COMPLEX HYDROTECHNICAL WORKS IN CRIS RIVERS BASIN

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ABSTRACT
The aim of the present paper is to show that in all stages of building a hydrotechnical facility and especially of a hydroelectric plant, the tendency is to include the facility in the natural framework in optimal conditions. Within Crisurilor basin, the embankment and drainage works were made to protect against flooding, to improve flood plains and swampy lands and for irrigations. Such works have started to be done even since last century but they have had a sporadic and local character.

Keywords: draining internal waters, hydrographic basins, hydrotechnical construction, drainage works, theoretical linear potential, hydropower potential

INTRODUCTION
By the early 20th century, a series of canals had been built which took the waters from the area of piedmont hills and led them into the main water courses. The most important reclaim work in the Cris Plain was carried out between 1896 and 1904: the sewer that connected Crișul Repede with Crișul Negru. Sewerage systems for draining internal waters as well as hydrotechnical works were made in the 20th century, today Crișul Repede being one of the hydrographic basins with the largest reclaim work. Thus, in the early 20th century –1908– the first hydroelectric plant on Crișul Repede, at Tileagd, came into operation, having an installed flow of 2 m³/s, a drop of 4 m and an installed power of 50 hp and respectively 30 kW.

MATERIALS AND METHODS
In 1944, U.H.E. Negreni-Bucea started to produce electricity, and had an installed power of 240 hp, respectively 156 kW.

Aștileu hydrotechnical facility was built between 1949 and 1954 in order to supply the industry in Aștileu-Aleșd area with electricity. It consisted of a concrete diversion dam of 3 m height – situated on Crișul Repede upstream from Vadul Crișului – a 10.2-metre-long paved channel and the power plant. The channel had a transport capacity of 12 m³/s, and the difference of level between its ends is of 33 m. These channel parameters allowed the installation of four Francis turbines of 1.050 hp and 750 kW each, thus resulting in a total installed power of 3 MW [1, 2].

The dam in Lesu was built in 1973 (thus resulting the lake with the same name) in order to supply Oradea with water. The works on the most important hydrotechnical facility – Drăgan – started in 1987. The works on U.H.E. Lugașul de Jos, Tileagd, Săcădat and Fuguțu started in the ninth decade as well (1982) [1, 2].

In all stages of building a hydrotechnical facility and especially of a hydroelectric plant, the aim is to include the facility in the natural framework in optimal conditions. The study of natural, geological, hydrological and topographical conditions continually encounters new situations that require, in addition to constantly improved equipment and machinery, an appropriate methodology and interpretation capacity based on vast experience. In addition to providing the usage they were designed for, hydrotechnical constructions and facilities have a significant influence on the
neighbouring regions: thus, by building dams, reservoirs are created that flood large areas. Besides
the fact that vast agricultural land, pastures, forests or other exploitations are lost, sometimes it is
required that houses, industrial plants, roads and railways with their annexes to be relocated.
Geological, hydrological and geomorphologic conditions must be carefully monitored and
interpreted whilst the calculations and design works must be run with rigour and precision [3, 10].

The subsequent behaviour of the operation works and therefore, their safety, depend on the
adjustments of the project site and the quality and accuracy of execution. The supervision of the
main operating parameters, by measuring and control devices, provides elements that confirm
normal operation or signals the phenomena that demand the alarm condition.

Large dams retain considerable quantities of water of million or billion cubic meters in
reservoirs. Numerous accidents in adductions of various types, in loading rooms, in forced pipes or
in air or underground centrals have been recorded. Besides the immediate damage, only when the
facility is out of work it totals energy losses with a significant economic equivalent. Within
Crisurilor basin, the embankment and drainage works (fig. 1) were made to protect against flooding,
to improve flood plains and swampy lands and for irrigations. Such works have started to be done
even since last century but they have had a sporadic and local character [4, 5].

Following some catastrophic floods that occurred over the years, regional measures have
been taken to impound the main courses and to regulate the riverbeds.

The works performed may be grouped into the following complexes:
- Hydroameliorative complex Barcău;
- Hydroameliorative complex Crişul Repede – Crişul Negru;
- Hydroameliorative complex Crişul Negru – Crişul Alb.
Hydroameliorative complex Crişul Repede – Crişul Negru is located in the hydrographic basin of these rivers and it stretches on an area of 63 400 hectares. The complex takes 11% of the surface of basins of the two Cris Rivers i.e. the plain region. This complex consists of 230 km of defence dams against overflow of waters from rivers and of 340 km of canals that collect and transport inland waters [4, 5].

As such, the improvement degree of rivers in Crişul Repede hydrographic basin is of 529 km (44%) out of the total length of rivers (1.206 km). The damming system of Crişul Repede River includes the dams on both banks, totalling a length of 35.38 km from the border, out of which 23.58 km on the right bank and 11.8 km on the left bank. The area protected against flooding is of 23 200 hectares (fig 1). The water energy of Crişul Repede River, regardless of the form it is submitted – potential, of pressure or kinetic one – has been used since ancient times, a fact reflected by the numerous identified hydrometric facilities (over 90 facilities with 462 hp).

Ersilia Iacob (1972) (quoted by [7]) calculated the theoretical linear potential (Pl) for an average annual flow, provided 50% for the rivers in Apuseni Mountains. The formula she used was:

\[
Pl = 9.81 \times Q \times H \text{ (kW)}
\]

in which:

- \( Q \) = flow, in m\(^3\)/s,
- \( H \) = fall, in m.

The data obtained for the rivers in Crişul Repede hydrographic basin are shown in table 1.

**Table 1. The hydro energetic potential of Crişul Repede hydrographic basin**

(source: Ersilia Iacob, 1972, quoted by [7])

<table>
<thead>
<tr>
<th>Nr. crt.</th>
<th>River</th>
<th>Altitude - m -</th>
<th>Distance from source - km -</th>
<th>Flow - m(^3)/s -</th>
<th>Slope m/km</th>
<th>Theoretical linear potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crişul Repede spring</td>
<td>710</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Confluent Călata</td>
<td>504</td>
<td>28.00</td>
<td>1.70</td>
<td>7.3</td>
<td>3535</td>
</tr>
<tr>
<td>3</td>
<td>Confluent V. Henţ</td>
<td>500</td>
<td>29.00</td>
<td>4.00</td>
<td>4.0</td>
<td>157</td>
</tr>
<tr>
<td>4</td>
<td>Confluent Drăgan</td>
<td>460</td>
<td>35.00</td>
<td>9.50</td>
<td>6.6</td>
<td>2943</td>
</tr>
<tr>
<td>5</td>
<td>Confluent Poicu</td>
<td>433</td>
<td>38.00</td>
<td>10.70</td>
<td>9.0</td>
<td>2843</td>
</tr>
<tr>
<td>6</td>
<td>Confluent. Iadului</td>
<td>354</td>
<td>49.00</td>
<td>16.50</td>
<td>6.1</td>
<td>5642</td>
</tr>
<tr>
<td>7</td>
<td>Confluent Brâtcuţa</td>
<td>340</td>
<td>56.00</td>
<td>17.20</td>
<td>2.7</td>
<td>1346</td>
</tr>
<tr>
<td>8</td>
<td>Confluent Miser</td>
<td>325</td>
<td>60.00</td>
<td>17.60</td>
<td>3.7</td>
<td>2589</td>
</tr>
<tr>
<td>9</td>
<td>PH Vadul Crişului</td>
<td>280</td>
<td>67.00</td>
<td>19.60</td>
<td>6.4</td>
<td>8652</td>
</tr>
<tr>
<td>10</td>
<td>Confluent Borod</td>
<td>262</td>
<td>72.50</td>
<td>20.00</td>
<td>3.2</td>
<td>3531</td>
</tr>
<tr>
<td>11</td>
<td>Confluent Ghepiş</td>
<td>214</td>
<td>85.00</td>
<td>21.00</td>
<td>4.0</td>
<td>7416</td>
</tr>
<tr>
<td>12</td>
<td>Confluent Medeş</td>
<td>150</td>
<td>106.00</td>
<td>22.20</td>
<td>3.1</td>
<td>13.066</td>
</tr>
<tr>
<td>13</td>
<td>PH Oradea</td>
<td>121</td>
<td>120.00</td>
<td>23.20</td>
<td>1.1</td>
<td>1820</td>
</tr>
</tbody>
</table>

**Total:** 65.023
The data in the table point out both the theoretical linear potential (kW) on the entire course of the river as well as the areas of maximum hydropower potential along the rivers (kW/km). By the energy intake brought, the hydrographic network has had a favourable impact in terms of spatial distribution of settlements. The settlements have valued the existence of valleys and alluvial cones created by the hydrographic network, the water being used for economic purposes – water supply, mills, transportation, and energy. The restrictions imposed by the hydrographic network had a sporadic character, being represented by the overflows of Crişul Repede River and its affluent rivers corrected by hydrotechnical works. Lakes and channels have been built recently; all of them are anthropogenic, built together with the hydropower exploitation of Crişul Repede River. The main lakes are those near Lugaşu de Jos (67 mil. cubic meters), Tileagd (54 mil. cubic meters), Fughiu (of a recent date). The impact of these facilities on the population and settlements consisted in the dismantling of 65 households and other additional buildings (Pop, 1996, quoted by [8]).

As we have mentioned, the main affluent rivers of Crişul Repede River is represented by Brătuţei Valley, Mişidului Valley, Borodului Valley and other less significant affluent rivers [8].

Surfaces occupied by water are currently the result of the evolution of hydrographic network and of human intervention by works of hydrotechnical facilities. Within the basin, the surface occupied is 2,910 hectares that is 2.7% of the total surface. Most of this surface is the result of human activities undertaken especially after 1980s (Pop, 1966, quoted by [8]). In the villages, the distribution is uneven, most of them having values ranging up to 3% of the total surface, Săcădat and Tileagd having values up to 5%, and the highest percentage being present in the village of Lugaşul de Jos with 13.2%. This value is due to the two lakes present on the territories of Tileagd and Lugaşul de Jos communes. The polarization potential indicates the number of villages that gravitate towards the centre of the commune. The formula (Surd and Nicoară, 1989, quoted by [8]) uses only the demographic potential of the commune centre, of the commune and of the conventional village. In our case, the conventional village has 985 inhabitants, a higher value than the national one of 780 (Şandru and Aur, 2009, quoted by [8]).

<table>
<thead>
<tr>
<th>Commune/town</th>
<th>Total population</th>
<th>Population in the commune centre</th>
<th>Polarization potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aleşd</td>
<td>10415</td>
<td>7387</td>
<td>3,1</td>
</tr>
<tr>
<td>Aştileu</td>
<td>3781</td>
<td>1528</td>
<td>2,3</td>
</tr>
<tr>
<td>Auşeau</td>
<td>3049</td>
<td>524</td>
<td>2,6</td>
</tr>
<tr>
<td>Borod</td>
<td>4173</td>
<td>1426</td>
<td>2,8</td>
</tr>
<tr>
<td>Brăteş</td>
<td>5567</td>
<td>1705</td>
<td>3,9</td>
</tr>
<tr>
<td>Copăcel</td>
<td>2477</td>
<td>475</td>
<td>2,0</td>
</tr>
<tr>
<td>Ineu</td>
<td>4075</td>
<td>2276</td>
<td>1,8</td>
</tr>
<tr>
<td>Lugaşul de Jos</td>
<td>3287</td>
<td>1536</td>
<td>1,8</td>
</tr>
</tbody>
</table>

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CONCLUSIONS

a) Agriculture: Law 18/1991 led to the division of property, to some lands left unplanted for various reasons, to deficiencies regarding carrying out some mechanized works. The Land Act of 1991 led to the emergence of numerous “agricultural holdings”, most of them of small size, under 5 ha of agricultural land. In the meantime, this explosion of small properties was doubled by the phenomenon called management aging by Bulgaru Mircea, 1996 (quoted by [8, 9]). This phenomenon is generated by the fact that, during collectivization, the right of succession to land property was denied; thus the land law grants land to former owners who were already advanced in age when the land law was issued in 1991. The small size of agricultural lots raises big problems in their rational and economic exploitation. Moreover, due to the right to inheritance, these surfaces will decrease even more in the case of families with more than one child. Also, the fragmentation of plots makes it even harder to economically use the agricultural machinery and to create family associations or small, economically profitable farms.

b) Pomiculture and viticulture: Vines are grown sporadically, around the household and provide the necessary grapes for making wine or for consumption. These take 601 hectares and represent 0.9% of the agricultural area of the basin. Significant surfaces generally taken by grapes are present in Tileagd commune which owns 389 hectares, representing over 50% of the total area occupied by them. Lugaşu de Jos and Ineu, benefiting from the existence of some favourable natural conditions rank among the communes with large areas cultivated with vine. In eight communes, vine is missing or is present on insignificant areas. The fruit growing, more present until 1990, takes a surface of 1552 hectares at the level of the entire area. As for cultivated fruit trees, these are apple, plum, peach, cherry, pear and nut trees. Extended surfaces cultivated with these cultures are present in the communes Lugaşu de Jos with 755 hectares, Borod with 167 hectares and the town of Aleşd with 208 hectares. The cultivation of fruit tress is a tradition, the commune Lugaşu de Jos becoming conspicuous by its cherry and apple crops as well as the peach crops whilst plum and apple trees dominate in the commune Borod and the town of Aleşd.

c) Livestock: Although within the localities in the depression there are a relatively high number of animals, officially there is not any husbandry farm. The recorded animals within the state bodies (Department for Agriculture) appear only on their owners’ names even though, in some cases, the number of heads recorded raises some questions. The large share of cattle is explained by their importance in terms of their use in agriculture, as labour force and for manure.

d) Industrial activities: Industry and related activities are generated by the existence of some soil and subsoil resources, by the existence of some de communication paths used in the transport of raw materials, by the presence of some markets in the neighbourhood, by the available labour force interested in this sector. Currently the major industrial units are represented by S.C. HELIOS S.A., S.C. HOLCIM S.A., HIDROCENTRALA AŞTILEU, S.C. MANFRED S.A. working in various industrial segments: energy, manufacturing, textile, building materials. In the industrial field there
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is a number of 229 units, generally focused on mining industry (clay, gravel, sand) and manufacturing one (building materials, wood, food, etc.).

e) Services: A feature of the service development since 1990, particularly in rural environment, is represented by the fact that they overtake part of the labour force dismissed from industry and agriculture or are generated by their presence and development (Smith, 2003, quoted by [8]). The range of services has diversified widely since 1990. The largest concentration of service activities is characteristic of the town Aleșd whereas in the rest of smaller villages their presence is directly proportional to the size and economic population of the village.

f) Touristic activities: Touristic activities have an older tradition but knew a more pronounced development after 1990. Tourism has an anthropogenic and natural potential, especially appreciated. Traditions and customs, wooden churches, karst topography, the presence of Crișul Repede River represent the premises of the touristic activities development. Communication paths, European and county road, the presence of railway lines, the proximity of some airports, the future presence of the highway, plus the exceptional potential of the area are prerequisites for the development of a significant tourism activity. Tourist activities are currently focused generally on short-term satisfaction of tourism- during the summer. The fishery potential entailed the emergence of specialized areas of recreation, but does not offer accommodation. Such units are those in Măgești – focused on trout fishing and the one in Husasăul de Cris. Entertainment complex in Husasăul de Criș has evolved in recent years; services have diversified (fishing, swimming pool, playground facilities, organizing events). The reservoirs in Tileagd, Lugașu de Jos and Fughiu, although they give the possibility of practicing water sports and fishing, do not have tourist facilities.

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