ANALYSIS HYDROPOWER POTENTIAL OF THE CRĂIASA VALLEY FOR EXPLOITATION IN THE FOREST SECTOR

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Abstract

Hydro was most exploited, even if lately, hydropower implementing programs in countries emerging were delayed because of financing, or social or environmental reasons. Unlocking the potential of hydropower streams, in our country, it should be treated with a maximum interest in the perspective shifting production of clean energy, especially due to the fact that the share of hydraulic energy exploited in Romania, represents less than half of that achieved in European countries, If hydrological and geo-climatic conditions comparable to those in our country.

Due to the relatively limited energy resources, relative to the increasing needs, development of human society requires intensive exploitation of all forms of energy. Forestry, by its binary (with specific biological and technical) should participate in solving energy problems.

The hydropower potential is the energy available to a volume of water and hydropower resources expresses the value of the rivers, on a given area.

The water course (stream) analyzed and presented in this paper (Crăiasa Valley) is located in the mountainous area of Bihor County (northwestern Romania), ie where there are favorable conditions for the development and exploitation of hydropower potential.

From measurements of flow and level differences conducted during 2005-2010 was done the analysis and evaluation of the merits of the hydropower potential of this stream. Thus, Crăiasa Valley sectors were defined watercourse k_i, starting with the k_1, the first after the spring, resulting in a total of eight sectors, denoted by k_1, k_2 ... .k_8 from the source to the control section, for analysis hydropower potential hydropower cadastre and representation. It was found that the hydropower potential of the Crăiasa Valley is directly influenced by great differences in level (considered by sectors) in connection with the flow, and not of the basin surface or length of water to which it is registered. It should be noted that the maximum considered, are recorded within the basin, excluding those in control sections (hydrological stations).

Key words: hydropower, forest sector, hydrographic basin, hydropower potential, specific powers

INTRODUCTION

Globally, of all renewable energy sources, hydropower was the most exploited, even if lately, implementing programs hydropower in countries emerging were delayed because of funding or social reasons or organic. The hydropower potential is still used to a small extent and 5% in Africa, 8% in Latin America, 9% in Asia (19***).

Unlocking the potential of hydropower streams, in our country, it should be treated with a maximum interest in the perspective shifting production of clean energy, especially due to the fact that the share of hydraulic energy exploited in Romania, represents less than half of that achieved in European countries, If hydrological and geo-climatic conditions comparable to those in our country (Jura, Brata, 1995).

Each water course should be considered a hydroelectric potential, and as such, is urgently needed greater attention, in order to use it. For example, rivers or mountain springs, which are built trout, have the advantage of the existence of construction, which can be set up to work less certain micro hydropower, which can serve the electricity production, both those trout and other consumers area, even some tourist facilities (Popescu, Popescu, 1991; Sariev, Nevenchanny, 2006).

Due to the relatively limited energy resources, relative to the increasing needs, development of human society requires intensive exploitation of all forms of energy. Forestry, by its binary (with specific biological and technical) should participate in solving energy issues (Gaspar, 2000).

Economic benefits and environmental recognized hydropower led to increased interest in hydropower development watercourses small mountain areas, remote where there are sights (Sabau, Iovan, 2015), small communities or even to supply small companies. On these rivers, often necadastrate (without hydrological measurements) suitable building picohydropower (PHC) whose installed capacity is below 5 kW (Wiliams, Simpson, 2009; Williamson et al., 2011; Teuşdea et al., 2012).

The hydropower potential is the energy available to a volume of water and hydropower resources expresses the value of the rivers, on a given area (Seteanu et al.,2000).

The hydropower potential theoretically represents all the energy they contain storm water or the leaking onto a surface (surface precipitation or leakage) and on watercourses (linear), without taking into account arrangements possible technical input, failures or loss of flow and yields achieved in the transformation of hydraulic energy into the electricity.

Because the energy change varies powers lower than a period of time, it is preferable that the hydropower potential to be played by energy production, or hydraulic power when there is envisaged a time.

Theoretical potential is the characteristic linear theoretical hydropower potential, which expresses the total energy considered available water courses along their whole length (from source to estuary) (Dumitrescu, 1969).

MATERIAL AND METHOD

The water course (stream) analyzed and presented in this paper (Crăiasa Valley) is located in the mountainous area of Bihor County (northwestern Romania), ie where there are favorable conditions for the development and exploitation of hydropower potential. This is part of the great Criș basin, characterized by a network density of 0.39 km/km^2 (Mancia, Mancia, 2003; 17 ***) and the Crișul Repede and Crișul Negru.

They are streams, consisting of springs and/or precipitation, which, under the influence of gravity and the slope, moves downstream on the line of greatest slope (Iovan, 2007).

Queen valley, crosses a river basin of 30 km^2 and a 1873 ha forest background, superimposed over a much appreciated tourist area (near the Bear Cave), with a total length of 10 km. The main source of water for trout Chişcău (which could be the main beneficiary of the hydropower potential), but in recent years suffering from numerous and large variations in flow (Cadastral Atlas, Romanian Waters).

Following measurements of flows (in terms of lack of flow measurements and recordings of precipitation is recommended when measuring characteristic sections of rivers) (Herschy, 1995; Harmel et al., 2006) and differences of conducted during 2006-2012 was done the analysis and evaluation of the merits of the hydropower potential of this creek, brook purpose of this paper is the study of the views hydropower. Thus, it is proposed hydropower representation plotting the cadastre.

It is considered a watercourse which is known in n sections: flow Q, shares to the Black Sea Z, and the lengths L to section located at the downstream end of the river.

For the calculations, it was attached to the current sector index k, from spring section (upstream) that are limited to areas where, up to the sections. The calculation was performed for each sector and through the steps below, as recommended by relations of Popa R. and Popa B. (2003):

a) fall sector ΔZ_k,

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

b) average flow on the *k* sector,

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

c) theoretical power of the *k* sector,

$$\Delta P_k = 9.80665 \cdot \overline{Q_k} \cdot \Delta Z_k \text{ [kW]} \tag{3}$$

d) the theoretical energy of the *k* sector,

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

e) length of the *k* sector,

$$\Delta L_k = L_k - L_{k+1} \text{ [km]} \tag{5}$$

f) specific linear theoretical potential of the *k* sector,

$$p_k = \frac{P_k}{\Delta L_k} \text{ [kW/km]} \tag{6}$$

calculated as specific power, respectively:

$$e_k = \frac{E_k}{\Delta L_k} \text{ [kWh/km]} \tag{7}$$

calculated as a specified energy.

On Crăiasa Valley sectors were defined watercourse k_i, starting with the k_1, the first after the spring, resulting in a total of eight sectors, denoted by k_1, k_2 ... .k_8 from the source to the control section (hydrological station,18***) for analysis and representation cadastre hydropower potential hydropower.

On the table 1 displays the cumulative length sectors, level differences ΔZ (m) and average flows (m3 / s) deemed appropriate sectors.

Table 1

The characteristics of the bounded sectors on Crăiasa Valley

Nr. crt.	Sectors	Limitation	Length cumulated (km)	Slope (m)	Average flow (mc/s)
1	k1	spring-S8	2.85	399	0.029
2	k2	S8-S7	3.86	139	0.063
3	k3	S7-S6	4.26	40	0.074
4	k4	S6-S5	4.61	64	0.077
5	k5	S5-S4	5.16	9	0.084
6	k6	S4-S3	7.45	107	0.093
7	k7	S3-S2	9.99	72	0.108
8	k8	S2-S1	22.75	158	0.138

RESULTS AND DISCUSSION

Differences in the level of heads of sectors considered, decreasing from the upstream sector k_1 (399 m) to the downstream sector to shed (ΔZk_8 = 158 m), but it should be noted that they have a large variation, indicating a longitudinal profile with gradients varied (Fig. 1).

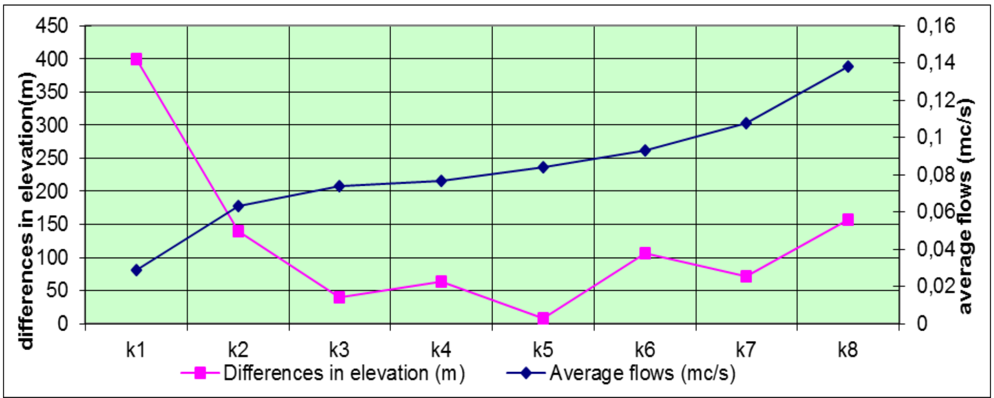

Fig. 1. The variation of the altitude differences and of the average flows on the defined sectors of Crăiasa Valley

Average flows of the sectors Valley Queen presents normal growth trend from upstream (Qk1 = 0.029 m3 / s) toward shedding, for this is the lastsectionk$_8$is 0.138m3/s.

Features hydropower river basin Valley Queen: power theoretical Pk (kW) and energy theoretical Ek (kWh) of each sector, the theoretical potential linear pk (kW / km) and specific power ek (kWh / km) and the sum of theoretical sectors Σ Pk (kW) are calculated and presented in table 2.

Table 2

The hydroenergetic characteristics of Crăiasa Valley

No. crt.	**Sectors**	**Length Sectors (km)**	**Theoretical power Pk (kW)**	**Theoretical Energy Ek (kWh)**
1	k1	2.85	113.473	994021.27
2	k2	1.01	85.877	752281.07
3	k3	0.40	29.028	254282.51
4	k4	0.35	48.327	423346.02
5	k5	0.55	7.414	64945.13
6	k6	2.29	97.586	854853.13
7	k7	2.54	76.257	668007.03
8	K8	12.76	213.824	1873099.96

No. crt.	**Specific linear theoretical potential pk (kW/km)**	**Specific power ek (kWh/km)**	**Sum P k1-k8 (kW)**
1	39.81	348779.39	113.473
2	85.03	744832.74	199.350
3	72.57	635706.28	228.377
4	138.08	1209560.06	276.704
5	13.48	118082.05	284.118
6	42.61	373298.31	381.704
7	30.02	262994.89	457.961
8	16.76	146794.67	671.785

Pk theoretical power sectors considered is between 870,737 kW on the first sector and that the sector kW 1067,297 kW spill.

Plotting the variation of theoretical power sectors, according to the cumulative length (km) from source to estuary (Giurgiu, 1972; Helsel, Hirsch, 1992), shows that there are two peaks reached in sectors end and minimum values are reached middle sectors where there were measurements of flows, the explanation being given by the distance between sections, which is much smaller (Fig. 2).

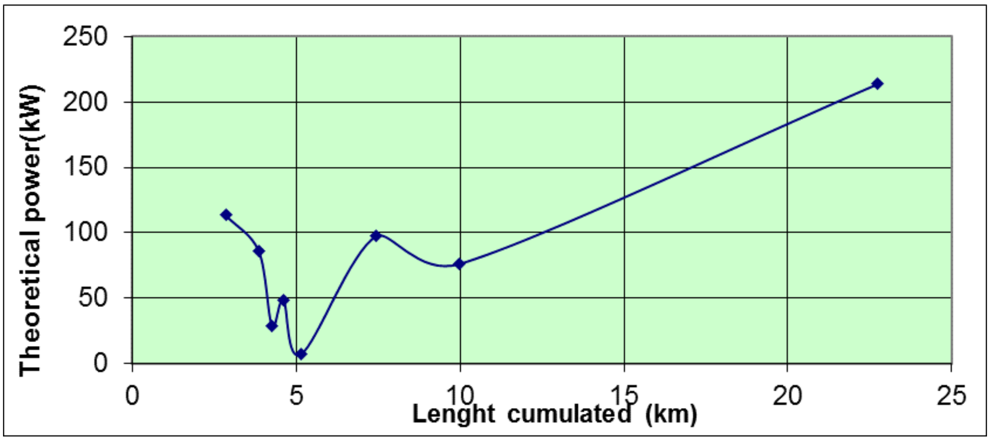

Fig. 2. The influence of the summed up water course length upon the theoretical power of the sectors on Crăiasa Valley

Specific linear pk evolution theoretical potential along Crăiasa Valley show a peak recorded in sector four of 138,08 kW/km, and the overall high values are located in the top four sectors, where their length is less (Fig. 3).

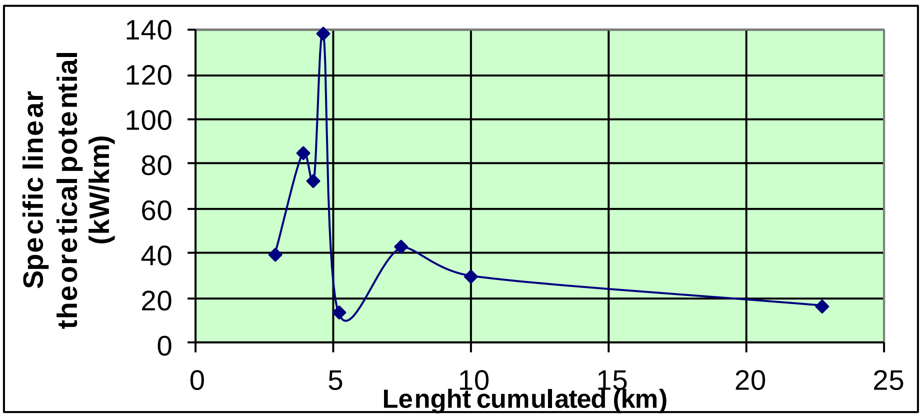

Fig. 3. The evolution of the specific linear theoretical potential pk along Crăiasa Valley

Specific power *e*k of Crăiasa Valley has the same evolution, along the watercourse analyzed with linear theoretical potential, but the values were between 942606,37 kWh/km respectively 8659350,40 kWh/km.

Theoretical energy sectors Ek, evolving in relation to cumulative length of the watercourse, considered by between 64945,13 kWh in the k_5 and k_8 sector 1873099,96 kWh (most downstream).

Theoretical powers accumulated ΣPk developments in sectors considered on Crăiasa Valley, in assessing the cadastre hydropower is shown in figure 4. It appears from this that the operation of a small hydro sections located downstream sectors defined in this valley could develop powers between 113,473 input kW respectively 671,785 kW in the control section.

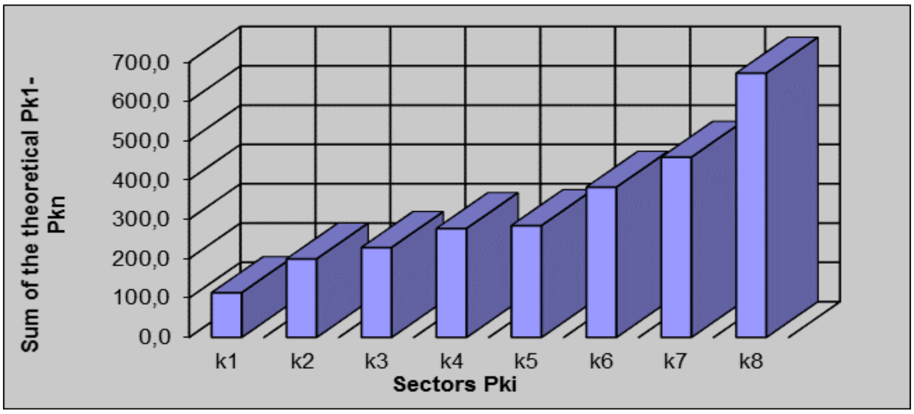

Fig. 4. The sum of theoretical powers on Crăiasa Valley

CONCLUSIONS

It was found that the hydropower potential of the Crăiasa Valley is directly influenced by great differences in level (considered by sectors) in connection with the flow, and not of the basin surface or length of water to which it is registered. It should be noted that the maximum considered, are recorded within the basin, excluding those in control sections (hydrological stations).

So we can say that this watercourse studied, located in the forest of O.S. Sudrigiu can provide a hydroelectric potential to harness for operating activities in the forestry sector (trout, sawn timber facilities, administrative buildings, etc.) and why not, in the tourism sector.

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