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THE MORPHOLOGICAL IMPACT OF THE COLIBIȚA HYDROTEHNICAL SYSTEM ON THE BISTRITA ARDELEANA RIVERBED

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ABSTRACT. Large dams, as well as conventional hydrotechnical constructions with the role of breaking the drainage slope (waterfalls or bottom sills), flood mitigation or with the role of protection against floods (shore defences) have a profound impact on the environment. Due to these constructions, the ecosystems on the Bistrița Ardeleană river have undergone changes or even established new ones. This paper wants to highlight the morphological changes of the Bistrița riverbed by analysing the transversal profiles made between 1972 and 2015. The profiles were made in the flow measurement section at two hydrometric stations, one being located in the upstream part of the river basin and the other before the Bistrița river flows into the Șieu river. By comparing the results obtained from the profiles made before the Colibița hydrotechnical system was started or completed with the data obtained from the profiles after the commissioning of the Colibița hydropower plant, we managed to highlight that the Bistrița Ardeleană riverbed registered several negative effects in terms of morphologically both vertically and horizontally. We also found that the riverbed downstream of the dam there is a phenomenon called hydraulic paving.

Key words: morphological impact, riverbed, hydrotechnical system, large dam.

1. INTRODUCTION

1.1 Literature on the chosen topic

Hydrotechnical systems have profound implications for the environment. They change the regime of surface and groundwater, giving rise to new ecosystems, different from the old natural ecosystems. Large dams and reservoirs also have benefits such as: ensuring the retention of water volumes needed by the population, industry, irrigation or mitigating floods. (Oncia, 2003)

By building the reservoir on the watercourse, the regime and extent of downstream processes and phenomena change. The most important primary effect is the change of the hydrological regime with many side consequences. Hydrotechnical systems have an impact on infiltration, evaporation, riverbed dynamics, alluvial runoff, water quality variation, etc. Flow variation leads to wildlife stress and the disappearance of many habitats in shallow waters, which

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adversely affects the ecosystem, until its possible disappearance (Ionescu, 2001; Şerban, 2007; Uscătescu, 2013)

1.2 Location and peculiarities of the study area

The Bistrita Ardeleana River Basin has a total area of 650 km² and is located in the northwest part of Romania. More precisely, the river springs from the central group of the Eastern Carpathians, later it cut its route through the hills of Bistriţa continuously through the depression of Bistriţa. They are located in the northeast of the hilly depression of Transylvania. The hills and the depression are made up of clayey, marly, tuff formations, trapped in a crease system. (Ieleicz and Pătraru, 2005)

It is part of the Somesul Mare hydrographic system and has in its vicinity: Budac River Basin in the southern part, Sieu River Basin (where it flows) in the western part, the Bargau mountains and the Calimani mountains in the eastern part (Fig. 1).

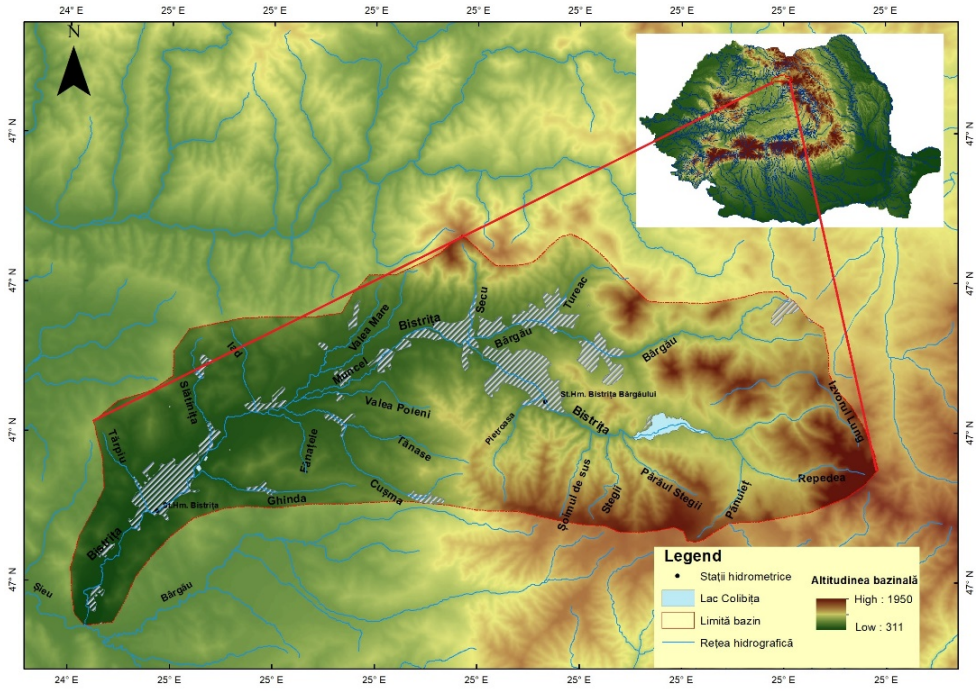

Fig. 1. ***The Bistrita Ardeleana River Basin: location, limits, hypsometry, hydrographic and hydrometric networks***

The climatic regime of the studied area is given by the effect of the polar maritime air currents from the west in the cold period of the year, with shorter transition seasons compared to those in the south of the country, and the summers warmer and quite humid. The air temperature has annual average values between 0^{o} – 2^{o} C on the mountain peaks and 9.1^{o} C in the depression area more precisely in Bistrita municipality. (Sofronie C. 2000)

The Bistrița river basin incorporates the hydrographic sub-basins: Tănase, Bârgău and Bistrița. (Tivadar, 1995)

2. DATA AND METHODS

In order to carry out the study, the annual studies at the Bistrița and Bistrița-Bârgăului hydrometric stations carried out by the Bistrița Hydrological Station within the Bistrița Năsăud Water Management System were consulted. From where we extracted hydrological, climatic and topographic data sets from 1972 to 2015.

The topographic data used in the paper were cross-sectional profiles made after the floods of 1970, a period in which there were no hydrotechnical constructions and cross-sectional profiles made after the completion of the Colibita hydrotechnical system. The profiles being used for flow measurements on the watercourse studied by us.

In order to be able to process the information mentioned above we used statistical methods and common software (such as Microsoft Excel 2013). In order to cartographically represent the studied area, we used ArcGIS 10.6 software with a license held by the Bistrița-Năsăud and Sălaj Water Management Systems where we carry out our professional activity.

3. RESULTS

We analyzed data regarding the transversal profiles measured at the Bistrița and Bistrița Bârgăului hydrometric station. The profiles being high between 1972 and 2015.

The data obtained are represented on two graphs, so that the degradation of the riverbed due to the accumulation of Colibita.

We found that the degradation of the riverbed occurred to the same extent at both locations. The highest degradation was recorded at the Bistrița Bârgăului hydrometric station in the upper position on the river, between 1972 and 1979 (Table 1).

This degradation may have been due to natural floods, the construction of the dam not being started.

When the large dam begins to take shape, the riverbed has also undergone changes in order to ensure the discharged flows rates. Following the topographic surveys in 1995, there was a rise of the riverbed compared to 1979. After 1995, the bed of the riverbed began to degrade, so in 2015 the trough was lowered by 0.24 m (Fig. 4).

At the Bistrița hydrometric station located downstream on the river, the degradation of the riverbed between 1972 and 2002 is not significant, in a period of 30 years. Let's not forget that the riverbed underwent changes in the 80's due to the constructions promoted for flood mitigation.

Table 1. ***Data on the process of degradation or warping of the Bistrița Ardeleană riverbed downstream of the reservoir lake***

Hydrometric station	Years in which the profiles were made	Extreme level mdMN (m)		The difference (m)
Bistrita	1972 - 2012	350.41	349.74	- 0.67
	2002 - 2012	350.20	349.74	- 0.46
	1972 -2002	350.41	350.20	- 0.21
Bistrita Bargaului	1972 - 1979	575.40	574.84	-0.56
	1979 - 1995	574.84	575.35	0.48
	1979 - 2015	574.84	575.08	- 0.24
	1995 - 2015	575.32	575.08	- 0.24

After analyzing the data from the transversal profile made in 2002 at 6 years after the commissioning of the Colibița hydropower plant and the profile from 2012 (Fig. 5) we found a decrease of the trough by 0.46 m in the ten years. Figure 5 shows that the profile in 2012 is 0.67 m lower than the profile in 1972.

4. DISCUSSIONS

In the river basin of Bistrița Ardeleană, two exceptional floods were registered at the Bistrița hydrometric station, the first being in 1932 when the flood had a level of 5.2 m and the second flood was in 1970 the level being 3.84 m, with a flow rate of 618 m^3/s (****).

Following the events of 1970, the decision was made to promote hydrotechnical constructions with the role of flood mitigation or flood protection.

The constructions are:

· regularization of Căstăilor brook and execution of an open collection channel in the urban area of Bistrița;

· regularization of the Bistrita river and its tributaries, as well as the defense of the upstream and downstream banks of the city of Bistrita;

· damming the Bistrița River in the downstream and upstream area of the city (**).

Also during this period, the construction of the large dam from Colibita was discussed for the first time, also was caught in the execution of the five-year plan 1976-1980. It is located on the upper course of the river Bistrita. The accumulation was made in order to ensure a reserve necessary for the water supply of the downstream localities. The realization of the investment "Colibita reservoir" was approved by the Decree of the State Council no. 239/1977 (****)

Riverbed degradation is not very spectacular, due to the 14 tributaries on both banks that contribute with alluvium to the main watercourse, during floods or in spring when high levels are recorded.

The Repedea, Șoimul de Sus and Șoimul de Jos watercourses are diverted to drain into the reservoir lake. These tributaries have the confluence with the main watercourse in the first kilometers downstream of the dam. Due to a significantly low flow that exists as a result only of runoff from the slopes, in this sector there is a process called hydraulic pavement.

The changes in the evolution of the riverbed downstream of the large dam can be observed shortly after its commissioning.

To make the graphs in figure 2 and 4 we used the transverse profiles used for flow measurements in the section of the two hydrometric stations. We failed to plot the stability of the riverbed over a longer period due to lack of information or changing location of the hydrometric station.

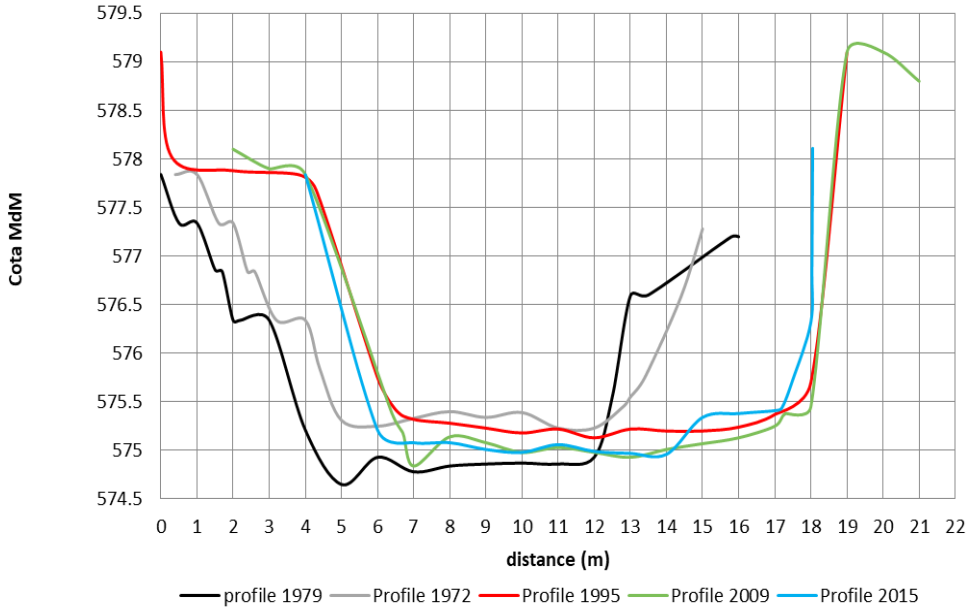

Fig. 2. ***The transversal profiles of the riverbed in the section of the Bistrita Bargaului hydrometric station***

However, in order to be able to observe the vertical trend of the riverbed without having the transversal profiles used in the flow measurements, was used minimum levels were selected during the summer and winter period.

In the case of the area studied by us, it had: a significant period of descent of the riverbed between 1902 and 1912 and a long period of relative stability between 1917 and 1931 (Diaconu, 1971).

It is clearly seen in the graph in figure 2, that the section of the watercourse at the Bistriţa Bârgăului hydrometric station, in the 70s the vertical erosion of the riverbed was favoured.

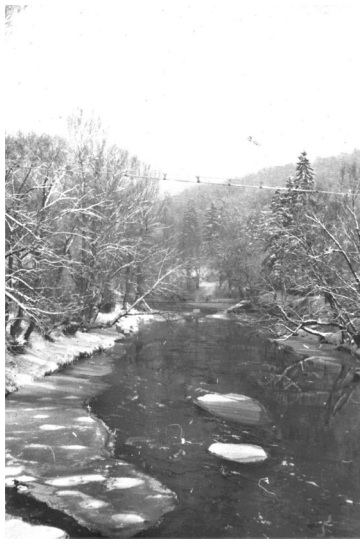

Fig. 3. ***Bistrița riverbed upstream of Bistrița hydrometric station in 1968 (*)***

Following the start of the Colibița hydrotechnical system, the riverbed underwent changes both horizontally and vertically. The riverbed was raised and the banks were reshaped. Even with these anthropogenic interventions, the riverbed continued to fall in level.

In 1972, at the Bistrița hydrometric station represented in figure 4, the vertical erosion was relatively stable as a result of the floods of 1970, we cannot say this about the horizontal erosion, more precisely of the right bank. Later, in the 1980s, investments were started on the watercourse, leading to a strong anthropization of the monitored section. Even with these investments, the riverbed experienced a vertical instability. Especially after the commissioning of the Colibita hydropower plant.

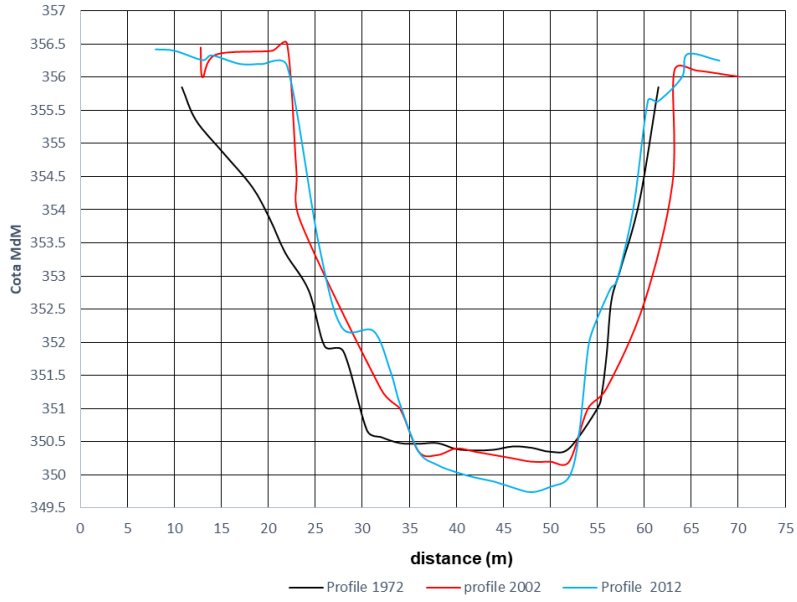

Fig. 4. ***Transversal profiles of the riverbed in the section of Bistrita hydrometric station***

No significant erosions of the horizontal and vertical riverbed were found in the studied profiles, which would endanger the socio-economic, administrative objectives, households, road infrastructure or others, but we cannot say this about the watercourse sectors that did not have human intervention.

a b

Fig. 5. ***Critical sector in a) Livezile and b) Unirea locality's in 2020***

In the localities, upstream of the municipality of Bistrița, significant bank and thalweg erosion were created. Through the erosion process of the riverbed, the alluvial material was removed to the marl layer.

Horizontal erosion of the riverbed is a pressing problem on this watercourse. This process reduces the stability of the banks, which leads to landslides or the collapse of the river banks, which can endanger agricultural lands, households, road and railway infrastructure or others.

5. CONCLUSIONS

Large dams, as well as conventional hydrotechnical constructions with the role of flood mitigation or with the role of protection against floods have a profound impact on the environment.

The hydrographic basin of the Bistrița Ardeleană river is a relatively small one, its hydropower is not significant. The role of the Colibița dam is to mitigate floods, ensure a flow for water supply to the downstream population and electricity production.

By initiating investments on the main watercourse, especially in urban areas, the morphology of the riverbed has changed vertically and horizontally, as can be seen from the data obtained by analysing the transverse profiles made at the two hydrometric stations between 1972 and 2015. The profiles made during the studied period, offered us the chance to observe the morphological evolution of the riverbed before and after the existence of the Colibița hydrotechnical system.

The effect over time of these natural oscillations of flows, but especially of the artificial ones resulting from the production of energy (with daily frequency) from the Colibita hydropower plant, is a visible one that tends to progress.

The riverbed is more intensely degraded outside urban areas due to the lack of hydrotechnical constructions (bottom sills, bank defences) that break the flow slope and encourage the phenomenon of hydraulic paving.

Even with the hydrotechnical constructions promoted in the 80s, the riverbed is more affected after the commissioning of the Colibița reservoir than before it existed.

REFERENCES

1. Diaconu, C., (1971) Rîurile României-monografie hidrologică, Institutul de Meteorologie şi Hidrologie, Bucureşti;
2. Ieleicz M., Pătraru I. (2005) Geografia fizică a României. Edit. Universitară, Bucureşti;
3. Ionescu Ş. (2001) Impactul amenajărilor hidrotehnice asupra mediului. Edit. H*G*A*, Bucureşti;
4. Oncia S. (2003), Curs Amenajări şi Construcţii Hidrotehnice. https://pdfcoffee.com/download/amenajari-si-constructii-hidrotehnice-pdf-free.html
5. Sofronie C. (2000) Amenajări hidrotehnice în bazinul hidrografic Someş-Tisa. Edit. Gloria Cluj-Napoca;
6. Şerban Gh. (2007) Lacurile de acumulare din bazinul superior al Someşului Mic. Studiu hidrogeografic. Edit. Presa Universitară Clujeană, Cluj-Napoca;
7. Tivadar A. (1995) Contribuții la istoria alimentării cu apă a orașului Bistrița. Edit. Tipomur;
8. Uscătescu M.R. (2013) Impactul asupra mediului produse de amenajările hidrotehnice de mică putere, Târgu-Jiu;
9. * Arhiva de fotografii - Stația hidrologică Bistrița. Sistemul de Gospodărire a Apelor Bistrița-Năsăud;
10. ** Planul Județean de apărare împotriva inundațiilor, fenomenelor meteorologice periculoase, accidentelor la construcții hidrotehnice și poluărilor accidentale pe cursurile de apă al Comitetului Județean pentru Situații de Urgență Bistrița-Năsăud 2018-2021 - Sistemul de Gospodărire al Apelor Bistrița-Năsăud;
11. *** Studii anuale la stațiile hidrometrice Bistrița și Bistrița Bârgăului. Stația hidrologică Bistrița - Sistemul de Gospodărire a Apelor Bistrița-Năsăud;

**** Studiu privind inundabilitatea orașului Bistrița - Sistemul de Gospodărire al Apelor Bistrița-Năsăud 1972. Sistemul de Gospodărire a Apelor Bistrița-Năsăud.