CONSIDERATIONS REGARDING THE IMPACT OF HUMAN ACTIVITIES ON HYDRO TOURIST RESOURCES RELATED TO KARST AQUIFERS FROM ARIEŞ BASIN, UPSTREAM OF BURU

M. CIGHER[1]

ABSTRACT. - Considerations regarding the impact of human activities on hydro tourist resources related to karst aquifers from Arieş basin, upstream of Buru. The impact of human activities on hydro tourist resources related to karst aquifers from Arieş basin may have negative, but also positive effects, the antagonism being dictated by the way in which the determinants of risk phenomena and processes are implicated, with anthropogenic or natural in origin. The existence of a thin soil layer, as well as the presence of system's large entrances, pits and sinkholes type, determinate the quick pollutants transfer and contamination or aesthetic degradation of karst aquifers. Hydro tourist resources afferent to karst aquifers are accessible through caves. Hydro entities due to endokarst morphology, flow rate types and climatic factors are revealed through underground rivers and lakes, ice deposits and karst streams. The negative impact of human activities on these resources endorse pollution with series of compounds or chemical fertilizers, dejections from septic systems, residues from animal ranches and aesthetic degradation by plastic waste accumulation in openings sinkholes type. The positive impact requires protection for representative natural areas and air, water and bio-soil-lithos layer quality control. The most damaged hydro tourist resources from the analyzed basin are associated to Vânătara and Ocoale aquifers.

Key words: hydro tourist resources, pollution, negative/positive impact, karst aquifer

1. Introduction

The main consideration should be taken into account in decoding the problem is the so-called ecosystem view of the karst in which the cave is situated, represented by the karst massif in which was developed or the hydrographic basin of which belongs. Before, the caves were considered independent entities, and the

[1] *„Dimitrie Cantemir" University, Faculty of Geography, Târgu Mureş, Romania, e-mail: cighermarius@yahoo.com*

efforts made by trying to study, preserve or protect the cave were destined to fail, due to external factors intervention in the economy and the cave balance. (Moldovan, 2006).

Cave water resources, materialized though streams, lakes and ice deposits (Fig. 1.), can suffer qualitative and quantitative modifications due to human activities developed in the area. This fact results also from the hydrogeology characteristics of the carbonate areas (formed on limestone and dolomite), karst aquifers resulted from storm water depth migration (organized, as well as unorganized) being through sinkholes in direct connection with the topographic surface. Moreover, weak soil substrate allows rapid transition of percolation water. This contributes significantly to disturb, up to annihilate the natural purification processes, taking place in situations where surface water slowly penetrates the layer of soil to reach underground systems (Marin, 2002).

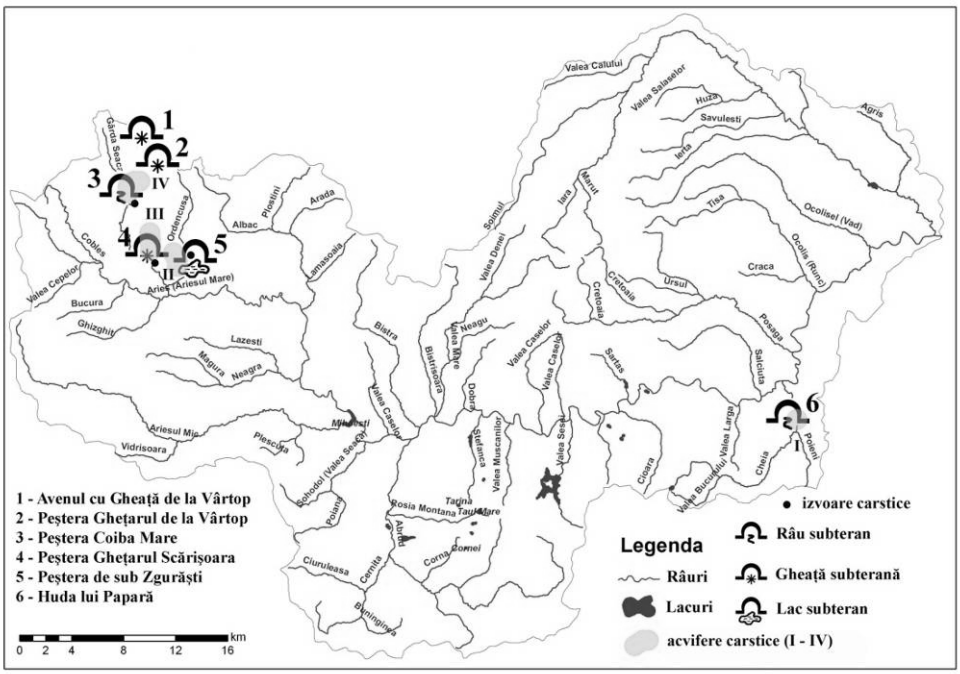

Figure. 1. Hydro tourist resources associated to karst aquifers from Arieş basin, upstream of Buru.
Karst aquifers: I, Vânătara; II , Zgurăşti; III, Ocoale; IV, Tăuz.

According to these considerations it follows the concept of an underground basin that includes both surface- and subsurface components (White, Culver, *ed.,* 2005). By associating surface water resources with defining elements of the karst

aquifer, and its discharges to surface, results a „standard model", that has different power sources: diffuse infiltration, allogene supply derived from surface courses, internal leakage (infiltrations coming from the so-called "karst windows", closed depressions such as dolina, uvala, polja).

Water that enters in the hydro-karst systems carries with it the imprint of external influences, contamination by pollutants or insoluble waste easily being accomplished through karst openings mentioned. This is a warning for possible economic management of water, although the general concept on a spring or artificially dug pit means "pure" source. This belief is generally untrue and even more irrelevant if it's applied to karst aquifers. Karst springs represent drained water outlets through systems of interconnected goals (network of cracks in which the karst aquifer water may have subterranean type storage – drowned or can be accumulated with free / aerated level). Water filtration and dilution of possible pollutants is made in a very small proportion. Karst springs must be viewed with the same suspicion shown to surface courses if we want to exploit them as drinking water.

2. Hydro tourist resources

Hydro tourist resources associated to karst aquifers from Arieş basin, upstream of Buru, are represented by springs, underground courses and rivers, ice deposits (ice blocks, ice speleothems). The main characteristics (morphometric, morphologic, dynamic, quantitative, qualitative and biotic), the manifestation character and degree of accessibility can confer the status of hydro tourist resource.

2.1. Karst springs

According to the classification proposed by the french A. E. Martel (1921), widely accepted, typology of karst springs is as follows: outlet (to appoint a karst spring whose source supply has not been detected in ground) and outflow (for a karst spring that the origin is known - the point of inflow).

Both for the two types of karst springs using local term 'izbuc'(ebb and flow spring), whether it's permanent or intermittent flow regime.

Tăuz spring is found in the median basin of Gârda Seacă, in the place named Fileşti, at the base of the right versant. The short river section, from the spring to the Gârda Seacă, about 60 m, represents the shortest river sector from Romania. The spring is located at the base of an 80 m high versant, the valley being closed. The artesian character, vauclusian type, to which is added the steep side of the valley, increases the attractive force of the spring.

Tăuz spring is part of the hydro karst system Coibe-Tăuz, a karst aquifer of lateral digression on account of which were formed a series of endo karst goals, representative for this area: Huda Oilor Cave (with underground lakes in lower galleries), Coiba Mare Cave (underground stream, we can explore a lenght of 800 m), Hodobana Cave (the largest underground labyrinth in our country). The high

flow of the spring (500 l/s, annual mean flow) is explained by the contribution of the main drain plus related secondary systems (Huda Orbului, Peştera de după Deluţ, Colibi, Sohodol).

Coteţul Dobreştilor spring is a resurgence vauclusian type that drains the waters of the karst aquifer Ocoale. This has one of the largest hydraulic heights from the whole area of the Apuseni Mountains - 450m, which explains the deep drainage and artesian nature of the karst emergence (Cocean, 2000). To high waters, caused by melting snow or heavy liquid precipitations, water is discharged also through Morii Spring that works, hereby, as overflow (located at 400 m downstream of the resurgence Coteţul Dobreştilor).

A very particular case is Cald (Feredeu) spring, emergence located near Morii spring and Coteţul Dobreştilor, on the right bank of Gârda Seacă. The spring is sub-thermal (Orăşeanu, 2010), recording a positive thermal anomaly: +17^{o}C. Deep drainage in this area, favored by cracks, could explain this phenomenon (geothermal step).

2.2. Underground rivers and lakes

Analyzing the hydro karst systems there were identified several underground rivers, accessible to all or part through the related goals network: underground river Bulz (Huda lui Papară), Coiba (Coiba Mică – Coiba Mare), Hoanca Apei (Hoanca Apei Cave), Dârninii (Dârninii Cave), Şesuri (Şesuri pothole) and Huda Orbului (Huda Orbului Cave). The most representative hydro entities from this category are the underground stream named Bulz from Huda lui Papară Cave and Zgurăşti lake located in the entrance zone of the Ghețarul de sub Zgurăşti Cave (Fig. 2.).

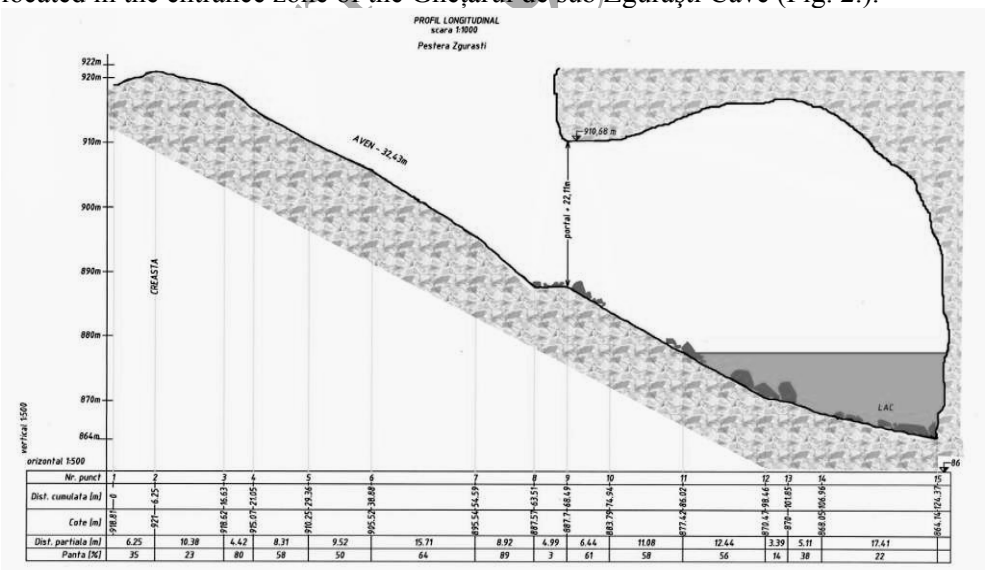

Figure. 2. Underground lake Zgurăşti (N-S profile direction)

Topographic measurements allowed drawing a map of the Bulz underground stream from Huda lui Papară Cave on a length of 986,57 m , capturing the most relevant morphologic and morphometric features (Fig. 3.).

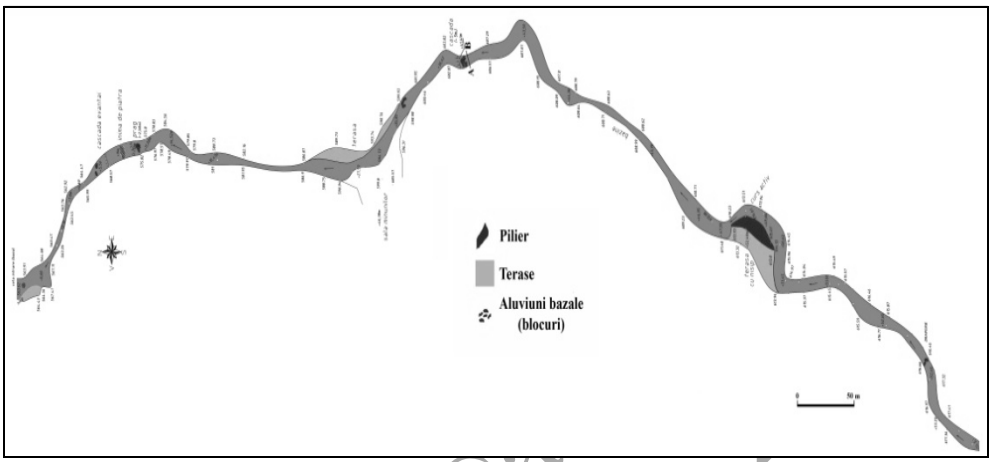

Figure. 3. Plan representation of the Bulz underground stream from Huda lui Papară Cave (unevenness: +54, 9 m; length: 986, 57 m)

2. 3. Ice deposits

Ice speleothems can form in the vestibular part of any cave from the analyzed area as long as the alimentation source maintains (percolation water) and the temperatures fall below freezing in the so-called meroclimate of disturbance. But the density, dimensional scale and typological diversity reach the exceptional in three cavities: Gheţarul de la Scărişoara, Gheţarul de la Vârtop (also called Wonderful Cave) and Ice Pothole from Vârtop (Table 1.).

Table 1. Tourism potential of caves with ice deposits from Arieş basin, upstream of Buru (Gârda Seacă basin)

Cave	Location	Ice deposits		
		Speleothems		Blocks of ice
		drip	Gravitati-onal trickle	
Gheţarul Scărişoara	Bihor Mountains –Ocoale-Scărişoara Plateau	x x x	x x	x x x
Gheţarul Vârtop	Bihor Mountains – Vârtopaş Massif	x x	x x	x
Ice Pothole from Vârtop	Bihor Mountains – Vârtopaş Massif	x	-	x x

x x x – great potential; x x – medium potential; x – minimum potential

3. Impacts induced by human activities

3.1. Positive impacts

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* requires establishment of structures that have the primary role administration of areas with special significance in terms of landscape, science, leisure.

As a major structure overlapping part of Arieş hydro basin upstream of Buru is Apuseni Natural Park, karst areas having significant weight among the managed objectives. For the protection and conservation of hydro tourist resources is necessary that the protected area should be extended to the whole area that supplies the karst aquifer that generated those resources (except cavities with ice deposits).

- *Improving the quality of the environment* contributes to attracting financial resources for monitoring the air and water quality, pollution of bio-soil-lithos layer, etc and to improve the aesthetics of the environment through landscape design, appropriate building design, tourist signs, etc (Dezsi, Ciangă, Rotar, 2002).

The most relevant project for monitoring underground and surface water quality across the analyzed basin was done in the area corresponding to interfluves between Ordâncuşa and Gârda Seacă, in Gârda Seacă basin, named „Durable development possibilities of a traditional est european region. Example: Apuseni Mountains, Romania. – Identifying the social, economic and ecological potential for a durable development". In the synthesis published by Marin C. (2002), „Surface and subsurface water geochemistry from Gârda – Gheţari – Poiana Călineasa", is shown that the main pollutants affecting underground waters are Cl^- and NH_4^+. If in the first case the incriminated factor binds to domestic discharges, in the second case is added the faeces-domestic contamination. Most resurgences and outlets, about eighteen, are in the main adjacent valleys, the only sources extensively used by local people as drinking water, being the spring from Casa de Piatră and Fântâna din Valea Iepei, although in the first case is invoked a local pollution due to, it seems, households located upstream of spring.

- *Increasing attractiveness* has a subjective substrate, but is relevant the assertion that the aesthetics of tourist facilities can cause metamorphosis of a landscape, until then monotone.

In the case of hydro tourist resources related to karst aquifers, the role of technical facilities (lighting, specific infrastructure – bridges, rails), can amplify the attractive valences as far as they take the form of structural physiognomies,

harmonized to endo karst environment, excessive artificiality harming to value.

- *Infrastructure improvement* requires upgrading or amending road, wastewater networks, etc., in order to build general and specific infrastructures involved in reducing pollution and improving environmental quality in those areas.

3.2. Negative impacts

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.

In the case of underground waters from Gârda Seacă basin (Platoul Ocoale-Scărişoara), general water chemistry does not deviate from the typical situation of karst areas that are mainly developed on carbonate rocks, predominant cations being Ca^{2+} and Mg^{2+}, and the dominant anion is HCO_3^-. The most important indicators of pollution are chlorides and nutrients, especially inorganic nitrogen species (ammonium, nitrite, nitrate).

- *Visual pollution (aesthetic)*. The first visual impact in a confrontation of tourist „supply and demand", which has as object of concern underground rivers and lakes, is given by the presence of floating waste crowded in narrow sectors of underground galleries. Also the existence of unnatural scents and inadequate water color, chase away potential tourists. Negative visual impact due to the abundance of floating or suspended waste (especially plastic), cancels to a large extent, any demarche of the tourist advantage.

- *Waste disposal* is a serious problem of these karst areas, sanitation services reaching hard the area. The activities of local communities can generate in the absence of waste collection points enormous damage to underground environment.

4. Conclusions

The most exposed karst aquifers from Arieş catchment area upstream of Buru are those located close to human communities or those which constitute a receptacle of tourism activities due to the attractive value of hydro tourist resources.

Underground water is extremely easy exposed to anthropogenic contamination due to increased fracture degree of carbonate rocks, constituting the substrate, this aspect favoring a direct link between surface and underground water. In this region, aquifers discharge is often almost instantaneous, the infiltrations do not benefit from a slow filtration to ensure chemical, biological or physical degradation of potential contaminants and attenuation of their concentrations (Marin, 2002).

Overgrazing in areas contributing to underground drainage, through infiltrations across them, lack of sewerage networks for sewage, absence of sanitation services and an ecological awareness are the main negative elements that interfere in the equation of hydro tourist resources management related to karst aquifers, the predictable result being their qualitative and quantitative degradation.

REFERENCES

1. Cigher, M., Mihalache, M., Negru, R., (2010), *Pârâul subteran din Huda lui Papară. Elemente de hidrologie subterană,* În Vol. Riscuri şi catastrofe, An IX, Vol. 8, Nr. 2/2010, Editura Casa Cărţii de Ştiinţă, Cluj – Napoca
2. Cigher, M., (2011), *Quality degradation issues regarding hydro tourist resources from Arieş catchment area upstream of Buru*, În Vol. Riscuri şi catastrofe, An X, Vol. 9, Nr. 1/2011, Editura Casa Cărţii de Ştiinţă, Cluj – Napoca
3. Cocean, P, (2000), *Munţii Apuseni. Procese şi forme carstice,* Editura Academiei Române, Bucureşti
4. Culver, D., White, W., *editors,* (2005), *Encyclopedia of Caves*, Elsevier Academic Press, Burlington, San Diego, USA, London, UK
5. Dezsi, Şt., Ciangă, N., Rotar, Gabriela, (2002), *Consideraţii privind impactul turismului asupra mediului înconjurător şi riscurile induse de activităţile turistice,* În Vol. Riscuri şi Catastrofe, Vol. 1/2002, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca
6. Marin, C., (2002), *Geochimia apei subterane şi de suprafaţă din zona Gârda – Gheţari – Poiana Călineasa*, Proiect Apuseni, Academia Română, Institutul de Speologie „Emil Racoviţă", Bucureşti
7. Moldovan, Oana, - *editor* - (2006), *Recomandări privind managementul şi monitorizarea peşterilor turistice*, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca
8. Orăşeanu I., Iurkiewicz, A., *editors,* (2010), *Karst hydrogeology of Romania*, Editura Belvedere, Oradea