UNIVERSITATEA DIN BUCUREȘTI
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MORFODINAMICA ALBIILOR ŞI EFECTELE LACURILOR DE BARAJ ASUPRA EVOLUŢIEI RELIEFULUI

CHANNEL MORPHODYNAMICS AND THE EFFECTS OF THE RESERVOIRS ON THE RELIEF EVOLUTION

THE EFFECTS OF THE HYDROTECHNICAL MANAGEMENT ON THE BISTRIŢA RIVER CHANNEL MORPHOLOGY

Efectele amenajărilor hidrotehnice asupra morfologiei albiei rîului Bistriţa

Ioniţă ICHIM

1. Introduction

The Bistriţa river has a drainage basin of 6,952 km^2 and an average discharge of 56 m^3/s at its confluence with the Siret river. It passes through all the great units of the Eastern Carpathians, the Moldavian Subcarpathians and a part of the Moldavian Tableland. In such natural conditions, the high waters of the river, having particular effects on the river channel morphology, take place between March-June and represent 60% of the annual river flow. The river bed deposits are gravels and boulders.

The reach of interest here is between Frumosu and the confluence with the Siret river (about 160 km) (Fig. 1).

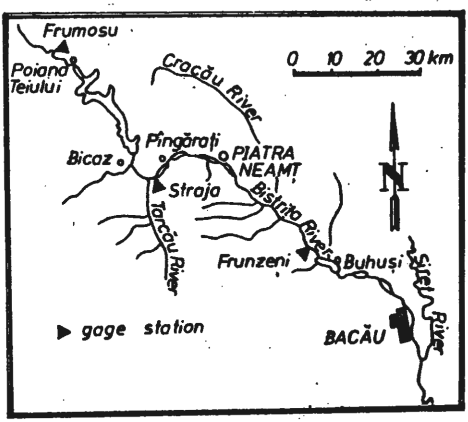

Fig. 1
General location of the channel reaches.

Below Poiana Teiului, on about 150 km, the river underwent hydrotechnical management. There were arranged: 8 reservoirs[1], 4,8 km of tunnels and 60.109 km concrete canals for hydropower stations. At the same time, downstream of Piatra Neamţ, other anthropic influences take place, such as a deforestation of the flood plain and the excavation of the river bed material (about 150,000 - 200,000 m^3/yr). These anthropic interventions radically changed the regime of the river channel dynamics. Some aspects are already known (Donisă, 1968; Ichim, Rădoane, 1982; Rădoane, 1983; Rădoane et al., 1979).

In this paper we attempt to predict the trend of the river bed elevation and the changes of the river channel unbraiding.

2. Data collection

Our conclusions are based on: geomorphological mapping; selected topographic maps, before (in 1960) and after (in 1972) the river management; channel cross-sectional surveys on the Bistriţa river channel upstream the Izvoru Muntelui reservoir (the reach temporarily flooded by the lake) and between the Izvoru Muntelui dam and Pîngăraţi reservoir; measurements of the hydraulic geometry elements in the following cross-sections: Frumosu (about 10 km upstream the Izvoru Muntelui reservoir, about 600 measurements between 1967-1982), Straja (about 12 km below the Izvoru Muntelui dam, about 300 measurements between 1974-1982), Frunzeni (about 25 km below Piatra Neamţ, about 500 measurements between 1975-1982); discharge and sediment data; water level frequency of the Izvoru Muntelui reservoir for the period 1960-1982.

3. Results and conclusions

In the present dynamics of the river channel of the Bistriţa

1. Izvoru Muntelui (V_t = 1,230 x 10^6 m^3), Pîngăraţi (V_t = 6 x x $10^6 m^3$), Vaduri (V_t = 4,8 x $10^6 m$), Bîtca Doamnei (V_t = 10 x x $10^6 m^3$), Racova (V_t = 10 x $10^6 m^3$), Gîrleni (V_t = 6 x $10^6 m^3$), Lilieci (V_t = 9,3 x 10^6 m^3), Şerbăneşti (V_t = 6 x $10^6 m^3$).

river there are two markedly different situations: 1) in which the influence of the new basic local level is decisive and 2) in which the reducing of the discharge is decisive.

1) The typical exemple of the influence of the new local basic level is the part of the river channel upstream the Izvoru Muntelui reservoir (formed in 1960). Intering into the reservoir, the Bistrița river has an average discharge of 32 m^3/s, suspended sediments of 332,000 t/yr and a bedload of 66,400 t/yr. The level of the dam-lake has a variation on a maximum amplitude of 34 m (sometimes even in one year) and the standstill at maximum levels during summer high waters; this amplifies the regressive deposition upstream the river bed. The lowest levels of the reservoir are during summer high waters; this amplifies the regressive deposition upstream the river bed. The lowest levels of the reservoir are during spring high waters, which determine a river bed scouring. Between the two extremes, the process that dominates is aggradation, which, on the first 4 km to 5 km upstream the lake is estimated at 1,5 to 2 m (medium). Because of the regressive deposition imposed by the new local basic level, the aggradation may be felt upstream. In our opinion, the tendency of the river bed elevation in the Frumosu cross-section (about 10 km upstream of the dam-lake, average discharge of 30 m^3/s, bankfull discharge of 250 m^3/s) may express such a conclusion (Fig. 2). Also, as an effect of the basic level elevation and the backwater, we noticed that for the same discharge the depth of the river raised and the velocity diminished. For exemple, at 20 m^3/s, before arrangements, the depth were 0,5 m and velocity of 0,7 m/s, after arrangements, the depth is 1,5 m and the velocity of 0,5 m/s. This is shown by analysing the exponents of the regime equations.

2) There are two situations in which the discharge reducing is decisive in the river channel evolution.

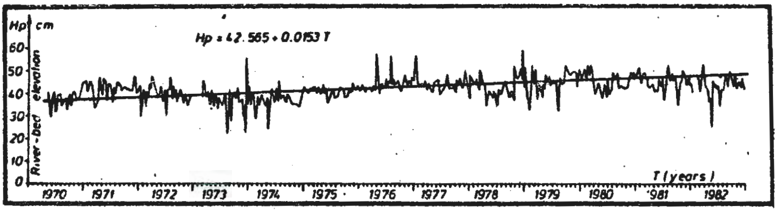

Fig. 2

The Bistriţa river bed in the Frumosu cross-section, at 10 km upstream the Izvoru Muntelui reservoir. General trend of the river bed elevation.

a) Between the Izvoru Muntelui dam and the Pîngăraţi reservoir (on about 15 km) the medium discharge of the river reduced from 40 m^3/s to 8,5 m^3/s and from 1980 to 4,5 m^3/s, because the Bicaz river was directed by a tunnel into the Izvoru Muntelui reservoir. Before the management of the Straja cross-section the bankfull discharge was about 340 m^3/s and now it is about 150 m^3/s. This determined the river channel to have a regime of underfitness.

In the first 14-15 years, there was an aggradation regime with a rate of 11 cm to 37 cm/yr in the area of confluence with the Tarcău river and the Bicaz river. The two rivers formed alluvial fans in the old Bistriţa channel. In the alluvial fan of the Tarcău river the thickness of the accumulated deposits overpasses 2,5 - 3 m. The identification of the alluvial fan may also be deduced by analysing the river bed deposits, which, before the arrangement, had elements of crystalline schists, characteristic to the Bistriţa river upstream the Izvoru Muntelui dam, and now has only typical flysch elements carried by the Tarcău river.

On the whole reach the aggradation reached of 1 m to 1,5 m on the average. After 1974 there appeared an alternation of short periods of aggradation and degradation. We may say that the river channel adjusted with the new conditions of the river flow. At the Straja cross-section (at 12 km below Izvoru Muntelui dam) the tendency of the river bed elevation is described in figure 3.

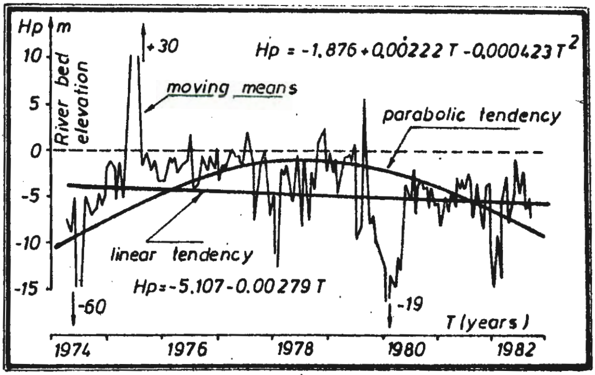

Fig. 3
The Bistriţa river bed in the Straja cross-section, below 12 km of the Izvoru Muntelui dam. General trend of the river bed elevation.

b) Between Piatra Neamţ and the confluence with the Siret river the arrangements of the river (the largest part of the water was directed by concrete canals and dam-lake for hydro-power stations) also determined a great discharge reduction in the old river channel. Before managements the average discharge was 56 m^3/s, the bankfull discharge of 450 m^3/s, after managements, the average discharge is 19 m^3/s and the bankfull discharge of 160 m^3/s (in the Frunzeni cross-section). On the other hand, there are some dam-over-flow discharge from the hydro-power systems upstream Piatra Neamţ, these have no ordered program and the dam overflow has a reduced sediment content. Under such conditions, the most important river channel morphology changes are:

- the reducing of the river unbraiding from an average coefficient of 3,22 (before management) to 1,6 (after management) (Fig. 4);

- the individualising tendency of a unitary river channel, but this proves a great instability. Thus in the Frunzeni river cross-

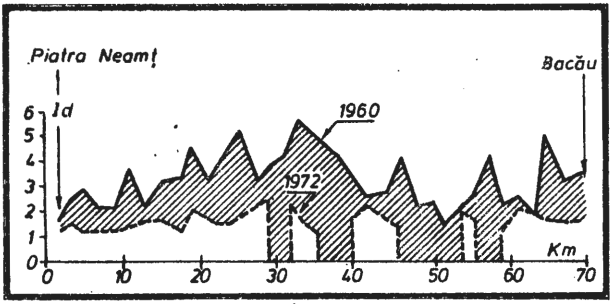

Fig. 4
Unbraiding coefficient variation (I_a) for the Bistriţa channel, between Piatra Neamţ and Bacău, before management (in 1960) and after management (1972).

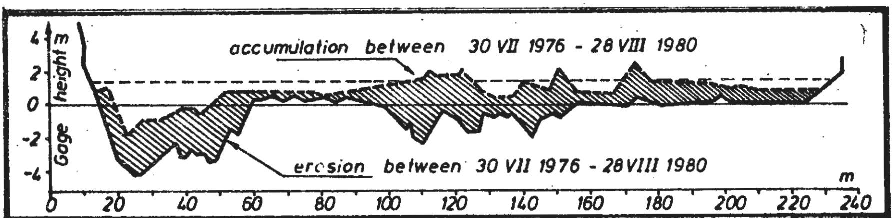

Fig. 5
The Bistriţa river at Frunzeni cross-section, 25 km downstream Piatra Neamţ. Movable river bed amplitude.

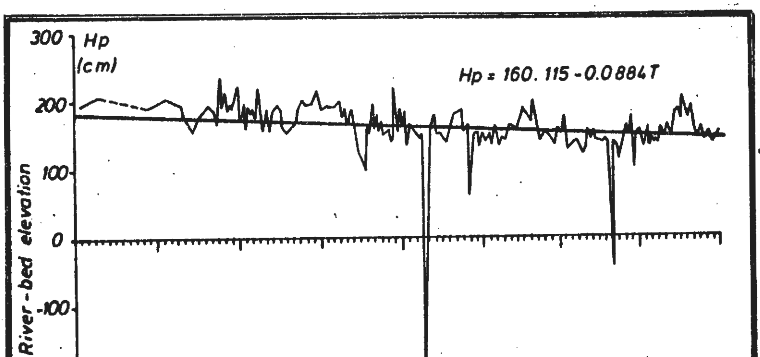

Fig. 6
The Bistriţa river at the Frunzeni cross-section. General trend of the river bed elevation.

section the great instability is proved and by the amplitude of the movable bed too, which is over 4 m (Fig. 5). On the main river channel the general tendency is of deepening (Fig. 6).

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REZUMAT

Influenţa antropică asupra dinamicii albiei minore a rîului Bistriţa se exercită în două situaţii diferite, în care: 1) noul nivel de bază local este determinant; 2) reducerea debitului este determinantă. În aceste condiţii au fost identificate următoarele tendinţe:

- colmatarea albiei minore pînă la 10 km amunte de lacul Izvoru Muntelui (după 23 de ani de la formarea lacului);

- subadaptarea albiei minore între barajul Izvoru Muntelui şi lacul Pîngăraţi şi colmatarea datorită aportului afluenţilor Bicaz şi Tarcău;

- reducerea albiilor anastomozate în aval de Piatra Neamţ, cu un coeficient mediu de 3,22 (înaintea amenajării), la 1,6 (după amenajarea şi adîncirea albiei principale).

Staţiunea de Cercetări "Stejaru"

Piatra Neamţ