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Surveying applications on Crişul Alb bed river for performing hydrological studies

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Abstract: The paper represent topographical survey on the Crişul Alb bed river, the area situated on the North side of Ţipari locality, and between 5 and 43 CSA landmarks, processing the field measurements in order to achieve transversal and longitudinal cross sections through the valley.

The main purpose represent a complex hydrological study, part of a breach rehabilitation project, that appear in the dam body due to the high water levels from the spring of 2000 year, by optimizing flow at high flow rates, creating corridors drain, reduction measures roughness, measures of highlighting the active erosions on the bank river, the dams, time tracking surveillance of dams and vegetation, the presence of the wooden mass into the major river bed, and also other aspects.

The main objectives followed were: Topographical works for achieving the longitudinal cross section of the river, the water horizon leveling and measuring the river bed depths.

Keyword: SOKKIA total stations, longitudinal cross section, roughness, dam subsidence, major bed river

1. INTRODUCTION

The geographic space from the west side of Romania has a large hydrographical network. The territory is situated between Mureş river on the North side, Danube river on the South side, Tisa river at the East side and Timiş-Cerna corridor on the West side, being crossed by inland streams and rivers that are sprinking from the mountains and hills, towards to Tisa, Timiş or Danube.

The Crişurilor basin is framed between 47°06' and 47°47' north latitude and between 20°04' and 23°09' east longitude, including the following main rivers: Barcăul, Crişul Repede, Crişul Negru and Crişul Alb, which are joined together two by two on the Hungarian Republic territory, forming a single water course and discharging in Tisa. The hydrographical basin named Crişuri, is framed at North and North-East by the Someş basin at East, at South by the Mureş basin and at West by Hungarian border. The total surface of the basin is 25537 km^2, from which 14860 km^2 on the Romanian territory (6,3% from the country surface), assigned on hydrographical basins as follow: Ier 1440 km^2, Barcău 2006 km^2, Crişul Repede 3354 km^2, Crişul Negru 3820 km^2, Crişul Alb 4240 km^2.

Barcău and Ier basins are draining the South-West side of Şimleu Depression. The hydrographical basin that belongs to the Crișuri is represented by several main water ways: Crişul Repede, Crişul Negru, Crişul Alb, Teuz, which collects numerous of small tributaries.

Crişul Alb (Figure 1), springs on the western slope of Bihor Mountains at an altitude of 900 m below the top Cartezul (1184m).

Figure 1. Crişul Alb overview

In the upper course, through its banks has a longitudinal profile unbalanced slopes averages around 0.9 - 2.5%. At Crişcior, after traveled 31 km, the river descends at altitudes of 292 m. From this point, toward to Ineu, on a distance of 150 km, the course falls with 187 m, that corresponds with an average slope of 1.2%, having the characteristically values of depressions corridors with strong silt. The longitudinal slopes of the river decrease up to Chişineu Criş village at the value of 0.07%, and upstream, in the plain sector until the value of 0.03%.

The first most important tributary is collected by Crişul Alb, having a length of 18 km. The rest of the tributaries from Metaliferi and Zărand Mountains are: Bucureşci, Luncoi, Chişindia, the largest tributary from the left side being Cigherul (56 km). Most waters collected by Crişul Alb are coming from the right side. Besides several small brooks flow: Artan, Brad, and important rivers such as: Ribiţa, Baldovinul, Hălmagiul, Sebiş, etc. Crişul Alb is dammed in the plain sector. At Buteni, on the left side was built Canalul Morilor, having a legth of 83.5 km.

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After passing through a backsiphonage under the Cigher and Canalul Matca, the Canalul Morilor is discharging its water into Ciohoş channel, turning on this way to the Crişul Alb upstream with the Hungarian border. The cannel is dimensioned at a flow of 2,5 m^3/s and is having 13 falls along its course, of 2 m each.

Matca channel makes the connection between Mureş and Crişul Alb rivers. It is having a length of 41,2 km. The maxim discharge is 20 m^3/s and the average discharge is 4 m^3/s. The water intake is made from Mureş River with the water catch from Păuliş.

The futures of the main water courses from the hydrographic basin Crişuri are:

- The hydrographic density network;

The hydrographic density network is 0,39 km/km^2 varying between 0,7 – 0,9 km/km^2 in the mountain area and 0,1 – 0,3 km/km^2 in the plain area;

- The number and length of coded watercourses;

The Crişuri hydrographic basin comprise a number of 365 coded watercourses, the length of the hydrographic network being of 5785 km (6,3% from the total length of the hydrographical network of the country).

2. PRESENTATION OF THE AREA STUDIED

The hydrographic system of the Crişul Alb River developed in the contact area of Bihor Massive, of Metaliferi Mountains, of Zărand Mountains and Moma Mountains are draining by its main course a succession of tectonic depressions located in the south and southwest of the Apuseni Mountains then after entering in the Western Plain. Crişul Alb springs on the western slope of Bihor Mountains.

Flowing at its beginning on the sout-east direction, its water smash near to „moara lui Medrea" (lower than the confluence with Orzastia) into the Jurassic limestone parapet at the height of 1266 m. heading to south.

The Crişul Alb river basin is having on the Romanian territory a surface of 3957 km^2, that means 92% from its basin of 4240 km^2 being with 13% smaller than the catching basin of Crişul Negru and with 64% larger than Crişul Repede basin. From the Romanian territory, the Crişul Alb basin is having 1,66 %.

The watershed basin bounding Crişul Alb neighbouring basins: at North Crişul Negru and Arieşul Mic basin, at North-East Abrud basin, at East Ampoi and Geoagiu and at South Mureş basin.

Mureş watershed basin is difficult to distinguish in the plain but easy to identify in hilly and mountainous area, where mountain peaks and hilly joining as follows: Otcovac Peak (382 m), Fântâna Rece Peak (572 m), Crucea Ţiganului Peak (546 m), Highiş Peak (799 m), Muntele Alb Peak (557 m), Piatra Păcurari Peak (629 m), Drocea Peak (836 m), Husului Peak (804 m), Dl. Plesu (726 m), Măgureaua Peak.

At North and North-East watershed to "Crişul Negru" by affluent Teuzului is very close and undecided, but close to the Sebiş locality begin through Dealul Mare followed by a succession of hills (Donceni – Dezna area), Izoi Peak, dl. Rontaru, Momuta Peak (930 m), Găina Peak, Curcubăta Peak (1849 m).

Watershed basin bounding Crişul Alb has a total length of 432 km from which 162 km on the right bank of the river and 270 km on the left bank of the river.

The hydrographic system Crişul Alb has a secondary network made by 41 first order affluents, 48 second order affluents, 10 third order affluents and 1 affluent of 4th order. Inside the Crişul Alb basin there are several channels for flow regularization or for drainage purpose such as: channel Morilor, channel Matca that make the connection with the hydrographic system Crişul Alb and Mureş, Militar channel.

Also, in the Crişul Alb basin there are three permanent storage lakes (Mihaileni, Taut, Chier) and six pisciculture arrangements Rovina, Ineu, Chişineu Criş, Socodor, Pilu and Seleus.

The most important localities along the Crişul Alb valley are as follow: Brad, Halmagiu, Gurahont, Sebis, Ineu, Pâncota, Chişineu Criş. As human settlements according to the traditional habits we have: pastoral settlements; Grosuri, Tomnatec, Botfei, mining-pastoral settlements Stanija, Blajeni, Obirsa, agricultural-pastoral settings Mesteacan, Vata, Dezna, craft settlements and agricultural settlements meet once with the entrance into Câmpia Crișurilor, from Buteni toward to Vărșand.

3. MATHERIAL AND METHOD

The purpose of the paper consist in making the topographical field measurements into the Crişul Alb bed river, area situated on the North side of Tipari locality, to achieve topographical transversal profiles through the bed river and a longitudinal profile.

The field measurements are only a small part of a long row of measurements made in the last years having as purpose to obtain a hydrological complex study, frame of a restoration project of the breach made into the dam body as consequences of the highest water level from the spring of year 2000.

This is a 3D informatics program that is having as destination the high speed data processing from the upstream and to alert with high accuracy the dimension of the flood wave propagation toward downstream, making easily to take the appropriates decisions and adequate decisions by the accreditated organs.

The project provides the optimization of the water flow at high discharges, creating the leakage corridors, measures for reducing the roughness, measures for highlighting the active erosions from the river banks, the presence of the hidrotechnical works into the minor or major river bed of Crişul Alb river, the surveillance of the dam behaviors and also many other aspects. For this paper the sector between cadastral mark CSA 5 and CSA 43 has been taken into account. The following tables, Table 1 to Table 6 present the points heights measured for drawing up the transversal profiles.

Table 1 Transverse profile-Gyula

TRANSV. PROFILE- O PODAV Gyula -Gyulavari			
Left Bank 0	92.88	72	84.66
4.3	93.34	74	84.66
5.8	94.08	76	84.61
7.3	94.15	78	84.76
10.3	94.72	80	84.76
14	94.17	82	85.16
17	94.04	84	86.01
20	98.83	86	86.51
23	91.49	88	87.01
25	90.69	90	87.53
26.5	90.15	92	87.92
30	88.85	94	88.05
32.5	90.49	97	88.13
34.5	89.87	100	88.03
36.5	89.62	105	87.95
39	88.63	110	87.93
41	87.66	114	88.04
42.8	87.01	118	88.71
45	86.41	121.5	89.41
47	85.86	124	89.69
49	84.96	128	90.14
52	84.76	132	91.47
54	84.86	134	92.44
56	84.86	136.5	93.86
58	84.76	140	94.05
60	84.76	144.5	94.14
62	84.76	146.4	94.12
64	84.76	150	92.38
66	84.71	155	90.83
68	84.66	160	89.78
70	84.66	163	89.48

Table 2 Transverse profile-Border

PROFILE 1 Km O+000 GRANITA			
Left Bank 0	88.39	87	84.53
6.5	89.48	89	85.45
12	90.44	91	86.93
15	91.36	95	87.91
18	92.53	98	87.86
20	93.80	101	87.80
21	94.07	104	87.71
24	94.09	106	87.82
26.5	93.82	109.4	88.26
29	92.82	112.4	89.25
31	91.91	115	89.49
34	90.76	118	88.82
36	90.75	122	91.21
41	89.49	124	92.31
46	89.30	127.4	92.85
50.2	89.02	131.5	83.95
53	86.93	134	94.04
55	85.45	136	93.86
57	85.03	139	93.04
59	84.38	140.4	92.58
63	84.43	144.2	92.58
67	84.43	146	91.84
71	84.48	149	90.19
75	84.58	152	90.01
79	84.48	160	89.90
81	84.53		

Table 3 Transverse profile-Varsand

PROFILE 2 km 0+960 Varsand			
Left Bank 0	89.80	73	84.42
8	90.26	77	84.62
11	90.64	81	85.27
14	91.72	83	85.50
18	93.37	88	86.79
22	94.62	90	87.92
25.5	94.58	92	88.17
30	92.79	100	88.10
34	91.30	112	88.00
38	89.85	125	88.36
40	89.75	132	89.70
43	88.84	140	91.41
45	87.52	145	92.74
47	86.67	148	93.46
50	85.50	152	94.71
52	85.02	155	94.68
55	84.97	158.5	93.27
57	84.97	162	92.25
61	84.92	167	91.60
65	84.62	175	91.15
69	84.47		

Table 4 Transverse profile – Km 3+000

PROFILE P3 Km. 3+000			
Left Bank 0	89.3	116	87.00
4.5	89.44	120	86.89
10	91.83	123	87.73
12	92.10	127	87.03
17	94.21	129	87.23
20.3	94.71	133	87.37
23.5	94.58	139	87.36
24	94.25	147	88.25
27	93.33	152	88.75
30	91.98	155	89.79
35	90.72	157.5	89.85
39	90.32	163	89.81
43	90.22	168	89.45
48	89.58	178	89.36
52	89.15	191	88.84
58	88.78	198	89.27
63	88.65	214	89.75
68	88.89	223	89.52
73.5	88.84	236	88.72
75	87.99	260	88.76
77	87.00	273	89.49
79	85.70	281	89.29
81	83.90	287	89.49
83	83.35	289	90.17
85	83.55	292	91.35
87	84.10	295	92.48
89	84.35	298	93.80
93	84.90	300	94.89
97	85.30	302.5	94.80
99	85.50	305	94.79
101	85.70	310	91.61
105	86.10	314	89.30
109	86.49	320	89.05
113	86.80		

Table 5 Transverse profile – Km 4+900

PROFILE P4 Km. 4+900			
Left Bank 0	89.60	174	89.42
2	89.70	182	89.34
4	89.71	190	89.35
7	90.51	200	89.39
9	91.43	205	88.91
11	92.35	211	89.10
13.5	92.58	213	88.14
15	93.15	214	87.55
17	94.18	215	85.82
20	95.27	218	85.19
24.5	95.18	220	84.59
27	94.69	225	84.69
31	93.67	229	84.79
34	92.83	233	84.14
40	91.36	235	84.69
47	90.21	240	87.09
51	90.08	246	89.25
57	90.22	250	89.38
65	90.03	253	90.28
75	89.95	256	91.33
86	89.42	259	92.17
100	89.49	262	93.40
113	89.85	265	94.64
125	89.72	267	95.43
135	89.39	270	95.32
143	89.35	276	92.80
152	89.54	281	90.25
161	89.73	290	89.71
169	89.19		

Table 6

PROFILE P5 Km. 7+000			
Left Bank 0	89.88	118	84.47
6	89.89	120	84.82
8	89.86	123	86.00
11	90.83	126	88.36
13	91.80	129	88.81
16	93.12	131	88.86
18	94.34	140	88.85
20	95.50	143	89.27
22	95.70	146	89.58
24	95.79	154	89.59
27	95.85	162	89.85
30	95.66	167	89.99
34	94.36	171	90.03
36	93.50	174	89.46
40	92.30	182	88.75
44	91.45	186	89.36
48	91.00	192	89.20
51	90.68	195	89.50
56	90.08	201	90.21
60	89.45	206	90.36
70	89.26	209	91.24
76	88.85	212	92.09
88	89.03	214	92.71
96	88.87	219	94.13
98	88.24	222	95.19
100	86.00	224	95.91
103	85.47	227	96.04
106	84.67	230	92.20
110	84.47	235	90.80
114	84.37	241	90.25

4. RESULTS AND DISCUSSIONS

For planning the topographical works land recognition is always necessary to be made. [1]

The kilometric landmarks position was identifying for CSA 5-43, situated along the left bank river of the Crişul Alb River, having knowing coordinates from prior topographical works. The integrity of the landmarks was check, the vegetation around the landmarks was removed in order to provide a facile access to the landmarks.

The visibility for the backsight points from the network was checked, by identifying the churches from the area, and also any other points of knowing coordinates from the area, points that can be sighted from the CSA landmarks. [4]

A lot of intermediary station points have been established, at about 500 m from the kilometric landmarks at the left bank of the river. The points were numbered and land marked

A number of 114 directions perpendicular to the minor bed river were identified to provide a optimal visibility for making the topographical measurements for achieving the transversal profiles. The distance between these profiles was somewhere between 100 and 150 m, due to the lack of visibility, only two distances exceeds 200 meters.

The 14 points from the intersection of the planned transversal profiles with the axes of the access road from the left river bank of the Crişul Alb situated nearly to the minor valley of the river and ensuring visibility toward the 5 station points of the traverse were marked by land marks.

In the elaboration phase of the project the coordinates of two churches and also the CSA landmarks coordinates were achieved (table 1 and table 2).

Sample of the transversal profiles obtained are shown in Figure 2, Figure 3, Figure 4, Figure 5.

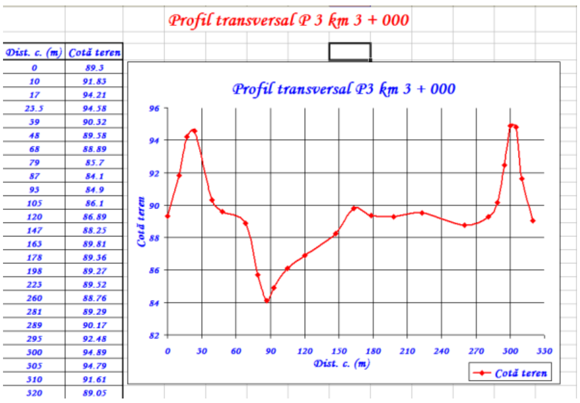

Figure 2. Transversal profile P3 (km.3+0.00)

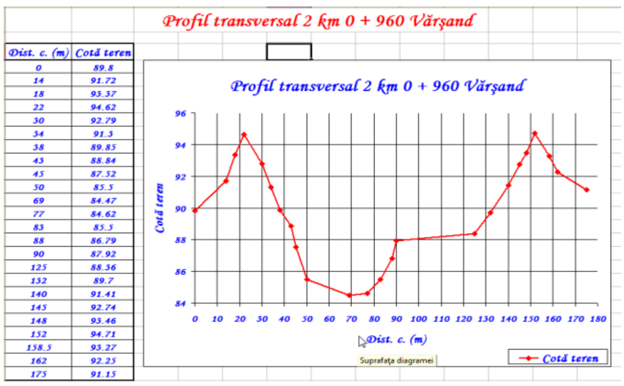

Figure 3. Transversal profile P2 (km.0+960)

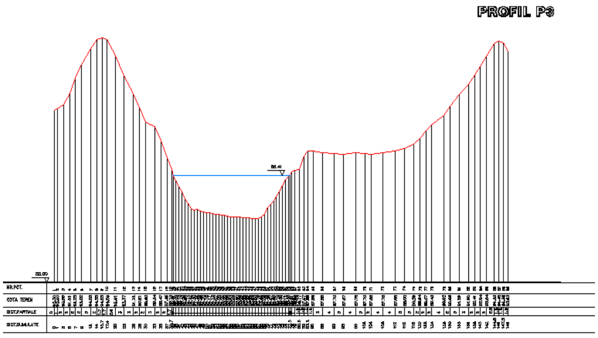

Figure 4. Transversal profile on Crişul Alb, CSA1 landmark at border

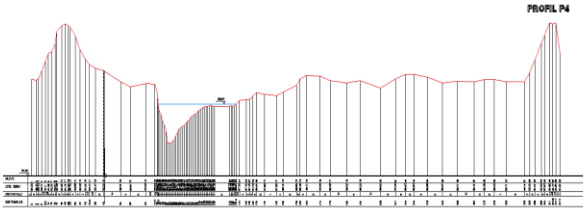

Figure 5. Transversal profile on Crişul Alb, km 3+0.00

Later, the field measurements were effectuated, at the main traverse, by using the total station SOKKIA and the topographical prisms [3].

The traverse was made between the CSA landmark were the first station was made. The station bearing was made by sighting the two churches from Ţipari and Chereluş. The points coordinate for P1 to P5 points were determined.

Table 7 contains the determinate points coordinates for the new station points.

Table 7 Points coordinates of station points

No.	Point	X[m]	Y[m]	Z[m]
1	P1	475138.29	225394.26	93.41
2	P2	475110.89	225502.46	93.38
3	P3	475032.91	225630.72	93.18
4	P4	474961.49	225720.06	95.21
5	P5	474923.31	225830.77	94.80
6	651	474841.23	225854.04	99.32
7	P6	474885.63	225958.00	94.26
8	P7	474914.79	226128.02	94.38
9	P8	474907.26	226263.14	94.83
10	P9	474891.22	226375.82	95.39
11	P10	474808.17	226494.08	95.31
12	P11	474737.07	226629.20	95.83
13	661	474697.23	226924.02	99.65
14	P12	474784.10	226797.02	96.91
15	P13	474847.20	227017.53	96.96
16	P14	474967.89	227199.69	96.98

Further, the total station was use for field measurements in each of the 14 points from the profiles and the characteristic points of the profile were measured.

By using the characteristic points coordinates of the profile the situation plane was achieved at the 1:2000 scale [5].

Considering the measured distances and the heights determined by using the total station SOKKIA the 14 transversal profiles for the minor bed river were achieved at 1:500 scale for the distances and 1:100 scale for the point heights. The longitudinal profile has the scale 1:5000 for the distances and 1:100 for the point heights.

On the plan draw by the beneficiary hydrologists, S.C. AQUAPROIECT S.A. BUCUREŞTI, the areas with severe bank erosion were identified. After filling the plan with other studies, projects considering the river banks consolidation can be take into account, also hydrotechnical works for improving the water discharge and for preventing the accidental floods in the future can be apply.

5. CONCLUSIONS

In the area were the measurements were made a huge advantage was due to the prior geodesic works finalized by the existence of the CSA landmarks with the knowing coordinates X,Y and Z and proper sighting conditions for the points such as the churches from the neighbor villages.

By using the SOKKIA total stations, a high efficiency was achieved also for the planimetrical works but for the altimetry works [2].

The sinuous route of the dams and also the presence of the abundant frostier vegetation in the major bed river and on the bank river of the minor valley imposed the increasing of the topographic network density with new station points situated between the CSA landmarks.

From the same reason, the lack of visibility due to the vegetation along the Timiş bank river, the distances between the transversal profiles take into the study were sometimes relatively large, in some cases even more than 200 meters.

For reducing the risk of flooding, the amelioration of the environmental factors into the area, establishing of a row of stable parameters by: stopping the erosions phenomena into the bed river, by irreversible land waste, by bank consolidation, by creating the ecological condition for an adequate balance in sustainable development on to the influence area for the planning works and for the executed works.

As part of the documentation, the works and measures necessary for restoration of the deteriorated environment and for maintaining in a favorable manner the environmental factors and the ecosystems from the sites must be take into account.

After the hydrotechnical works of protection against floods were made, these must be exploited according to the proper exploitation regulation made by the planner.

The regulation must contain necessary equipments (hydrometric post, stuff for water level measuring etc.) and also the program of surveillance the construction behavior.

For the terrain temporary occupied or being as private propriety the expropriation according to the law must be made in order to have a better control of the works.

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