SOME ASPECTS CONCERNING EVALUATION OF THE ALLUVIA SOURCES FROM AGRICULTURAL WATERSHEDS

Sevastel Mircea

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd., District 1, 011464, Bucharest, Romania, e-mail: smircea@usamv.ro

Abstract

Soil erosion and conservation represents a huge problem for the agricultural land sloping in Romania, as well as for the water bodies, especially during the last twenty years. Sediments themselves are also a pollutant in a broad sense, and together with some chemicals carried out downstream, can increase the level of nutrients in water bodies, contributing in this way in time to water eutrophication. The paper presents mainly some aspects concerning the alluvia sources, their producing and transport process from the small agricultural torrential watersheds, as well as their evaluation, as a result of a case-study carried out in the hilly region of the Buzau Sub-Carpathian Curvature. There are taken into account and briefly evaluated by different methods – by deterministic models or direct measurements in the field on the runoff plots from the Aldeni-Buzau Soil Erosion Research Station, both sheet and gully erosion, as well as some appreciations on the landslides and riverbanks erosion, as the major sources of alluvia from a given torrential watershed.

Key words: land degradation, soil erosion, alluvia, torrential watersheds, runoff plots, gully erosion

INTRODUCTION

Soil erosion process, as a natural hazard, is well known as being one of the major causes of the hilly land degradation in the world. Practically, amongst all natural disasters (water erosion, landslides, floods, fires, draughts, earthquakes etc.) – that are frequently confronting Romania too, especially in the last period of time, it is considering that water erosion is the most important factor, having a huge impact, both social-economical and ecological ones, on-site and off-site. Today, it is well known that the most important negative impact that water erosion has on environment is soil fertility loss, with a huge final effect on the prices increasing of the food as well as on downstream water bodies' premature siltation. Competent and relevant scientific analysis carried out in the last period of time have shown that, in the world and on a long term, water erosion represents one of the most important current problems of the humanity, vital for its progress and economically stability and viability (Brown, 1988).

The alluvia origin issue from a torrential watershed has became crucial in the world in terms of sources identification and potential causes of downstream water pollution, as well as the establishment of the antierosion strategies. Despite the lack and/or inappropriate information at the world scale concerning the provenience of the sediments from the water bodies, somehow considerable progresses have been made by the soil erosion specialists in terms of conceptualization and better understanding of the erosion process from the small watersheds, and the fact that both rainfalls erosivity and soils erodibility represents the key factors that governments sediments' mobilization from the watersheds (Morgan, 1995).

The impact of soil erosion and sediment deposition occur both on- and off-site. On-site impact is particularly important on agricultural land where redistribution of soil within a field, the loss of soil from a field, the breakdown of soil structure and the decline in organic matter and nutrients result in a reduction of cultivable soil depth and a decline in a soil fertility. Off-site impact result mainly from lowlands and waters sedimentation downstream, which reduces the capacity of rivers and retention ponds, enhances the risk of flooding and muddy floods and shortens the design life of reservoirs. Sediments themselves are also a pollutant in its own right and, together with some chemicals carried downstream, can increase the level of nutrients in water bodies, contributing in this way to water eutrophication. Compared with on-site impact, off-site impact is easier measured and can be expressed in economic terms (Anton, J.J. *et al.*, 2003).

MATERIAL AND METHOD

In the Curvature zone of the Carpathians – this being one of the most affected area by water erosion and landslides from Romania, one of such affectyed watersheds is represented by Slanic Valley Watershed, from Buzau County, having a total surface of 54,440 hectares and the lenght of 65 km. In Buzau County has been inventaried a gully erosion network of about 1,000 km, that represents about 1,000 hectares of agricultural lands (Mircea, 2000, 2006).

Having in view the complexity of the land degradation processes in the Slanic Valley watershed, a huge interest is represented by several of the sub-watersheds, being mainly located in the low and medium third parts of the watershed, which were taken into study in this paper, such as (Figure 1 and Table 2): Basti/Draghici, Oarzei, Irimesti, Caldaresti, Vladului and Plutesului – that are located on the left side of Slanic River, respectively Putului/Galbeaza, Balaurului, Mereului, Road's Valley, Tatarului and Funduri Valley - that are located on the right side of Slanic River.

It has to be mentioned here that all those sub-watersheds – actually, as well as the main majority of the rest of the watersheds from the Curvature zone of Carpathians, present gully erosion on the valleys' talwegs (Stefanescu A. et al., 1992). Practically, it can be said that there is no one valley talweg from a certain sub-watershed from Slanic Valley watershed without gully erosion processes. Hydrographical network developing in this region is mainly conditioned by some natural factors, the main important being the rainfall erosivity and geological structure, as well as the steepness of the versants and talwegs (ISPIF, 1992). The agricultural lands on the slopes cover about 35% from the total surface of the County and are severe affected by water erosion. In this area soil losses reach locally to about 30-45 tons/ha/year (Motoc, 1984).

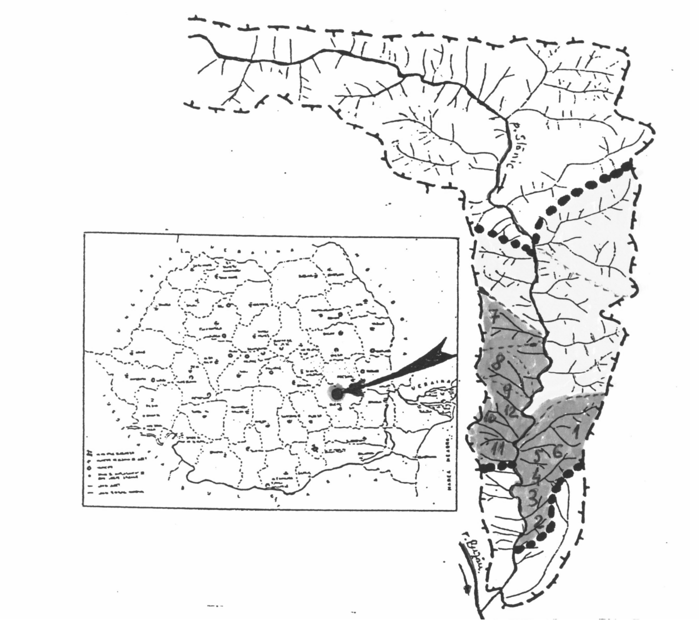

Fig. 2 Scheck of the Slanic-Buzau watershed with the sub-watersheds taken into study

With respect to the sediment sources in making-up of total erosion in Romania, Motoc M., 1984, has paid a special attention (Table 1).

Table 1

Table 1 Total erosion by types of water erosion in Romania (Motoc M., 1984)

No.	Type of erosion	Total erosion	
		million tons / year	% from total erosion
1	Surface erosion	61.8	49.0
2	Gully erosion	29.8	23.6
3	Landslides	15.0	11.9
4	Gully erosion on woodland	6.7	5.3
5	Riverbanks and localities erosion	12.7	10.2
	TOTAL GENERAL	126.0	100.0

For the studied area, in each sub-watershed, a soil erosion prediction was done by using some Romanian deterministic models (Motoc M. et al, 1979), models that are presented below as well as the results in the Table 2.

In the meantime, for the comparison of the obtained results, soil loss was measured direct on the runoff plots (Figure 2).

Long-time field measurements, since 1970, conducted at the Soil Erosion and Conservation Aldeni Research Station - Buzau (Subcarpanthians Curvature zone) on the standard runoff plots of 40 m^2 and 100 m^2 respectively, (Figure 2), with loamy textured chernozomes and mean annually precipitation of about 450 mm, out of which about 350 mm are fallen during the vegetation period, April-September, illustrate the big influence of slope and crops cover on soil loss (Ionita et. al, 2006).

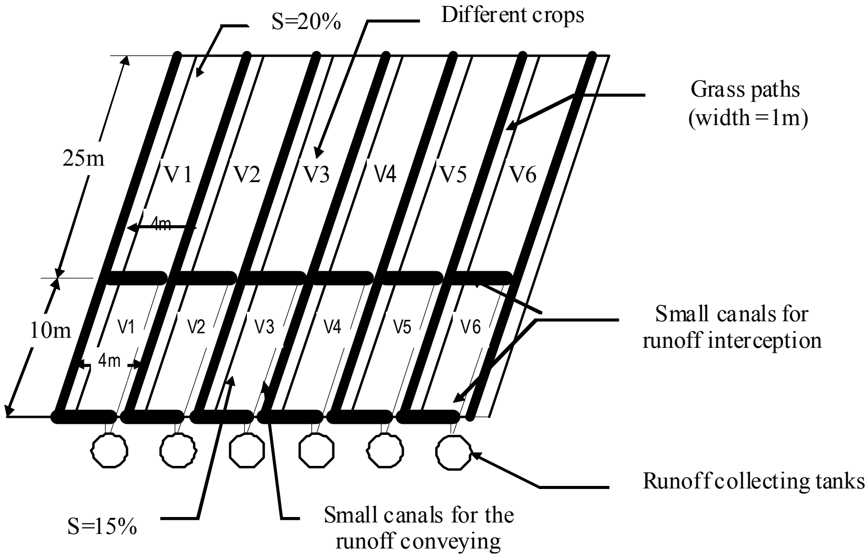

Figure 2 Sketch of the runoff plots at the Soil Erosion Research Station Aldeni / Buzau

Based on the research carried out over a long period of time, a prediction model for surface soil loss was developed (Motoc M. et al, 1979). The model has the same type as Wischmeier's USLE model, (Wischmeier & Smith, 1978), as follows:

$$E_s = K_a \cdot L^m \cdot i^n \cdot S \cdot C \cdot C_s$$

where:

E_s is the mean annual soil loss, in t/ha/year;

K_a - rainfall agressivity correction factor, having the values of 0.08÷0.16, which represents the ratio between soil loss on the standard runoff plots - having 100 m^2 (25 × 4 m), 15% slope and maintained bare soil - and I_p index (this I_p index represents the product by the total amount of precipitation (H - in mm) times the maximum I_{15} intensity (I_{15} - in mm/min) for a given rainfall;

L^m - the slope length factor with L in meters;

i^n - the slope steepness factor, with i in %; S is the soil erodability factor, which have been determined using information from runoff plots under natural rain;

C - the crop management factor, and

C_s - the erosion-control practice factor.

For gully erosion prediction experiments have been conducted by comparing aerial photographs taken at least at ten years time intervals. As indicator, the volume of annual eroded soil from the gully active surface unit was used.

Computing the total annual volume of eroded soil by gulling is as follows:

$$W_s = q \cdot S_{active}$$

where W_s is the total annual volume of eroded soil by gulling, in m^3/an; q is the volume of sediments, in m^3/ha/year and S_{active} is the gully active surface, in hectares

RESULTS AND DISSCUSIONS

Soil detachment process and transportation of the sediments is being considered as a complex system compounded by versant subsystems, a small watershed with ephemeral discharge and watersheds with permanent discharge, as it is schematically presented in the Figure 3 (Mircea S., 2006).

1.1

1. Versant subsystem 2. Small watershed subsystem with ephemeral discharge 3.Watershed subsystem with permanent discharge

Figure 3 Simplified diagram of soil erosion and solid discharge in a certain watershed

Experimental research and the obtained results, as regard to soil loss, are referring to the first two subsystems, namely to the surface erosion on versants as well as gully erosion. In the versants subsystem the rainfalls represent one of the input elements and their most important characteristic is represented by the amount of the rain as well as the kinetic energy. Runoff on the versants' slopes is based on micro-rills and, formation, duration, discharge and sediments amount vary with the input, respectively with the precipitations, infiltration capacity, shear strengths of the soil, soil roughness, and the state of the soil surface after agricultural practices.

Another input element is representing by the slope of the versants. The energy of the concentrated micro-flows increases accordingly with the versants' slopes (Mircea, 2008). As a result of the micro-flows appear the rills *(ephemeral gully)*, having different depths. These rills can be erased through out agricultural practices on contour lines, or, contrary, can quickly develop and transform in gully erosion, having different sizes whether they are not destroyed in due time through out the agricultural works.

Total and effluent soil erosion prediction model from a given watershed is as follows (Motoc M. et al, 1979):

$$E_{efl} = E_{tot} * c_e \qquad \text{(t/ha.yr)}$$

where:

Ee_{fl} (t/ha/yr) is the effluent erosion (amount of sediments at outlet);
E_{tot} - total erosion (t/ha.yr);
c_e - effluent alluvia coefficient (c_e <1).

$$E_{tot} = E_{sa} + E_{al} + E_{ad} + E_{other\ sources} \qquad \text{(t/ha.yr)}$$

where:

E_{sa} - surface erosion, (t/ha.yr);
E_{ad} - gully erosion, (t/ha.yr);
E_{al} - erosion from landslides, (t/ha.yr);
$E_{other\ sources}$-erosion from other sources (localities, roads, riverbanks).

Surface soil erosion prediction was done for the 11 sub-watersheds, by using Motoc model (Motoc M. et al, 1979), as presented in the Table 2.

Table 2

Soil loss prediction in some sub-watersheds from the Slanic/Buzau watershed

No. crt.	Ver-sant	Sub-watershed	Watershed area (ha)	Soil loss (t/ha.yr)
1	LEFT	V. Vladului	98.73	0.39
2		V. Plutesului	112.50	0.54
3		V. Vladului	98.73	0.39
4		V. Caldaresti	294.32	5.74
5		V. Irimesti	176.25	6.52
6		V. Baesti	655.00	16.22
7	RIGHT	V. Balaurului	478.75	11.63
8		V. Mereului	86.25	8.68
9		V. with Drum	78.75	4.05
10		V. Tatarului	51.25	5.74
11		V. Funduri	160.62	18.21

CONCLUSIONS

Having in view the great necessity in the world do develop new prediction models for soil erosion, there are strong preoccupations in this respect in Romania too. The most important amount of sediments comes from the surface erosion. In some sub-watersheds there are recorded soil losses that are 2-3 times more than the tolerable erosion, which is of about 5-6 t/ha.yr, the main causes being the agricultural works done mainly from up to down as well as the presence of large areas of pastures that are very high degraded.

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