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The quantitative and qualitative balance of the water from Rosia Montana area

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Abstract - The paperwork describes a hydrographical network from Rosia Montana area. The paper presents the average, maximum and minimum rainfall of the studied area and caries out an analysis of determinant factors for the runoff. Based on these data it presents some considerations as regards the quantitative and qualitative balance of the water in this area, in terms of using in the technology process of mining at Rosia Montana area.

1. INTRODUCTION

Rosia Montana is located in Apuseni Mountains (Fig.1). The area consists of the valley alternation that rises to a height of 500 meter above the Black Sea in the West on the Abrud valley to about 1200 meter in the East.

Rosia and Corna Valley together with the Abruzel and Seliste valley flows into Abrud River, a tributary of the Aries River. The Stefancii Valley flows directly into Aries River to North.

The Aries River flows into the Mures immediately upstream of Alba Iulia city. The Mures River flows to North and then West through Deva and Arad at Hungary frontier.

After leaving Romania, the Mures River flows into Tisa River in Szeged upstream. Tisa flows to South crossing the Serbia frontier and then it flows into Danube.

Aries River is the most important water resources from Apuseni Mountains of Alba County; ¾ of its watershed and a length of 164 km being in this area. Aries River flows about at 10 km North of Rosia Montana collecting the waters of the various tributaries (e.g. Abrud River) and many local valleys (e.g. Stefanca) and it presents considerable variation of the discharges.

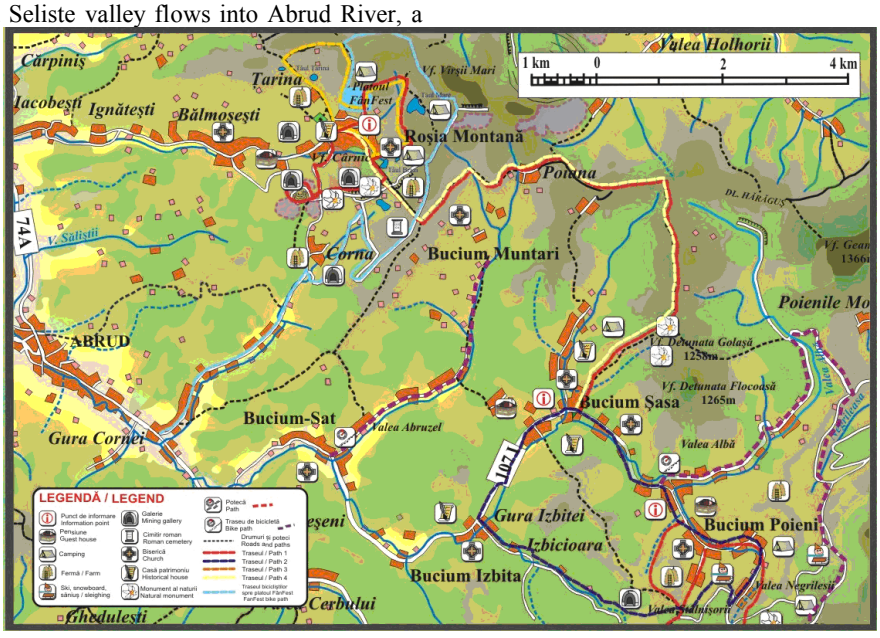

Figure 1 – Rosia Montana and the water courses of this area

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The Abrud River springs of near Detunata peak and has a length of about 32.5 km. The rates of the Denutana peak are about of 961 meter and decreases to about 540 meters downstream at the fork with Aries River.

2. INITIAL CONDITION

2.1 THE DETERMINANT FACTORS OF THE RUNOFF

The rainfall is in the form of the rain most part of years, snow falls in some months of the winter. Data on the monthly average, maximum and minimum rainfall (INMH Rotunda and Abrud Gage) is presented in Table 1 and figures 2 and 3 for Rosia Montana.

Table 1 – The rainfall of Rosia Montana and Abrud (source: INMH and RMGC)

Staţia		Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Nov	Dec	An
Roşia Montană (Staţia INMH Rotunda)	Medie 1983-2005	40,0	33,1	41,2	62,2	81,6	89,5	91,8	86,9	72,7	44,5	41,4	54,1	739,0
	2005	46,5	51,9	75,2	111,3	89,1	65,5	230,9	130,6	71,6	21,5	51,1	95,1	1040,3
	Maxima 1983-2005	96,4	76,3	157,0	119,7	150,2	180,3	230,9	203,5	143,2	116,0	73,4	146,1	1056,9
	Minima 1983-2005	7,0	6,1	7,3	16,7	25,3	19,2	21,1	26,2	9,8	3,0	7,2	12,2	563,7
Roşia Montană (Staţia RMGC)	Media 2001-2005	41,0	26,9	35,6	65,3	59,0	76,6	150,5	106,2	81,2	56,6	44,4	39,4	751,0
	2005	17,7	25,3	65,2	103,8	73,5	83,4	168,1	94,6	69,5	13,9	20,9	51,0	786,9
	Maxima 2001-2005	72,8	53,4	65,2	103,8	73,5	114,6	168,1	146,9	131,2	145,3	61,4	54,2	841,8
	Minima 2001-2005	12,3	8,3	14,3	29,0	39,5	46,4	106,8	13,8	40,9	13,9	20,9	25,8	633,5
Abrud (Staţia INMH Abrud)	Medie 1978-1999	51,6	44,4	46,7	66,5	88,3	106,4	84,0	74,3	68,5	49,7	46,3	79,8	806,5
	Maxima 1978-1999	132,3	143,6	146,8	97,3	169,0	187,9	181,7	176,3	176,3	150,6	97,3	232,4	996,3
	Minima 1978-1999	7,4	4,8	15,2	25,2	27,1	52,2	18,3	26,7	7,4	4,3	2,7	18,1	573,6

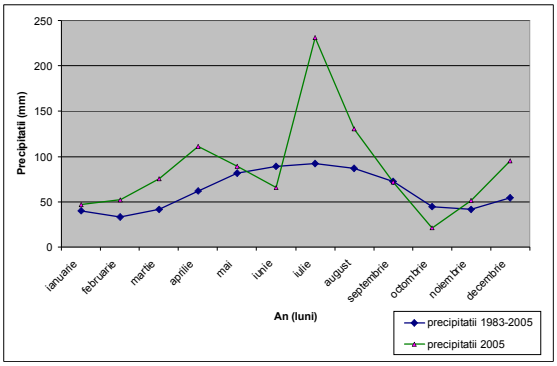

Figure 2 – The rainfall fallen in Rosia Montana – INHGA Rotunda Gage

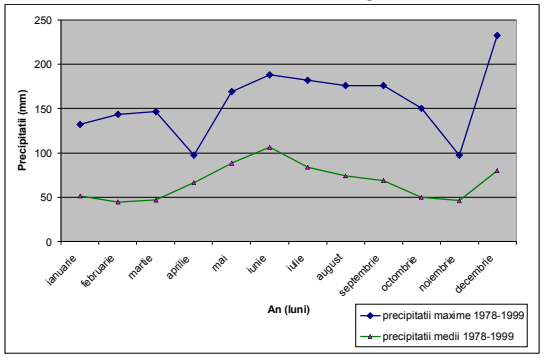

Figure 3 – The average rainfall fallen in Abrud – INHGA Abrud Gage

At the Rotunda and Abrud Gage, highest values of the monthly averages were of 91.8 mm (July) and 106.6 mm (June). As against the summer months, the rainfall values of the winter are lower, with overall average of 30 -50 mm.

In terms of the rainfall fallen in a period of 24 hours and the maximum is determined the surface runoff volume.

$\bar{P}_{multianuala} = 806,5mm$ - multiannual average rainfall at Abrud gage

$S_{b.h.} = 109km^2$ - Abrud watershed surface

$k = 0,42$ - the runoff coefficient

V_{sc} - the runoff volume of rainfall in a medium year

$V_{sc} = \bar{P} \; S_{b.h.} \quad k = 36.852,9 \quad 10^3 cm \rightarrow Q = 1,168 m^3/s$

The most significant rain was recorded in 1936 July at Deva, 262 mm in 24 hours. This phenomenon has produced at a distance of only 50 km South of Rosia Montana. [Drobot, 2004]

The runoff coefficients vary very much for small watersheds, between 35 – 80 % and depend on the hill slope, afforestation coverage, the soil texture of each sub-basin.

For the probable maximum precipitation for the summer is thought a reasonable runoff coefficient of 80%. The coefficients for the phenomena of probable maximum precipitations that vary between:

30 – 45% for a probability of 10%; 35 – 60% for a probability of 1% and 50 – 70% for a probability of 0.1% or greater. The domain limits of variation correspond to the minimum duration and maximum rainfall respectively [Drobot, 2004].

2.2 THE WATER QUALITY ISSUES

The mining of Rosia Montana area has been practiced since Roman period.

Table 2 – The surface water quality of Rosia Montana

i	Sampling point	Water course	Surface water grading				
			I	II	III	IV	V
1	S17	BUCIUM (Valea Albă)				X	
2	S18	ŞESII Buciumani	X				
3	S19	VALEA BUCIUMULUI înainte de valea Izbicioarei	X				
4	S20	IZBICIOARA					X
5	S01	ABRUD					X
6	S21	MUNTARI Abruzel, din depozitul de steril Roşia Poieni					X
7	S22	PETRENI curs superior Abruzel	X				
8	S02	ABRUZEL înainte de Abrud					X
9	S03	ABRUD înainte de Corna					X
10	S32	Cârnicel (vechi depozite de steril)					X
11	S33	Cârnicel (după vechile depozite de steril)					X
12	S04	Corna înainte de abrud					X
13	S05	CERNITA înainte de Abrud					X
14	S06	ABRUD înainte de valea Seliştei					X
15	S07	SELIŞTE înainte de abrud					X
16	S23	Abrud înainte de depozitul de steril Gura Roşiei					X
17	S08	ABRUD înainte de valea Roşiei					X
18	S09	Roşia Montană după evacuarea preaplinului de la concasor					X
19	S10	Roşia Montană, înainte de râul Abrud					X
20	S11	ABRUD după valea Roşiei					X
21	S12	ABRUD înainte de râul Arieş					X
22	S13	ARIEŞ înainte de râul Abrud				X	
23	S14	ARIEŞ înainte de Valea Ştefancei					X
24	S15	STEFANCA înainte de Arieş				X	
25	S16	ARIEŞ după Valea Ştefancei				X	
26	S24	VALEA ŞESEI Lupşa înainte de Arieş					X
27	S25	Sărtaş evacuare de ape de steril înainte de Arieş					X
28	S27	Râul Arieş la Lunca	X				
29	S26	Râul Arieş la Sărtaş				X	
30	S28	Mureş la Alba Iulia			X		
31	S29	Curs superior RM înainte de Tăul Mare		X			
32	S30	Curs RM după Tăul Mare		X			
33	S31	RM Valea Nanului				X	

The water courses of Roşia Montana area (table 2) is characterized by water shadiness because of the water from the old mines, of the rock dumps flows and from the settling ponds, the households and industrial activities [Raport, 2006].

The mining activities of the upstream especially from Bucium (Valea Alba) and Abruzel springs represent the pollution sources. The dilution ensured to a certain extent by other tributaries makes to improve the Abrud water quality.

Corna River is significantly polluted by the mine water discharges, although until the flow in Abrud is produced a considerable dilution (Table 2). Rosia Montana tributary has a high pollution degree (e.g. 600 mg/l SO_4; Q_{min} =0.01148 cm/s) and downstream of the confluence with Aries River is produced a significant dilution after mixing (226.47 mg/l SO_4).

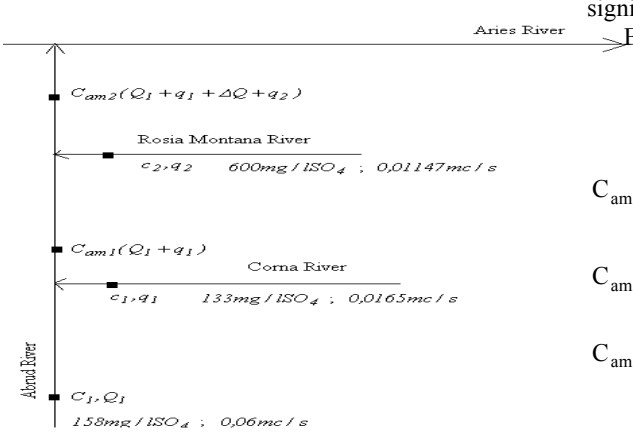

Figure 4 – The SO_4 concentrations on the water courses of Rosia Montana area

$$C_{am} = \frac{C \quad Q + c \quad q}{Q + q}$$ - the mixing concentration

$$C_{am1} = 152{,}6 mg/l \quad SO_4$$

$$C_{am2} = 226{,}47 mg/l \quad SO_4$$

$d = \frac{Q+q}{q}$ - the dilution coefficient

$d_1 = 4{,}636$

$d_2 = 6{,}23$

The water quality from Aries is improved by the discharge contribution from the clean tributaries until it receives the water of Stefanaca Valley – the poorly pollution of the settling pond and then of Sesii valley – extremely contaminated of the mining water discharges from Rosia Montana.

3. CONCLUSIONS

After the drawoff of the initial data could make an analysis of the surface runoff of Rosia Montana area and one establish the runoff volume of Abrud watershed.

The runoff coefficients of this area vary between 35% and 80% and they depend of the hill slope, afforestation coverage, the soil texture of each sub-basin. Seeing the concentrations determined for Abrud - Corna - Rosia Montana - Aries sector, the dilution, a significant downstream of the confluence with Aries was determined

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