

EROSION OF THE HILLSIDE OF THE FORMER BAUXITE QUARRY IN THE PADUREA CRAIULUI MOUNTAIN, ROMANIA

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Abstract. The paper is based on the researches carried out during 2005–2007 in the former bauxite quarry of Zece Hotare, the Bihor county. After the end of the bauxite exploitation in 1998, in 2004–2005 large works took place in the former bauxite quarry. Considering the slope, mattresses were made on the hillside of the former quarry. Determinations carried out in 2008 show the covering degree with natural vegetation of 80% on the hillside with a 20% slope, of 69% on the hillside with a 31% slope and of 57% on the hillside with a 44% slope; as a consequence, the land losses were of 5.2 t/ha on a 20% slope, of 8.6 t/ha on a 31% slope and of 15.4 t/ha on a 44% slope. The absence of the mattresses on the hillside with a 10% slope determined a land loss of 100.6 t/ha in comparison with the loss of 3.9 t/ha registered on the hillside with mattresses.

Keywords: erosion, hillside, mattress, former bauxite quarry.

AIMS AND BACKGROUND

Erosion affects the hillside of the former bauxite quarry, too, and the paper studied this phenomenon in the Padurea Craiului mountain under the influence of the slope and the mattresses.

Erosion is a natural process produced under the rainfall or wind influence and consists of soil, land or rock detaching, their transport and sedimentation in other places^{1,2}. This phenomenon had been observed far back by Plinius the Old but particular researches were carried out at the beginning of XX century^{3–6}.

Erosion phenomenon affects the ploughed land of north-western Romania and determines big losses of soil (4.5–70.8 t/ha/year in maize placed on hill down to valley in the Bihor county), humus (64 110 t/year in the Bihor county), fertilisers (4863.8 t/years phosphorus and 4366.2 t/year potassium in the Bihor county) and yields (10–52% in maize cropped from hill to valley in the Bihor county)^{7–9}.

EXPERIMENTAL

The researches were carried out at a bauxite quarry located in Zece Hotare, the Bihor county. The exploitation of bauxite ended in 1998, and in 2004 and 2005

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large-scale works for setting up, levelling and acacia tree planting on the levelled area as well as spruce tree on the slope area began^{10,11}.

The acacia and spruce tree saplings were planted at a 1-m distance on every row, and at a 2-m distance between rows. The holes had $40 \times 40 \times 40$ cm in dimension, and 6.0 kg of manure were used for each hole. In order to ensure a high rate of plant development, right after being put into the ground they were watered with 16.0 l water each. On the hillside of the quarry, mattress was made out of oak stakes and beech rods at a 2-m distance in order to prevent soil erosion (Fig. 1).



Fig. 1. Beech tree mattress after being set up (2004), in the former bauxite quarry of Zece Hotare, Bihor

Two experiments were made. The first was made on the hillside with slopes of 20, 31 and 44% with works against erosion consist of mattresses and planted with spruce tree. The second experiment was made on hillside without and with mattresses and planted with spruce tree, on the level curves, too.

The covering degree of natural vegetation was established by counting. The data regarding the covering degree were processed by variance analysis methods¹¹.

RESULTS AND DISCUSSION

Erosion potential in the Zece Hotare area. The multiannual average of the rainfall in the Zece Hotare area is 615.1 mm. The biggest monthly quantity of the rainfall is registered in June, 84.7 mm. In the research period, the year with the biggest quantity of rainfall was 2006, 872.0 mm; 815.8 mm were registered in 2005 and the most droughty year was 2007, with 585.2 mm, only (Fig. 2).

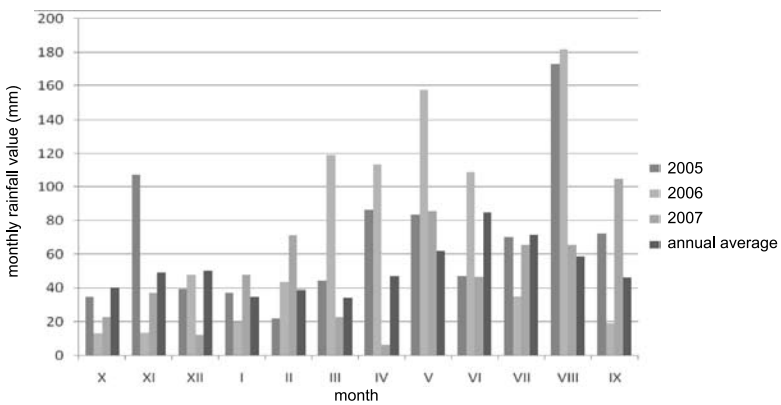


Fig. 2. Monthly values (mm) of the rainfall registered in the area of the former bauxite quarry at Zece Hotare 2005–2007

The rainfall registered in 24 h was used for emphasising the rainfall aggressiveness under the hillside of the former bauxite quarry. Analysing the maximum values for every month of the year it is clear that the biggest quantity of rainfall fall in 24 h in June. In the average of the summer months, the biggest quantity of rainfall fall in 24 h was registered 52.0 mm, in comparison with 40.0 the average value for spring, 39.7 the average value for autumn and 30.4 mm the average value for winter. In average on the year the biggest values of the rainfall in 24 h were registered in 2005, 20.31 mm, in 2006 a quantity of 11.9 mm/24 h and 11.46 mm/24 h were registered in 24 h in the year 2007. The biggest monthly quantity of rainfall fall in 24 h was registered in August 2005 – 35.4 mm. In the years 2006 and 2007, the biggest quantity were registered in August, too – 23.4 and 25.6 mm (Table 1).

Slope influence on erosion. The determination was carried out in spring (April) of 2008 on the hillside of the former bauxite quarry with the following slopes: 20, 31 and 44% . In 2004 the mattresses were made on these hillside and spruce trees were planted. The determinations show that the natural vegetation (*Calamagrostis epigeios*, *Tussilago farfara*) covers 80% of hillside surface with 20% slope, 69% of the hillside surface with 31% slope and 57% of the hillside surface with 44% slope (Table 2).

Table 1. Maximum rainfall (mm) registered in 24 h in the area of the former bauxite quarry of Zece Hotare, Bihor, 2005–2007

Specification	Month												Average
	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	
Value	58.0	29.0	28.0	37.0	26.3	29.2	45.8	45.0	61.3	49.6	45.1	32.1	40.53
Value	12.8	19.2	4.8	12.9	17.9	18.7	25.8	28.2	31.2	19.2	36.4	16.6	20.31
Difference versus multian- nual average	-45.2	-9.8	-23.2	-24.1	-8.4	-40.5	-20.0	-16.8	-30.1	-30.4	-8.7	-15.5	-20.22
%	-78	-34	-83	-66	-32	-36	-44	-33	-49	-63	-39	-49	-49
Value	2.0	3.4	12.4	19.0	7.3	16.0	14.8	9.8	20.4	11.8	23.4	2.4	11.90
Difference versus multian- nual average	-56.0	-25.6	-15.6	-18.0	-19.0	-13.2	-31.0	-35.2	-40.9	-37.8	-21.7	-29.7	-28.63
%	-97	-89	-56	-49	-73	-46	-68	-79	-67	-76	-49	-93	-71
Value	11.2	5.7	7.4	7.5	11.2	5.6	1.0	20.4	11.4	10.2	25.6	20.4	11.46
Difference versus multian- nual average	-46.8	-23.3	-20.6	-29.5	-15.1	-23.6	-44.8	-24.6	-49.9	-39.4	-19.5	-12.0	-29.17
%	-81	-80	-74	-80	-58	-81	-98	-55	-82	-79	-44	-47	-72

* Agricultural year.

Table 2. Slope influence on covering degree with natural vegetation on the hillsides of the former bauxite quarry of Zece Hotare, 2008

Hillside slope (%)	Covering degree with natural vegetation (%)		Difference (%)		Statistically significant
20	80	100.0	–	–	control
31	69	86.3	–11	– 13.7	–
44	57	71.3	–23	– 28.7	–

LSD 5% 3.1; LSD 1% 5.6; LSD 0.1% 8.8.

As consequence, the erosion had different values in function of the slope. The smallest value of the erosion was registered on the 23% slope, 5.2 t/ha. In the hillside with slope of 31%, the erosion increased with 65.3% (8.6 t/ha) and on the hillside with slope of 44%, the erosion increased with 196.2% in comparison with the hillside with 20% slope (Table 3).

Table 3. Slope influence on land losses from the hillsides of the former bauxite quarry of Zece Hotare, 2008

Hillside slope (%)	Land losses		Difference	
	(t/ha)	(%)	(t/ha)	(%)
20	5.2	100	–	–
31	8.6	165.3	3.4	65.3
44	15.4	296.2	10.2	196.2

Mattresses influence on erosion. There were determinations in the spring of 2008 on the hillside without mattresses but with spruce trees planted on the level curves and on the hillside with mattresses. The hillside slope is 10%. Determinations show a degree of the natural vegetation covering 94% on the hillside with mattresses; the species were *Calamagrostis epigeios*, *Tussilago farfara*, *Cirsium arvense*. A smaller degree of vegetation covering 15% was determined on the hillside without mattresses and with spruce tree planted on the level curves; *Tussilago farfara* and *Cirsium arvense* were met and *Calamagrostis epigeios* was absent. The difference is very significant statistically (Table 4). As consequence, on the hillside with 10% and with mattresses on the level curves, the erosion was 3.9 t/ha. On the hillside without the mattresses, the erosion (100.6 t/ha) increased with 2479.5% (Table 5).

Table 4. Influence of the mattresses on covering degree with natural vegetation on the hillside of former bauxite quarry of Zece Hotare, 2008

Variant	Covering degree with natural vegetation (%)		Difference (%)		Statistically significant control
1. Hillside with 10% slope and mattresses	94	100	–	–	
2. Hillside with 10% slope and without mattresses	15	15.9	–79	–84.1	–

LSD 5% 3.9; LSD 1 % 7.2; LSD 0.1 % 13.8.

Table 5. Influence of the mattresses on land losses of the hillside of former bauxite quarry in Zece Hotare, 2008

Variant	Land losses		Difference	
	(t/ha)	(%)	(t/ha)	(%)
1. Hillside with 10% slope and mattresses	3.9	100	–	–
2. Hillside with 10% slope and without mattresses	100.6	2579.3	96.7	2479.3

Aspects from the locations of the experiments are presented in Figs 3 and 4. We can observe the land erosion and small degree of vegetation covering the hillside without mattresses and high degree of vegetation covering and low erosion on the hillside with mattresses.

CONCLUSIONS

Researches carried out during 2005–2008 in the former bauxite quarry of Zece Hotare in the Padurea Craiului mountain determined the following conclusions.

There is an erosion potential in the area of the former bauxite quarry. The maximum values of the rainfall fall in 24 h were registered in August: 36.4 mm in 2005, 23.4 mm in 2006 and 25.6 mm in 2007.

The slope of the hillside influenced very much the land losses. The smallest losses were registered at the slope of 10%, 5.2 t/ha. The increase of the slope to 31% determined the increase of the land losses with 65.3%; the biggest land losses, 15.4 t/ha were registered at the biggest slope, 44%.

The increase of the slope determined the decrease of the covering degree (%) with natural vegetation: 80% at 20% slope, 69% at 31% slope and 57% at 44% slope.

The presence of the mattresses on the hillside with 10% slope determined an erosion of 3.9 t/ha. The absence of the mattresses determined the increase of the erosion (100.6 t/ha) with 2579.5%.

The absence of the mattresses on the hillside with 10% slope determined a covering degree with natural vegetation of 15% in comparison with 94% on the hillside with mattresses on the level curves.

The results of researches sustain the importance of the mattresses in the erosion control on the hillsides of the former bauxite quarry of Zece Hotare, in the Padurea Craiului mountain, Romania.

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