Assessing the Hydro Power Potential of Bistrita River

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Abstract: *The aim of the paper is the study of the Bistrita River from the point of view of water. It proposes a linear representation of the specific synoptic potential and graphical representation of water cadastre. The calculation is done on each sector and it follows the steps: sector fall, average flow per sector, theoretical power sector, theoretical energy sector, sector length, specific theoretical linear potential of the k sector and the specific power. Using specific software for the representation of the theoretical linear synoptic potential and analyzing the water cadastre representation, one can notice that the maximum amount of hydro power potential is achieved on one specific sector. Therefore, it is most suitable for hydropower facilities.*

Keywords: *River, potential, energy, evaluation, flow, cadastre, power*

1. Introduction

Use of water energy purposes is known for thousands of years. An approach to investment in the field of renewable resources, selecting locations favourable energy applications is done taking into account certain criteria that include technical, economic and environmental conditions and restrictions.
The main selection criteria are as follows [1]:

- renewable energy potential of the energy source in the area of interest;
- concrete conditions of the terrain: morphology, roughness, obstacles, the nature of the terrain;
- proximity to human settlements;
- nature reserves, historical areas, archaeological tourism;
- special highlights: prohibited areas, civil/military airport, goals of special telecommunications;
- the existence and condition of access roads;
- conditions of use of the land: the legal regime, the concession/purchase;
- connection possibilities to the power grid: power distance, etc.
- potential investors in the area
- potential auto-manufacturers in the area
- the possibility of a public/private partnership
- technical-economic indicators performance in selected location.

The aim of the paper is the study of the Bistrita River from the point of view of water.
It proposes a linear representation of the potential specific synoptic and graphical representation of water cadastre.
Theoretical linear potential of water courses represent the maximum energy that can be obtained on the river Bistrita (or on a particular sector), without taking into account the losses which arise from transformation of hydraulic energy into electricity.
Considering the great lengths of water courses for the interests of potential values, dozens or even hundreds of kilometres, the calculation is done on the sectors [2].
Evaluation of linear potential joins two graphics:
-synoptic representation of linear theoretical potential, p,
-land-or water-power profile, where on the same graph are depending on length [3].

2. Method and research

For study it was selected the River Siret, Bistrita [4]
This river springs from Rodna Mountains in Maramures County, flows through the Eastern Carpathians, then passes through the towns of Bicaz, Neamt, Stone Roznov, Buhuşi and Bacău to spill in the Siret River near the town.

- *Geographical data*

The Iezerul Mare river mouth area: Bistrita, Rodna Mountains
From its source elevation: 1649 M.A.S.L. (metres above the sea)
Emissary: Crafty
Elevation: 134 M.A.S.L.
Coordinates: 49 ° elevation 29 ' 28 "N 26 ° 59 ' 13" E
Point of bloodshed: Gălbeni
Difference in elevation: 1515 m

- *Hydrological data*

Reception basin: 6400 km

- *General data*

Traversed counties: Maramureş, Suceava, Neamţ, Bacău
Location: Romania
Isometric view of the river requires four sizes:

- profile of the river in long-odds corresponding to the characteristic sections, Z;
- flow characteristic in sections, Q;
- linear theoretical potential, p;
- theoretical power limits for each sector-specific basis, as the sum of the powers of the sectors between that limit and the upper limit of the river.

Bistriţa River is considered to be in respect of which there are 7 sections:

- flow-module Q,
- Z shares black sea level and
- the lengths it toward the downstream section located at the end of the river.

For the calculations shall be attached to the current sector index k, the same as that of the upstream which confines, where: k = 1, n – 1.

The calculation is done on each sector and it follows the steps below:
1) sector fall, ΔZ_k

$$\Delta Z_k = Z_k - Z_{k+1}[m], \tag{1}$$

2) average flow per sector k,

$$Q_k^- = \frac{Q_k + Q_{k+1}}{2};[m^3/s] \tag{2}$$

3) theoretical power sector k,

$$\Delta P_k = 9.81 \cdot Q_k \cdot \Delta Z_k;[kW] \tag{3}$$

4) theoretical energy sector k,

$$\Delta E_k = 8760 \cdot \Delta P_k;[kWh] \tag{4}$$

5) sector length, k

$$\Delta L_k = L_k - L_{k+1};[km] \quad (5)$$

6) specific theoretical linear potential of the k sector ,

$$p_k = \frac{\Delta P_k}{\Delta L_k};[kW/km] \quad (6)$$

Finally, there is calculated the specific power:

$$e_k = \frac{\Delta E_k}{\Delta L_k};[kWh/km] \quad (7).$$

3. Results and interpretations

3.1 Data of river sections

Bistriţa River is considered from Fig. 1. Share course through 7 sections in the sectors.
Its boundaries are numbered as follows:

1-section upstream; 7-section downstream, 2 ... 6-intermediate sections that divide the river into sectors.

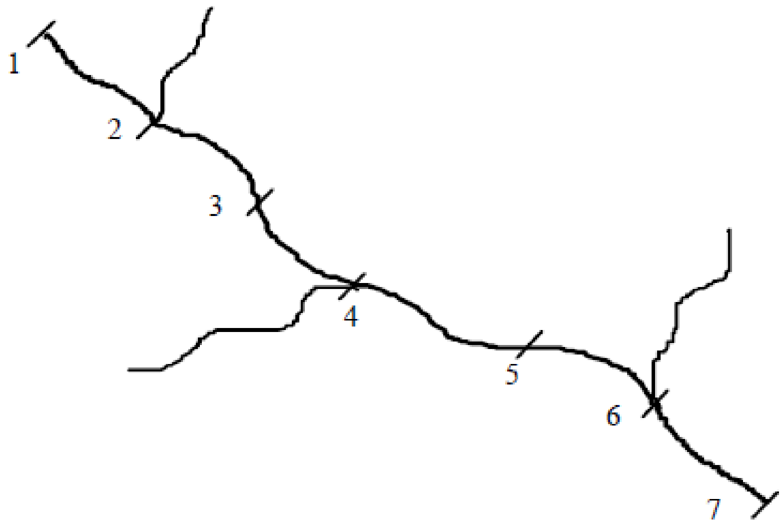

Fig. 1. River sector scheme

For each section: 1, 2, ... 7, the following features are known:

- the multiannual average flow rates, *Q*,
- the odds against black sea level *Z*, and
- lengths against section 7 (downstream), *L*.

These values are presented in Table 1.

Table 1: Data on the characteristic section

Section	Value: Q [m³/s]	Z [M.A.S.L.]*	L [km]
Section 1	35.37	1623	63
Section 2	39.58	1612	56
Section 3	42.94	1603	46
Section 4	46.26	1621	37
Section 5	50.19	1626	28
Section 6	52.46	1593	26
Section 7	61.01	1586	23

**MASL= metres above sea level.*

Tipical sector sizes for the studied river are presented in Table 2.

Table 2: Sizes for each sector of the river

Size/sector/unit		1-2	2-3	3-4	4-5	5-6	6-7
ΔZ	[m]	45	90	95	60	30	40
Q	[m³/s]	37.47	41.26	44.62	48.22	51.32	56.73
ΔP	[kW]	16541	36428	41583	28382	15103	22260
ΔE	[GWh]	144.89	319.10	364.26	248.62	132.62	194.69
ΔL	[km]	7	10	9	9	2	3
P	[kW/km]	2363	3642.8	4620.33	3153.55	7551.5	7420
E	[GWh/km]	20.69	31.91	40.47	27.62	66.31	64.89
ΣΔp	[kW]	16541	52969	94552	122934	138037	160297

3.2 The representation of theoretical linear specific synoptic potential

Figure 2 contains the representation of the theoretical linear specific synoptic potential *p* [3], by following the steps below:

- choose an appropriate scale for lengths and is the route of the river;
- inspection of corresponding line of *p* in the Table 2 and is chosen for its convenient scale representation;
- on a sector that is part *p* lane width proportional to it, the chosen, the symmetric part of the river and it marks the lines perpendicular to the route of the river.

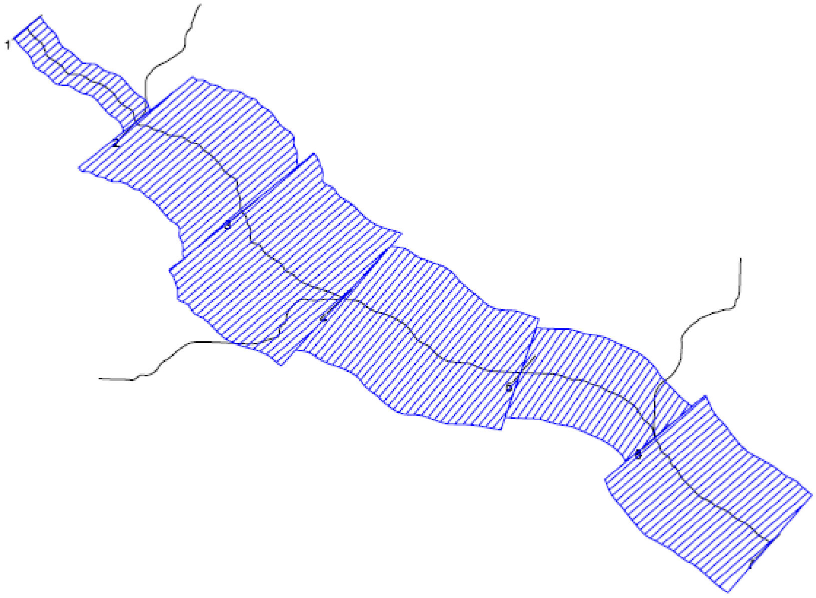

Fig. 2. The representation of the theoretical linear specific synoptic potential

3.3 The representation of hydro power profile

Figure 3 contains the representation of the water cadastre for Bistrita River:

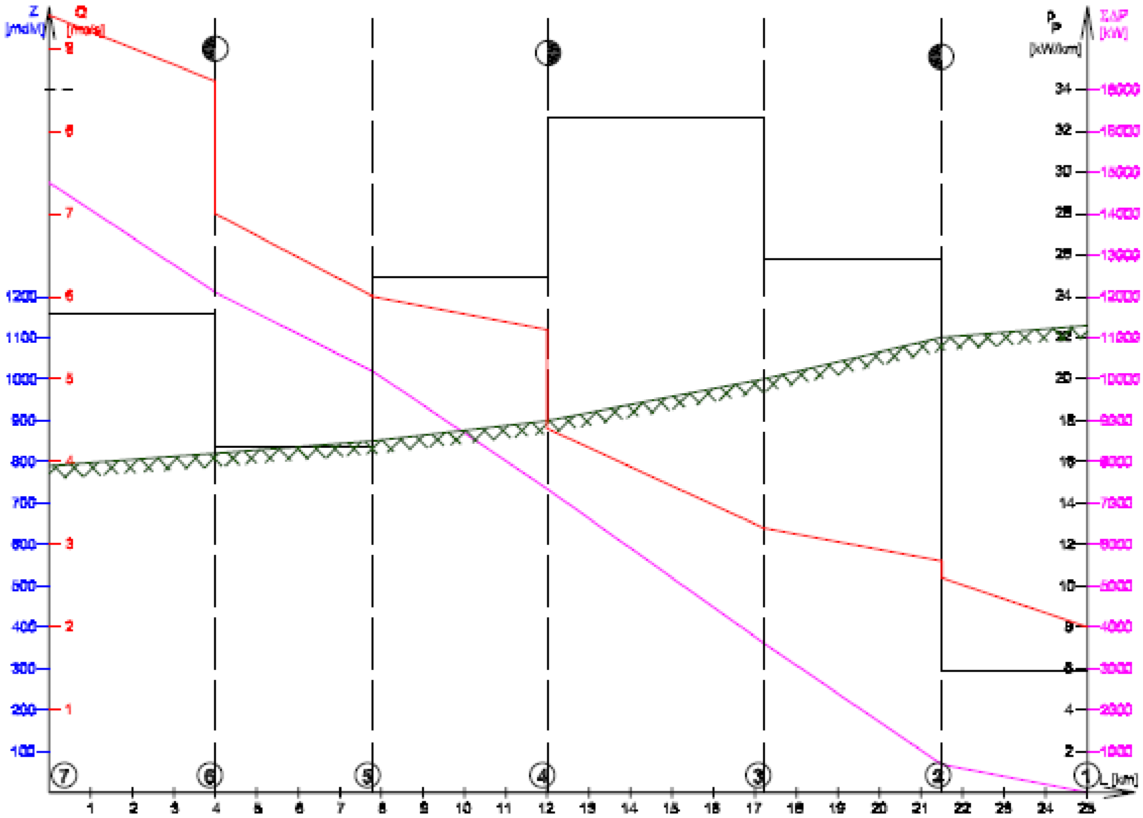

Fig. 3. The representation of the hydro power profile for Bistrita River

As one can see, the section 3-4 presented the maximum hydro power potential.

4. Conclusions

Analyzing the figures, we can conclude that:

- the maximum amount of hydropower potential is achieved on specific sector 3-4;
- therefore, it is most suitable for hydropower facilities;
- for the river is advantageous to carry out a dam in section 4, section characterized by share the thalweg: Z_0 = 900 M.A.S.L. and the multiannual average flow, Q_m = 62.5 m^3/s.

References

[1] *** UPB, ENERO, Hidroelectrica, 2006;
[2] R. Popa, "Elements of rivers hydrodinamics" ("Elemente de hidrodinamica raurilor"), Didactic and Pedagogic Publishing House, R.A. Bucharest, 1997;
[3] R. Popa, "Modeling water quality from rivers" ("Modelarea calitatii apei din rauri"), *H*G*A* Publishing House, Bucharest, 1998;
[4] http://cadastru.8k.com/catalog.html;
[5] http://PSpice-manuals-SCHMURGD.pdf.