the tourist potential, also providing valuable tool in the evaluation.

The water surface entities take multiple aspects: rivers, lakes, waterfalls, swamps, water in solid form (snow cover and ice waterfalls) and reflect a complexity of conditional factors.

The extended carbonate areas have led to the appearance of ample hydro karst systems thus favouring the appearance of some underground water formations which thanks to their accessibility can be analyzed from a tourist point of view. To this criteria those of morphological, morphometric, quantitative and qualitative nature can be added all of them being included in the category of the hydro-tourist indicators.

The nature had curious manifestations: hydrogeology (intermittent, sub-thermal and vauclusian springs), hydrologic (the largest underground lakes in Romania, underground courses that are 1000 m long), glaciological (perennial ice deposits). Although it is an unnatural attribute of the Romanian landscape, the perennial ice meets favorable conditions for multiannual accumulation and perpetuation due to a combination of morphological and micro-climate features of several cavities, some found on the analyzed territory: Scărișoara Glacier and Vârtop ice pothole. By their mere existence the fossil glaciers become an objective of high interest for the visitors of those caves. In addition to these elements, the underground ice, through its physiognomy and way of accumulation, is indeed a unique tourist attraction factor. This paper particularly focuses on the carbonate areas, the springs included (all are located in limestone or dolomite substrate). The criterion is not random, because there are the amplest and most spectacular hydrologic events, essential attributes in establishing the tourist potential of a taxonomic unit.

## CHAPTER 1. GEOGRAPHIC LOCATION AND TERRITORIAL UNIT ELEMENTS

### 1. 1. Geographic location and limits

The analyzed territory is located in the eastern part of the Apuseni Mountains. With an area of 2043 km<sup>2</sup>, the region includes the middle and the upper Arieș hydro basin, longitudinal extreme points being Muncelul Peak (1499 m) in the west and Torsa Peak (899 m) in the east. As latitude landmarks, diametrically opposed, are considered to be Creasta Plopilor Peak (1178m) in the north and Brădișorul Peak (1043 m) in the south.

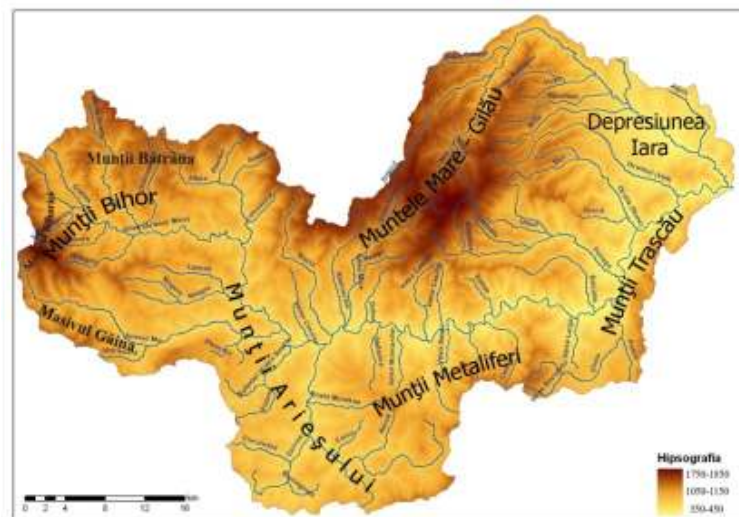
### 1. 2. Territorial unit and regional subordinate elements

On unitary character of the region we can bring a series of arguments logical lined, after a stated geographical algorithm: succession of narrow sectors of the valleys (gorges, defiles) with those of enlargement, individualized as lowland; the permanent character of most of the water courses; presence of areas formed on carbonate rocks where there were karst aquifers downloaded through springs; relatively high population density for a mountain area, especially in „Țara Moșilor”(43,6 inhab/km<sup>2</sup>); high density of rural settlements; high human pressure on environment components (high density of the buildings, widespread practice of mining, forestry and tourism).

Multiple differences that still occur, allow individualization of two major geographical areas: mountain area itself and lowland space occupied by glens and lowlands.

Lithology, tectonics and morphology of ensemble determined highlighting of

distinct subunits: Bihorului Mountains, Metaliferi Mountains, Muntele Mare - Gilău Massif, Trascău Mountains, to which are added low areas such as Iara Lowland and Arieș defile (Fig. 1.).



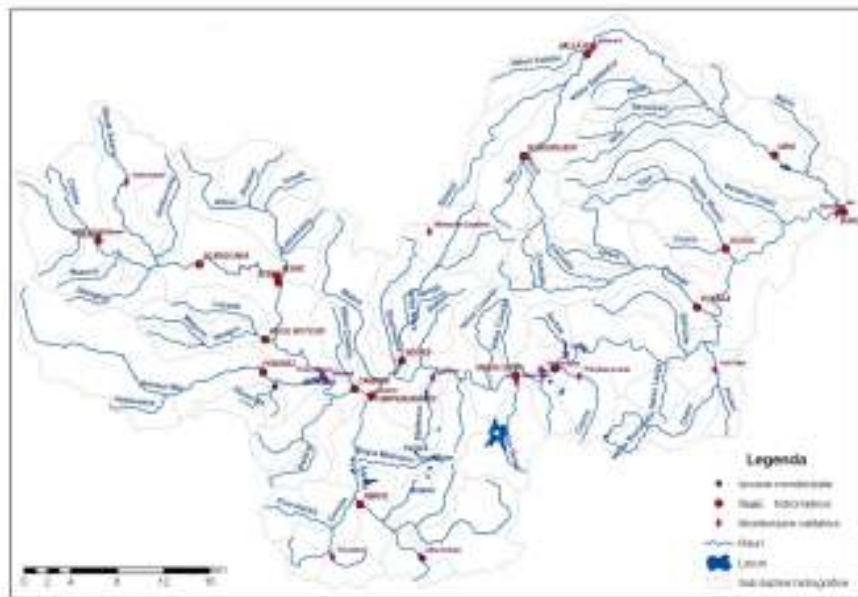
**Fig. 1.** Map of territorial units and regional subordinate elements from Arieș basin upstream of Buru

## CHAPTER 2. GENERAL FEATURES OF THE WATER RESOURCES

### 2. 1. Rivers network

In the Arieș hydro basin upstream of Buru there is a dense network of rivers, most of them with permanent drainage. Flow direction is the result of a long development to which an important role have played, besides climatic conditions, tectonic, relief and geological structure (Iacob, 1971) (Fig. 2.).

The main valleys of the basin are inserted into major tectonic lines: Arieș on the contact area between crystalline rocks of Muntele Mare – Gilău and cretaceous deposits



**Fig. 2.** Map of hydrometric network from Arieș basin upstream of Buru (after Administrația Bazinală de Apă Mureș, 2009)

of Metaliferi Mountains, Arieșul Mic to the interference of Paleozoic deposits of crystalline limestone from Poieni Plateau and crystalline deposits of Bihor. On tectonic trajectory, fluvial erosion has removed some of the brittle material stored and broke barriers made of harder rocks, depression resulting in alternating areas with narrow defiles or gorges: Arieș Defile between Sălciua and Buru gorges in Arieș upper basin (Mândruțului and Albacului).

The hydrographic network related to the main one, has adapted, focusing for major drainage lines, valley morphology vary depending on local conditioning (lithology and relief).

### 2. 2. Lakes and swamps

In the area of Arieș hydro basin upstream of Buru there are a limited number of lakes, with a modest economic relevance. Prevalent, the origin of lacustrine units is anthropogenic,



identified as lakes used in the processing of ores in the past, non-permanent reservoirs and lakes for decanting waste resulting from mining.

The typology of natural lakes is depending on lake basin genesis. There are two major categories: nival lakes and lakes formed on soluble rocks (limestone and dolomite). In the first category is part of a single unit, represented by Cucurbăta Lake.

The main areas of bogs, molhaşuri called in the Apuseni Mountains, are found in high regions of Muntele Mare – Gilău Massif and on Bătrâna Massif, part of Bihor Mountains. The marshes from highland are also taken into account, usually located in the vicinity of springs.

These bogs reach maximum density in the country in the Apuseni Mountains. Are small, their surface does not pass the 10 ha. Most are typical oligotrophic marshes, often convex, with a complex of regeneration, hosting common plants from fen and others, especial: *Sphagnum balticum*, *Carex magellanica*, *Drosera intermedia*, *Pedicularis limnogenae*, *Swertia punctata*, etc. (Pop, 1960).

### **2. 3. Water in solid form**

Cold season generates, depending on local conditioning, presence of water in solid state, materialized through the layer of snow and ice formations on the river. Snow layer characteristics (duration, thickness, structure) are a consequence of a number of factors: landform (morphometry, morphology, exhibition, fragmentation), climatic (solid precipitation). Ice formations from rivers that can arouse interest in tourism are ice waterfalls, climbing is the main form of exploitation in this regard.

Duration of snow cover is conditioned by substrate and air temperature maintained below 0°C, and the amount of solid precipitation.

Since October, the occurrence of snow is possible in most of the area, except the eastern slopes, affected by adiabatic processes and valley corridors located at low heights where the first layer of snow occurs, on average, in November. In most years, the first layer of snow makes its appearance when the ground is not well frozen, and the snow melts without forming a consistent layer.

Average date of snow disappearance is delayed depending on stations altitude, higher heights (on average, at the beginning of the second decade of May, at heights above 1500 m), while in low areas overlap the second half of March. Annual average number of days with snow cover varies a lot between low spaces, where it remains about 60-70 days (67 days at

Câmpeni), and high areas of the Bihor Mountains and Muntele Mare Massif, where a cumulative period of about five months there is snow cover (Arghiuș, 2008).

The only solid storage formations in the rivers, covered by this study, are waterfalls of ice. Frequently, in cold season, especially on valleys, where thermal inversions often occur, real „lakes” with cold air, because of low temperatures, the water trickles down the slopes can freeze. The phenomenon is even more spectacular when the freezing process affects a watercourse that crosses a threshold important morphological, where it forms a waterfall (Fig. 3.).



**Fig. 3.** Pișoaia Waterfall (Vidrii) –Poieni Plateau

After outlining a curtain of ice, water continues to flow in behind it, supporting all fabric is permitted, first, by the basis extensive formation and, secondary, by points of attachment to the original rock wall.

#### **2. 4. The underground waters**

The main groundwater bodies related to analyzed basin are: Gârda Seacă – Bihorului Mountains, Poieni - Metaliferi Mountains, Abrud - Metaliferi Mountains, Brădești – Trascău Mountains, Vulturese – Muntele Mare Massif, floodplains and terraces of Arieș, Iara and Ocolișel.

In the Arieș hydro basin representative are the karst springs, of outlets category, fewer in number are emerges. The last are „bursts” of water that circulated under pressure (through cracks) and are characterized by highly variable flow that can achieve significant values. A single case is known within the studied basin, emerge type with intermittent flow, on simple siphon principle: Bujor ebb and flow spring (located immediately downstream of Poșaga Gorges, in Muntele Mare Massif). Here, the operation is based on the principle of communicating vessels.

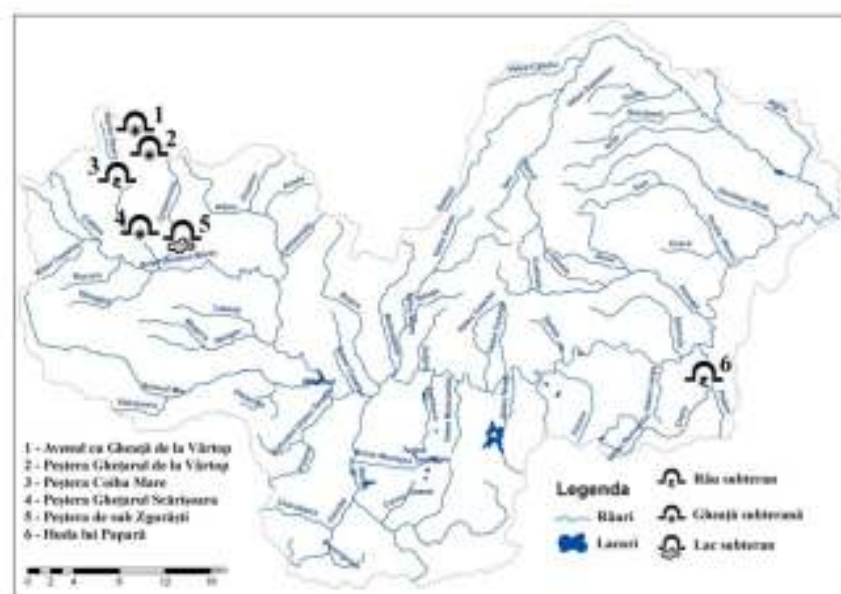
Local geological conditions, climate, hydrology, vegetation and soils, as well as the time factor occurred in the outline of underground drainage systems of storm water. The most important movement is performed in carbonate rocks (limestone and dolomite), a large

porosity, structure, texture and soluble material ( $\text{CaCO}_3$ ) that characterize them, allowing the formation of karst aquifers, hydrodynamic systems in different evolutionary stages.

Edification of major hydro karst systems in the Arieș water catchment area determined creation of underground cavities housing water bodies of underground rivers and lakes category.

Among them are detached the systems from sub-basins Gârda Seacă (Coibe – Tăuz, Zgurăști – Poarta lui Ioanele) and Cheia (Vânățara – Huda lui Păpară Cave).

The presence of underground lakes in the area of Arieș basin upstream of Buru links to the existence of important hydro karst systems. Most important regarding the presence of water retention as underground lakes is the hydro karst system Zgurăști (Fig. 4.).



**Fig. 4.** Repartition map of hydro resources from the caves related to Arieș water catchment area upstream of Buru

Essential condition for the appearance of ice deposits is the existence of negative temperatures needed for the process of freezing water and sublimation of water vapor in the cave atmosphere. During cold season, such topoclimate conditions can be achieved in entrance zone of the cavities in the area of so-called meroclimate of disturbance, where ice speleothems are formed, with temporarily character.

Particular case is the permanent storage of ice, accumulations that can reach impressive volumes (75000 mc ice block from Scărișoara Glacier Cave). The main issues raised by the presence of these formations have focused their genesis, paleoclimatic information held in ice mass, analysis of plant and animal remains to reveal the defining features of Quaternary paleomedium.

Conditions for the emergence of this true „glacial” topoclimate also meet in other cavities in the area of Arieş basin: Ice Pothole from Vârtop and Gheţarul de la Vârtop Cave.

## **CHAPTER 3. THE IDENTIFICATION OF THE HYDRO-TOURIST POTENTIAL**

### **3. 1. Types of hydro-tourist potential**

Hydro tourist potential can be identified taking into consideration several criteria, and depending on the aspect of potential, there are different types: landscaping, energetic, dynamic, of cure and relaxation. Hydro tourist potential can also be identified based on the main sources of water: under and above surface.

The great diversity of water resources and of specific attributes offers a great variety of types of relaxation and of the aspects in which it manifests itself.

### **3. 2. The touristic potential of above surface waters**

From all the hydro components that are the objective of touristic analysis, the network of surface waters prevails through the multitude and consistency of its components: rivers, lakes, swamps, solid water (snow, ice on rivers).

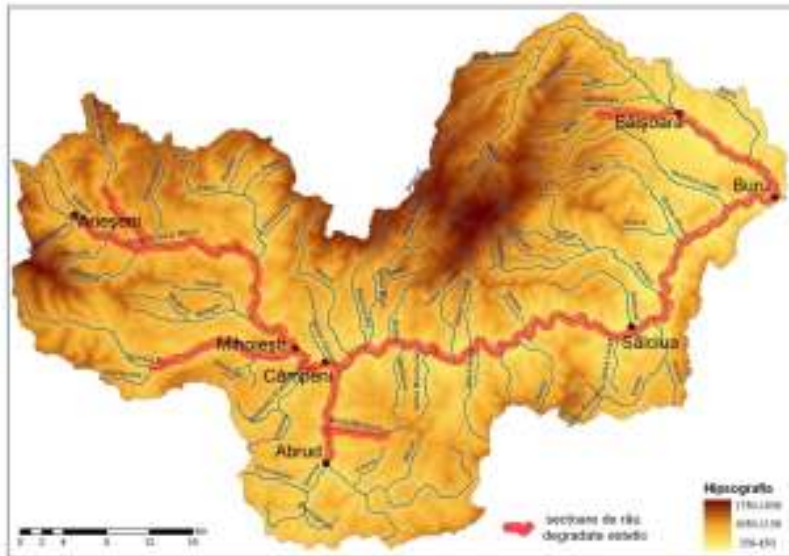
In the case of Aries water catchment area, upstream of Buru, the surface waters contribute along with those under surface at giving shape to the touristic legacy, both being in a balance. Evaluation of touristic potential of water resources must be also based on the different territorial aspects that these hydro components might have.

The identification of hydro tourist potential of the rivers’ network is based on a set of indicators – morphometric, morphologic, quantity and quality, dynamicity, biotic – which define the touristic potential of different river sectors. Quantification of these parameters will offer the possibility to shape the areas with hydro-touristic potential relevant for the whole network of rivers for Aries river basin.

The morphometric elements refer to rivers’ real components: slope, depth, width, and sinuosity. Knowing the slope and depth is the main aspect in evaluating the river sectors that can be exploited through different types and styles of touristic activities (navigation and recreation fishing, extreme water sports). Depending on these two parameters one can set limits of the favorable sectors for white-water sports (rafting, hydro-speed, canoeing, and leisure navigation).

The morphology of watercourses includes aspects related to the morphology of the longitudinal profile (sectors with sill, rapids) to the morphology of the valley in cross-cut profile (sectors of gorges or couloirs), to the morphology of rivers' bed (islands, dead channels, etc.). Correlating water resources with the touristic potential of the relief is often inevitable and necessary.

Determining the quality of water can distinguish between favorable and unfavorable water sectors for fishing as a sport, navigation, week-end tourism on river banks, moreover



**Fig. 5.** Repartition map of aesthetic degraded rivers sectors - Arieș basin upstream of Buru

taking into consideration that Aries River has sectors of accentuated degradation (metal pollution, micro-biologic pollution – due to spill – over of garbage, thus leading to the settlement of these garbage in the vegetation along river banks) (Fig. 5.).

The fish fauna that are settled in the hydrographical basin of Aries river

upstream Buru are strongly affected by the spill-over from the mine exploitations from Abrud, effects that travel on Aries river – in the sector Cămpeni-Buru- and also by uncontrolled fishing. Only on sectors not polluted by people the evolution of fish fauna is regulated by natural agents (floods, diseases, predators).

Beside the special landscape (lake scenery) lakes have a touristic potential resulted from its morphometric and morphologic characteristics, physical and chemical properties of its water and from the presence of it's therapeutically mud.

The touristic potential offered by lakes has generated various activities related to water sports, fishing and navigation.

In the Aries River basin, upstream Buru, the main category of rivers that has been identified is the anthropic one. Natural lakes have a much reduced share, being limited to two categories: lakes created by snows (Cucurbăta/Zănoaga) and karst lakes (formed in sinkholes or small karst depressions).

Tourist potential of peat swamps like the ones low in minerals, determines a particular type of polyvalent tourism, the scientific research (precious floral species, including tertiary relicts).

Swamps low in minerals and nutrients and which have peat bedding are characteristic for the mountainous structure of Muntele Mare Massif at altitudes of 1600-1700m.

Solid waters offer favorable conditions for various touristic activities, most important being winter sports. Complementary, there can be misleading elements related to some risk aspects (low temperatures, avalanches, etc.) which can reduce the touristic potential of these resources.

In relation with the impact on tourism, one can differentiate two aspects: a positive role in accommodating winter sports and a negative role associated with troubling transportation traffic. There are two forms in which solid water can be found: snow and ice.

One can find only scarce data about snow levels due to the low number of meteorological labs in the area: Roșia Montană, Băișoara and Câmpeni. In the hydro-graphic basin of Aries River, uphill Buru, it has been identified only one icefall that has the necessary parameters to be exploited in tourism because of its possibility to escalate it: Pișoia Vidrii.

### **3. 3. The tourist potential of the underground waters**

Groundwaters have a great tourist potential sustained mainly by their physic-chemical particularities, their suitability to be used water supplies for habitats, to be exploited in treating various medical affections etc.

In the Aries water catchment area upstream of Buru one can find karst springs, part of the outlets waters category, fewer in number being also emerges. The later are `bursts` of the water that circulated in a drowned state (through crevices) and are characterized by extremely variable flows which can attain high water marks. On the territory of the basin under study there is one case of such spring, of type with alternative streaming regime, with simple aeration: Bujor Ebb and flow spring (situated immediately downstream of Poșaga Gorges, Muntele Mare Massif). Here, its functioning is based on the principle of communicating vessels.

As peculiarity and without a scientific explanation regarding the water temperature there is the resurgence situated in Gârda Seacă meadow, on its right shore, in the vicinity of the intermittent spring from Cotețul Dobreștilor. According to the hydrological studies carried on by Iancu Orășeanu (1996), this spring is sub thermal, recording temperatures of

+17°C. More curiously is the fact that karst drainages close by, such as Cotețul Dobreștilor and Morii Spring, have normal temperatures for these areas: +8°C (Table 1.).

**Table 1.** Springs from Arieș water catchment area, upstream of Buru

Nr. crt.	Spring	Location		Hydro typology	Special mentions
		Massif	Catchment basin		
1.	Gura Apei spring	Bihor Mountains	Gârda Seacă	resurgence	Gârda Seacă's spring
2.	Tăuz spring	Bihor Mountains	Gârda Seacă	resurgence	500 l/s annual mean discharge; vauculian
3.	Cotețul Dobreștilor spring	Bihor Mountains	Gârda Seacă	resurgence	vauclisian
4.	Cald (Feredeui) spring	Bihor Mountains	Gârda Seacă	emerge	sub thermal: +17° C
5.	Vulturului spring	Bihor Mountains	Gârda Seacă	resurgence	
6.	Morii spring	Bihor Mountains	Gârda Seacă	resurgence	Ocoale karst system
7.	Valea Cerbului spring	Metaliferi Mountains	Abrud	outlet	
8.	Valea Dolii (Morii) spring	Metaliferi Mountains	Pleșcuța	resurgence	drinkable
9.	Feredeui spring	Muntele Mare – Gilău Massif	Poșaga	outlet	
10.	Bujor spring	Muntele Mare – Gilău Massif	Poșaga	outlet	Ebb and flow spring
11.	Șipote spring	Trascău Mountains	Arieș basin	outlet	

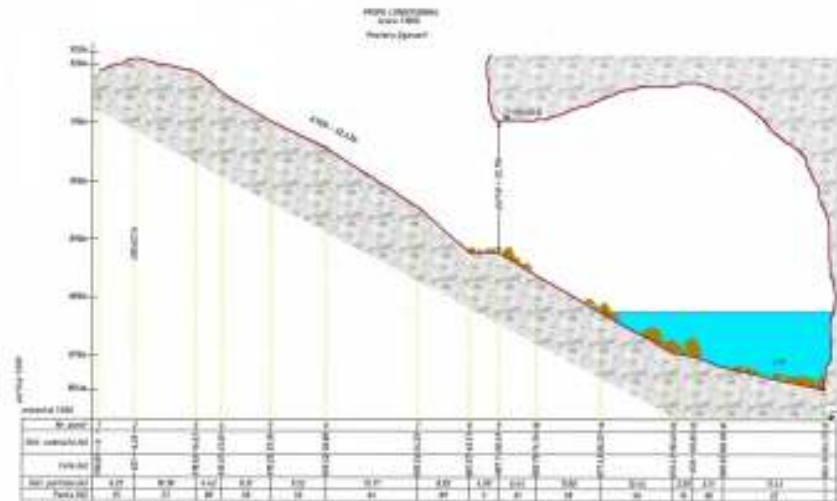
Through these two hydro entities, the subsurface domain gives shape to the tourist offer of Arieș River basin upstream of Buru. The morphometric, morphologic, quantitative, qualitative, dynamical and biotic indicators offer, as in the case of surface waters, valuable and needful instruments in order to characterize and evaluate (for a possible touristic exploitation) the subsurface rivers and lakes.

The investigation of these resources had as scope the identification of hydro karst systems that are developed enough to be able to host such resources. Thus, the most relevant subsurface rivers and lakes can be found in hydro karst systems Vânătoră - Huda lui Păpără, Coibe – Tăuz, Ocoale – Cotețul Dobreștilor și Zgurăști – Poarta lui Ioanele.

By analyzing the hydro karst systems there have been identified more subsurface rivers partially or totally accessible through their network of excavations: Bulz underground river

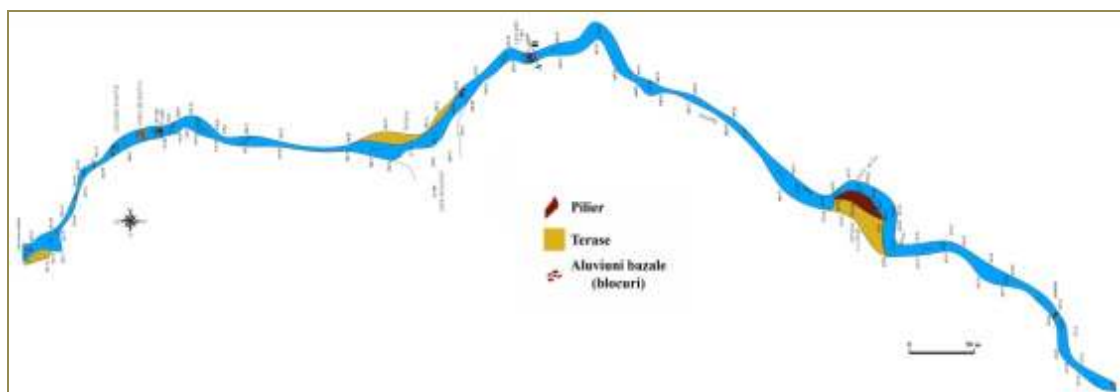
(Huda lui Păpară), Coiba (Coiba Mica - Coiba Mare), Activul de Vest (Hoanca Apei Cave), Dârninii (Dârninii Cave), Șesuri (Șesuri Pothole) and Huda Orbului (Huda Orbului Cave).

Personal analysis focused on the Bulz underground stream of Huda lui Păpară and Zgurăști Lake located at the entrance zone of Ghețarul de sub Zgurăști Cave. For this approach were drawn maps from surveying (Fig. 6.).



**Fig. 6.** Underground Zgurăști Lake (N-S side elevation)

Topographic measurements made with the total station allowed drawing a map of the Bulz underground course of Huda lui Păpară (a length of 986.57 m), capturing the most relevant morphological and morphometric features (Fig. 7.).



**Fig. 7.** Map of Bulz underground stream from Huda lui Păpară (unevenness: +54,9 m; length: 986,57 m)

The touristic potential of subsurface lakes is given essentially by their original placement. Their charm is heightened by the morphology of the cave system and also by their own valences: an accentuated transparency of water. Tourism for leisure represented by



navigation and the polyvalent one (scientific research and exploitation) 'vindicate' the exploitation of these natural resources.

The largest subsurface lakes are located in caves from Gârda Seacă basin: Ghețarul de sub Zgurăști, Hoanca Apei, Huda Oilor, Coiba Mare.

Ice formations can take shape in the entrance zone of any cave in the area under analysis as long as there is a continuous source of water (percolating water) and the temperatures are below freezing point, the so-called percolating microclimate. The density, extensiveness and typological diversity are exceptional in three caves: Ghețarul Scărișoara Cave, Ghețarul de la Vârtop Cave (also named Wondrous Cave) and Ice Pothole from Vârtop (Table 2.).

**Table 2.** Tourism potential of caves with ice deposits from Arieș water catchment area, upstream of Buru (Gârda Seacă)

Cave	Location	Ice deposits		
		Speleothems		Ice blocks
		drip	gravitational trickle	
Ghețarul Scărișoara Cave	Bihor Mountains – Ocoale-Scărișoara	x x x	x x	x x x
Ghețarul de la Vârtop Cave	Bihor Mountains – Vârtopaș Massif	x x	x x x	x
Ice Pothole from Vârtop	Bihor Mountains – Vârtopaș Massif	x	-	x x

x x x – great potential; x x – important potential; x – limited potential

The characteristics of ice formations depend on the specifics of each cave: elevation of the entrance, slope exposition, dimension of cave network, unevenness, micro-crevices of limestone deposits, underground morphology. According to these agents the morphometric and morphologic elements of ice formations present a great diversity leading to a various type of tourist potential.

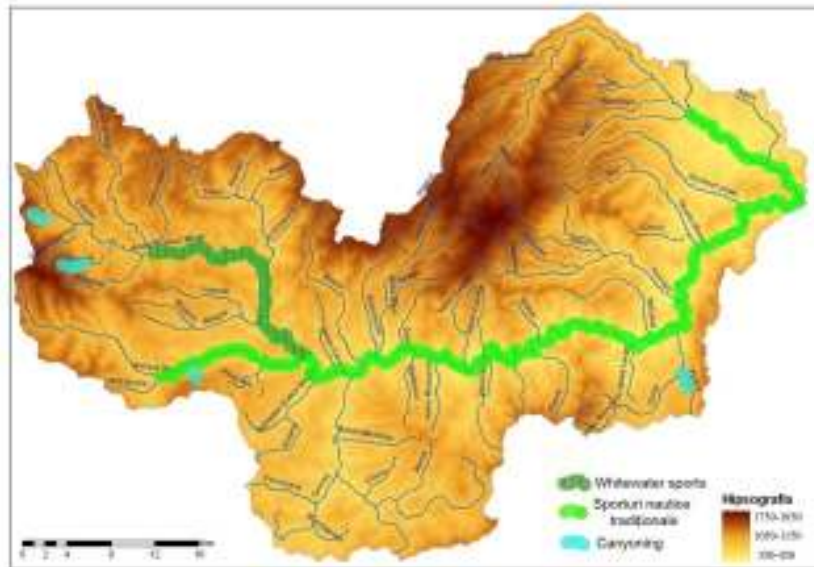
## CHAPTER 4. TYPES, FORMS AND TOURIST ACTIVITIES INDUCED BY THE WATER RESOURCES

### 4. 1. Types, forms and tourist activities induced by rivers

Rivers' water resources offer a high touristic potential, sustained by their various possibilities of exploitation and also by the way in which they can be integrated in a

territory's tourist offer (Băținaș, Sorocovschi, 2011). There are diverse types of tourism allocated to the three main types (leisure, cure and polyvalent), to which there can be associated a whole line of specific activities (Fig. 8.).

Of all the rivers from Arieș river basin, upstream of Buru, only Arieș River and the inferior sectors of Iara, Abrud and Arieșul Mic can host tourist activities of leisure and recreation. Fishing as sport, with all its aspects (stationary and dynamic) is privileged by the virgin areas (not touch by people) and it is to be found on the upstream sectors of Arieș and on some branches (excepting Abrud).



**Fig. 8.** Distribution map of the water sports in the Arieș water catchment area, upstream of Buru

#### **4. 2. Types, forms and tourist activities induced by lakes and swamps**

Although at a theoretic level is a great similarity between touristic forms and their associated activities generated by rivers and lakes, the touristic offer related to lakes from Arieș' basin uphill Buru is extremely modest. Somewhat relevance is presented by the lakes from Rosia Montana, these lakes being able to generate activities connected with fishing as a sport and tourism for treatment.

Bogs with the predominant species of Sphagnum family, and also marshes without peat bedding from the Muntele Mare – Gilau Mountains, generate activities from the area of polyvalent tourism. Scientific interest is due to valuable floral species, with peculiar fitogeographic importance (endemic species, tertiary relicts).

#### **4. 3. Types, forms and tourist activities induced by solid water resources**

The landform and climate conditions of the studied area are favorable to forming the two forms of solid water (snow layer and ice) which represent the frame for developing

tourist activities. Among the types of tourism related to these resources we can find the recreation and leisure and the multipurpose one.

In the Arieș basin, upstream of Buru, the areas propitious for the accumulation of the snow layer are represented by the high mountain masses from the middle side (Muntele Mare - Gilău) and from the western area (Bihor Mountains). The high altitudes (1826 m in Muntele Mare and 1849 m in Bihor Mountains), the rich solid precipitations and the low temperatures from winter, ensure the best parameters for the snow layer (thickness, length of time, solidity, etc.).

Slopes were arranged in different lengths and degrees of difficulty with infrastructure facilities, allowing tourists' access to points of interest. In Muntele Mare - Gilău Massif there are two mountain resorts - Buscat and Băișorii Mountain and in Bihor Mountains, also two - Vârtop-Arieșeni and Ghețarul – Gârda de Sus.

The facilities of the Ghețarul – Gârda de Sus ski area, cumulative length of runs will be close to 5000 m, value that will hold the record compared to other resorts. Currently, the largest flow of tourists is known about complexes Buscat - Băișorii Mountain and Vârtop - Arieșeni resorts.

The degree of favorability for the establishment of a mountain resort is high for northern and western sectors. If the only criterion for analysis is the climatic factors, favorability decreases from west to east, with diminishing rainfall.

As concerns the frozen waterfalls, the morphology-hydrology-climate complex is poor. The only identified waterfall is Pișoaia (Vidrii) from the Arieșul Mic basin.

#### **4. 4. Types, forms and tourist activities induced by underground waters**

The groundwater resources include the normal and deep aquifers or a particular form of these: the subterranean rivers and lakes. These aquifers are discharged by springs whose physical- chemical properties can offer many usage possibilities. As a spectacular and particular form we remind the perennial ice accumulation from some caves of the Arieș basin, upstream from Buru. However, due to the difficult access to touristic enhance, by positioning them underground, the normal aquifers offer few opportunities. If the therapeutically value of the mineralization is proven, the curative tourism can be practiced either through technological aid (drilling) or through natural springs adjoining touristic structures. The types of tourism resulted from these resources cover the whole typological spectrum: recreation and leisure, curative and polyvalent.

The caves from Arieş basin offer a large number of recreation and leisure activities: cave-diving, cave-tubing, cave river trekking, swimming (free or in apnea), etc.

## CHAPTER 5. THE EVALUATION OF THE TOURIST POTENTIAL OFFERED BY THE WATER RESOURCES

### 5.1. Methodological aspects

A first step in approaching the subject is to detect those areas which present the most favorable qualities for developing the above mentioned activities. Concerning the rivers, it will be used to outline the relevance of tourism morphometric, morphological, quantitative, qualitative, dynamic and biota indicators.

*The morphometric indicators* include elements that define the spatial extension of the analyzed hydrographic entities: length, width, depth and slope.

*The morphologic indicators* fully synthesize the attractive aspects of the water course: rapids, steep slope, waterfalls, cataracts, gorges, defile, river mouth types, etc.

The longitudinal profiles in steps or counter- slope give an accelerated kinetics to the water body which open the way for practicing “whitewater sports”. The collocation stands for nautical sports such as canoeing, kayaking, rafting, hot-dog, canyoning, hydro speed.

*The dynamic indicators* refer to speed, currents, waves and tide. A series of dynamic phenomena are produced in the riverbed. The instability of these phenomena – speed and level changes, currents, flow capacity – depend on the changes of the climatic and morphologic elements of the riverbed and on the water flow regime.

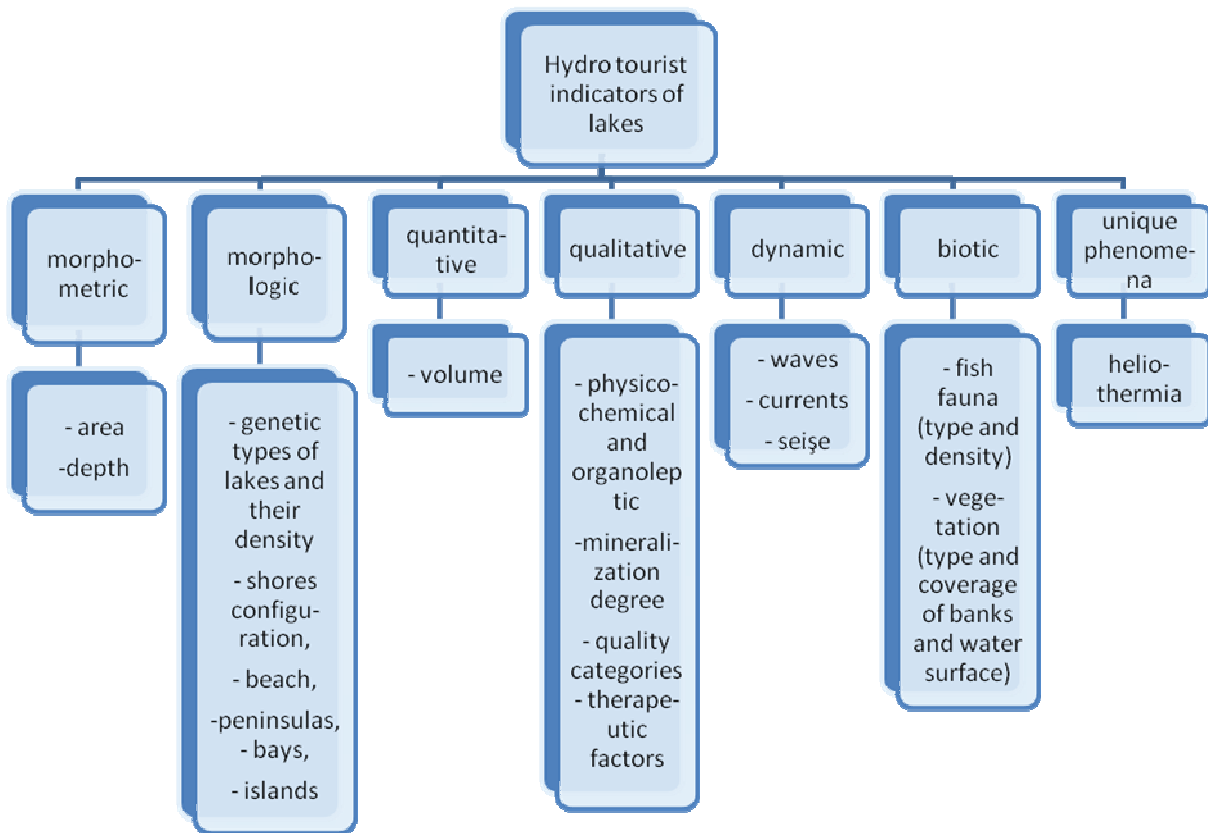
*The biotic indicators* express the touristic potential offered by the biota specific for the rivers: fish fauna and vegetation. The following are also taken into consideration: the type and density of the fish fauna, the type and coverage degree of river banks with vegetation.

*The quantitative indicators* refer to the liquid, solid and chemical flow capacity. Mean annual flow and maximum seasonal flow will be taken into consideration to see if some river sectors can be used for tourism purposes in order to practice whitewater sports. The solid flow is a restraining factor for practicing these sports.

*The qualitative indicators* refer to the physical- chemical and organoleptic properties and also to the quality categories.

Lakes individualize themselves in the landscape more strikingly than the hydrographic network. The touristic value is tightly related, to a great extent, to their origin. Their touristic

individualization is outlined by a series of attributes connected to fishing, canoeing, swimming, landscape and curative possibilities (Fig. 9.).



**Fig. 9.** Hydro tourist indicators of lakes (after Sorocovschi, 2007)

Like for the rivers, the tourist potential offered by the lakes can be assessed by morphometric, morphologic, quantitative, qualitative, dynamic and biotic indicators.

When we speak about solid water we refer to the snow layer and the frozen waterfalls. In order to analyze the first form of manifestation the following parameters are taken into consideration: morphometric (thickness, surface), morphologic (stratification, granulation), qualitative (density, solidification degree) and also temporal (length on time of the snow layer).

The groundwater manifestation has specific forms, materialized on the surface (ebb and flow springs and permanent springs) and underground (streams, lakes) with all its attributes is taken into consideration.

The underground flow gives dynamic to the cave environment, amplifying the majesty of this phenomenon. These tempestuous rivers, with their longitudinal profile, with numerous

breaks of slope and important oscillations of level, represent daringly exploitation attempts, and sometimes a support for leisure tourism, even in extreme forms - black water rafting. Joining leisure and recreational tourism – like trekking (in the mountain area) – with its water resources can determine a new touristic form of exploitation: cave river trekking. This form can be extremely selective if the underground course requires the usage of different techniques: navigation, swimming, cave climbing, apnea swimming, free climbing, etc.

The hydro tourist indicators of water course aim at elements connected to morphometry, morphology, dynamic and flow discharge.

## 5.2. The evaluation of the hydro-tourist potential of the Aries basin upstream Buru

In order to evaluate and make a hierarchy of the water resources from the hydrographical basin of Arieş, upstream from Buru, the analyzing tree method based on criteria and under criteria has been used. The level of appreciation has been given through a weighting process of a total of 100 points (Bătinaş, 2008). The score has been given to each resource after estimating the touristic valence generated by the characteristics of each hydro tourist indicator: morphometric, morphologic, quantitative, qualitative, dynamic and biotic.

According to the detailed analysis regarding the characteristics of each hydro entity from chapter 3, the following score has been established: surface water – 60 points and underground water – 40 points (Fig. 1).

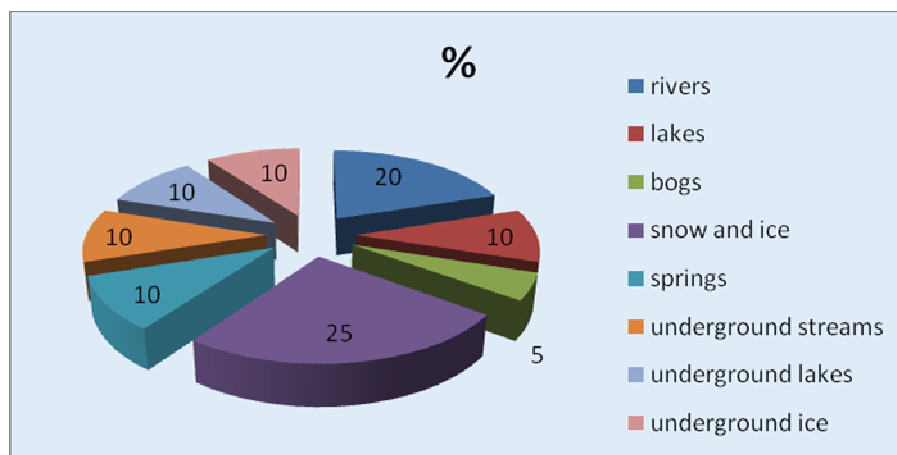


Fig.1. Percentage share of the water resources in order to evaluate the hydro touristic potential form the Arieş basin, upstream from Buru

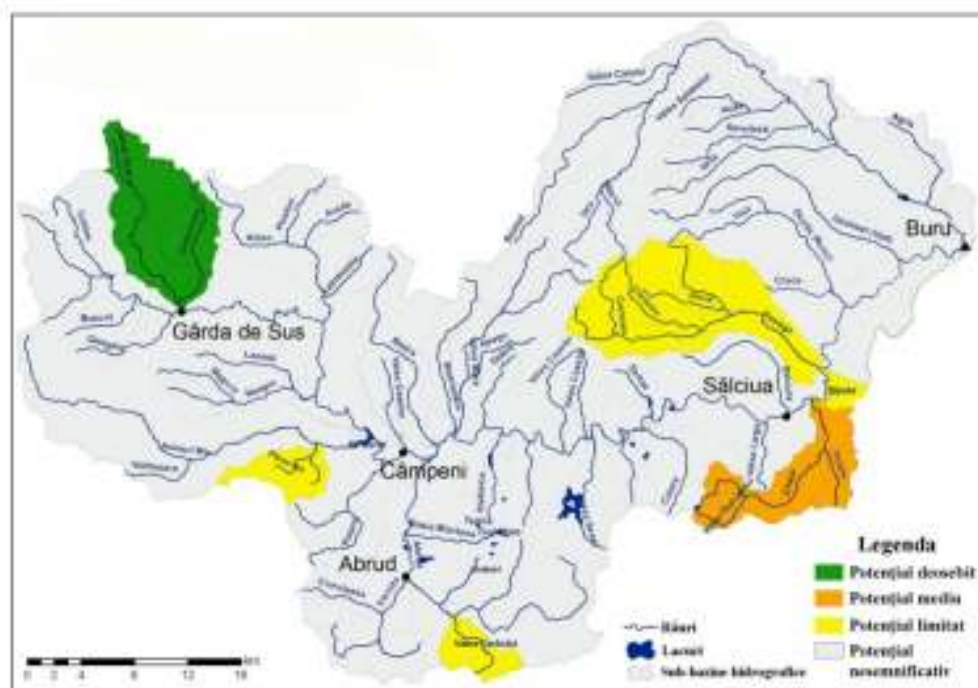
The following percentage shares are for the surface waters: 20 points for rivers, 25 points for solid water (snow layer and ice), 10 points for lakes and only 5 points for swamps.

As for the groundwater a perfect balance between the resources that form this category (rivers, lakes, ice and springs) was estimated: 10 points.

The surface waters from the analyzed basin represent a high touristic potential. The 60 points value out of all the resources is justified by the parameters of the hydro tourist indicators used in the assessment of the touristic potential. The differentiation and the ranking of these resources had as a basis common assessing criteria materialized by a series of specific indicators.

The specific hydro resources of the surface waters typical for the Arieș basin, upstream from Buru are the water courses, lakes, swamps, snow layer and ice. The touristic potential of ice is given by the characteristics of the formations that can occur on the riverbed section (frozen waterfalls) or ice bridges on the surface of rivers or lakes.

In order to evaluate the groundwater hydro touristic potential, the differences of manifestation in time and space were taken into consideration. This led to two different categories: springs – surface and underground forms – rivers, lakes and ice deposits (speleothems and ice blocks).



**Fig. 11.** Repartition map of tourist potential associated with groundwaters from Arieș water catchment area, upstream of Buru (taxonomic sub-basin units)

The ranking had as a basis common assessment criteria, under the form of some specific indicators of the water resources: morphometric, morphologic, quantitative and

qualitative indicators. For the groundwater, the position related to the terrestrial surface and the manifestation form (springs, underground accumulation in cave spaces) was taken into consideration (Bătinaş, Sorocovschi, 2011).

The score given to different water type resources was established after the assessment of the tourist valences generated by each resource. Thus, the highest importance was attributed to the cave water resources – rivers, lakes and underground ice – (30 points), followed by springs (10 points). In the first group dissociations were made. These dissociations were imposed by the character of the springs (ebb and flow and permanent), water temperature (cold, sub-thermal), the degree of mineralization, the artesian character, debit and areal density (Fig. 11.).

The group represented by the water courses and the underground lakes has as hydro touristic indicators elements similar to the aquatic units which are developed on the surface: morphometric, morphologic, quantitative, dynamic and biotic indicators.

### **5.3. The impact of human activities on hydro tourist resources**

Although the concept of impact is usually associated to negative sense, there is also a positive connotation, consequence of the integration of scientific and technical achievements due to evolution of human society.

In the Arieş hydro basin upstream of Buru, positive impacts are determined by a series of measures to conserve, restore and capitalization of hydro tourist resources:

- *Protecting representative natural areas*
- *Improving the quality of the environment*
- *Increasing attractiveness*
- *Infrastructure improvement*

Structure, quality and quantity of hydro tourist resources may be threatened or undermined by the negative impacts. The most significant are:

- *Underground water pollution* is a consequence of rapid water movement through karst aquifer, chances of chemical transformation or microbial degradation are reduced.

- *Visual pollution (aesthetic)*. The first visual impact in a confrontation of tourist „supply and demand”, that has as object of concern surface and subsurface river and lakes, is given by the presence of floating waste crowded in narrow sectors. Also the existence of unnatural scents and inadequate water color, chase away potential tourists.



- *Waste disposal*. The activities of local communities can generate in the absence of waste collection points enormous damage to the aquatic environment.

## CHAPTER 6. POSSIBILITIES TO EXPLOIT THE TOURIST POTENTIAL OF WATER RESOURCES

### 6. 1. Possibilities to exploit the hydro -tourist potential of the underground stream from Huda lui Papară

To classify the underground river for *cave river trekking* practice were analyzed the values of hydro tourist indicators, the most relevant being the morphometric, morphological and quantitative indicators.

According to the classification system proposed for underground courses in the preceding section, the river from Huda lui Papară cave is coded as 3 RC III for *cave river trekking*, the other form - *cave tubing* – being recommended on quasi-horizontal sectors (Fig. 12.).

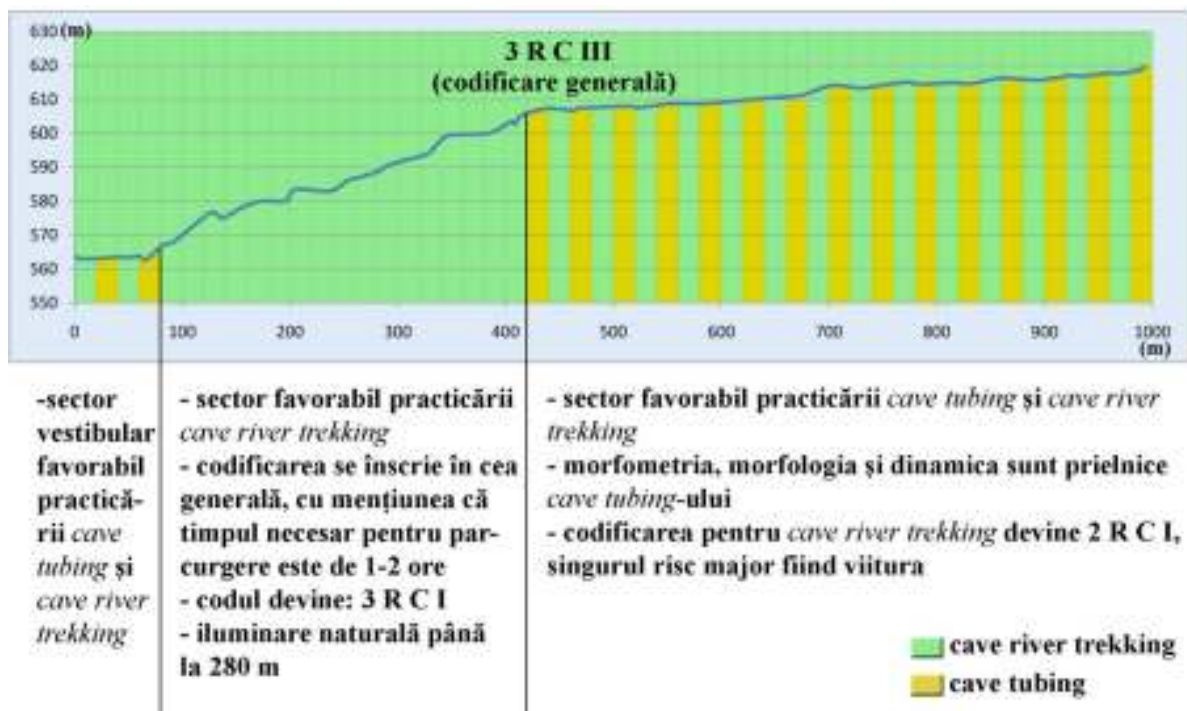


Fig. 12. Coding of underground river from Huda lui Papară Cave for practice of *cave river trekking* and *cave tubing*

The tourism practiced on such underground courses is rather selective and falls under the polyvalent with its specific forms – expeditions and explorations, scientific - , but also has

recreational and leisure connotations. For possible valorization of hydro tourist potential of underground river of Huda lui Papară Cave is proposed underground trekking (trekking river), a form that combines the techniques TSA, canyoning, swimming or covering the quasi-horizontal sectors of the cave, all under speleological spectrum.

## **6. 2. Possibilities to exploit the hydro -tourist potential of the underground lake Zgurăști**

Thanks to unusual location and that is at maximum level, the largest underground lake in the country, its touristic valorization would complete the offer, however valuable, of the Gârda Seacă water catchment area: Ghețarul Scărișoara Cave, Poarta lui Ioanele Cave, Pojarul Poliței Cave, Tăuz Spring, Cotețul Dobreștilor Spring, Ghețarul de la Vârtop Cave, Coiba Mare Cave, etc.

The main tourist activity you can develop on Zgurăști Lake belongs to the sphere of recreational and leisure tourism: navigation with light boats, inflatable. The charm of these activities is enhanced by the grandeur of the Entrance Hall – pothole entrance – fog produced by air ionization found at the entrance of pothole, underground morphology.

## **6. 3. Possibilities to exploit the hydro -tourist potential Vânățara waterfall**

Waterfalls are set as milestones in the landscape of a tourist area, especially the landscape it creates, but also beneficial to the mental state induced to the viewer.

Vânățara Falls is located on the flanks of the antithetical step developed to the north of karst depression Vânățara – point of loss of the valleys Poieni, Ponor and Valea Seacă.

Tourist valorization of the waterfall can be done by canyoning, recreational sports activity that combines alpine caving techniques (TSA), swimming, jumping. Arranging the route is temporary – is done only when crossing - , and the rope and sometimes the artificial anchor, are recovered. Therefore, the detriment to the natural environment is minimal.

## CONCLUSIONS

The scientific approach of the study on the identification and evaluation of the tourist potential of the Aries basin upstream of Buru followed the specific logical steps: the identification of physical-geographical boundaries that define the area (spatial and regional subordinate elements), general features of water resources (surface and underground), identification of the tourist potential of water resources by a complex analysis of the defining elements (size and abundance) the assessment of the tourist potential by using hydro-tourist indicators (morphometric, morphological, qualitative, quantitative, dynamic, biotic), and finally, possible ways to exploit the hydro-tourist potential. For surface water courses there have been used basic data from the hydrometric stations across the basin on a monthly period between 1978 - 2008, resulting in the monthly and seasonal flow regime, monthly and seasonal coefficients of variation, characteristic data on annual flows, data on annual flow variation ( $K_{max}$ ,  $K_{min}$ ,  $C_v$ ). All these data have provided information needed to identify sectors of rivers with certain classes of annual average flow values, the quantitative hydro-tourist indicator being relevant in identifying river sections favorable to certain forms and tourist activities. Moreover, the morphometric features of the watercourses - depth, slope, width, length, degree of convolution - have provided important guidelines to identify river sectors with high potential to sustain water sports, especially those sparkling waters (whitewater sports) , data related to average annual flow and morphological features of the riverbed. Moreover, the morphological characteristics of the riverbed are those that increase the attractive force of a sector of the river and determine in particular cases, the emerging of particular forms and tourist activities: canoeing, climbing frozen waterfalls, etc. The dynamics of rivers, by characteristics of speed, waves and currents, provides the optimum framework for whitewater sports (rafting, canoeing, and kayaking). The study of the biotic component of running waters (ichthyofauna, bird population) has generated sectors favorable to tourism activities such as sport fishing (stationary and dynamic) and bird watching (bird population observation).

The lakes and swamps in the Aries basin upstream of Buru, although modest in terms of areas and volumes, still support recreational and leisure tourism activities (fishing, swimming) and polyvalent ones (professional and scientific expeditions) . Water in solid form (snow cover and ice waterfalls) has a great potential for tourism, the specific tourist activities leading to a large number of practitioners (winter sports), concentrated in three locations - Mount Baisorii - Buscat, Vârtop – Arieșeni și Gârda de Sus, with the cumulative

length of 9.5 km . The multi-criteria assessment of the potential offered by surface water clearly indicates one area with a great hydro-tourist potential - Aries valley axis – mentioning that the resorts for the mountain sports (Arieșeni, Gârda de Sus) are located in the slopes. A major drawback, in terms of hydro-tourist indicators, is qualitative one, the negative consequences referring to the aesthetic or biotic component (especially for the Ariesului sector between Mihoiesti and Buru).

Regarding the underground waters, one sought to identify the factors that generate them. Given the fact that all analyzed resources are found in areas of carbonate areas, we used their strict analysis (identification and characterization of carbonate deposits and dolomite areas, their distribution in the territory). The carbonate areas dating from the Mesozoic and Paleozoic age are well represented, four entities being outlined: the interfluvies Gârda Seacă – Ordâncușa (Ocoale - Scărișoara Plateau), Poieni Plateau, Vulturese and Bedeleului massifs. The largest is located in the limestone section of the Garda Seaca River, opposite being the area of crystalline limestone of the Vulturese Peak. The most ample subsurface karst phenomenon (host of underground water resources) and carbonate deposits have developed in the Mesozoic (Triassic and Jurassic especially), easier soluble (by a high  $\text{CaCO}_3$  content) than the Paleozoic deposits composed of crystalline limestone (partially re-crystallized). However, due to increase of bracks from these crystalline limestone, karst processes is widespread in the Poieni Plateau, proof being the numerous springs in the surrounding area. Among the categories that have been hydrological analyzed (springs, lakes, rivers and the underground ice) they are all equally highlighting the tourist potential of the Aries basin (following the evaluation method of tourism potential). Relevant aspects can be distinguished: vauculian and intermittent springs (simple intermittence), extensive underground lakes – really large underground seas, tumultuous underground rivers - with spectacular morphological features, perennial ice deposits - real paleoclimatic and paleomedium archive for the Quaternary era.

According to the analysis of the hydro-tourist indicators for taxonomic and sub-basin units, the assessment allowed the identification of some areas with a special tourist potential (Gârdei Seaca sub-basin), medium (Cheia sub-basin) and limited (Șipote, Poșaga, Valea Cerbului and Morilor Valley sub-basins).

To exploit the opportunities given by the hydro-tourist potential, some original objectives have been set: Bulz underground stream (Huda lui Papară), Zgurăști Lake (Ghețarul de sub Zgurăști Cave) and Vânățara waterfall ( Trascău Mountains).