QUANTITATIVE ESTIMATES OF SEDIMENT DEPOSITED BY SURFACE EROSION FROM BONTIDA-GHERLA PERIMETER USING THE HYDROMETER (SIMULATED RAINFALL)

Dirja M., A. Pop, Adela Hoble, T. Salagean
University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture, 3-5 Manastur St., 400372, Cluj-Napoca, Romania; dirjamarcel@yahoo.com

Abstract. Soil (ground) is for people amid social and economic activities, natural resource invaluable, the most precious wealth of a nation. From this point of view, Romania has a great wealth, especially given balanced structure planning: third area of forests, meadows third of hills, orchards and vineyards and third lowland land where farming takes place. We live in an excessive continental climate area, prolonged droughts and growth in the last 10 years, annual average temperatures 0.2 to 0.6 ° C and decreasing precipitation with 10 to 15 mm, to multi-annual averages, due current decrease geosystem reveals a clear tendency to increasing and expanding desertification phenomena and land degradation especially in the south and east of the country, however the necessary impetuous clear evidence nationally, regionally for different areas (hilly area of lowland, mountain) land situation in Romania. Preventing soil erosion requires measures imposed by climatic characteristics of the area and socio-economic status, medium and long term actions to improve the situation of soil, which can then be combined nationwide to save and to ensure rational use and exploitation and sustainable land it holds Romania, regardless of land ownership.

Keywords: heavy rains, soil runoffs, water runoffs, simulated rainfalls, hydrometer

INTRODUCTION

To identify risk areas for soil erosion is necessary to set limit values of tolerance levels and set the type of soil and its characteristics, except that vary from region to region and depending on the type coated surface of the land.

Degree of soil erosion is considered acceptable within certain limits, different for different geographical areas, starting from a value of 0.4 ha to 15 ha annually. In Romania maximum acceptable limit soil erosion process is about 5-6 ha · year^{-1} (ROJANSCHI, 1997).

The limit values are values below which ecosystems are not in equilibrium with the risk in terms of triggering accelerated erosion and are important for understanding the relationship between geomorphological and hydrological processes, is easily monitored through process modeling (BORDMAN, 2006; BAARTMAN *et al.*, 2007).

Tolerance levels they relate to environmental, economic and social, which are determined by the degree and intensity of erosion cannot be sustained.

Phenomena that lead to the elimination of soil fertility are called phenomena or degradation processes. The report JRC (Joint Research Centre) of the European Commission "Addressing soil degradation in EU agriculture: relevant Processes, Practices and Policies", 2009, presented at the annual meeting of the American Association of Advanced Science (AAAS), are the six processes Soil degradation: erosion, organic matter decline, compaction, salinisation, contamination and biodiversity decline, which risk factors should be monitored to reduce negative effects on soil fertility occurs continuously.

Soil erosion occurs corresponding to climatic zone, as determined by geo-climatological data (P = height monthly rainfall - mm, E = potential evapotranspiration - mm, using Thornthwaite method, Δ_{-}= PE, water scarcity, monthly and yearly or Δ_{+} = PE, monthly and annual water surplus, ΔN = Σ (EP), cumulative net impairment during the year; t = monthly average temperature, P · n-1 = monthly or annual rain height ratio of the number of days with precipitation greater than 1 mm to characterize the intensity of rainfall, even in hilly areas where climatic conditions have a high spatial variation and greater uniformity in time (IONESCU, 1972).

MORGAN and QUINTON (2001) considered to assess the intensity of erosion following: erosive potential energy – capable of energy to detach soil particles and later to transport, with the most important indicator slope, potentially eroded soil material depends on the parent material, particularly its solubility, transport capacity - dependent on the flow velocity and erosion energy and current erosion - is lower than the potential.

To work to prevent and combat soil erosion interested in pouring rain with insurance typically 10% (NICOLAU et al., 1970; DÎRJA, 2000) and are considered heavy rain, so heavy with aggressive, to be taken into account rains whose core torrential 15-minute intensity is at least 0.6 mm · min-1 (BIALI and POPOVICIU, 2006). Rainfall intensities greater than about 1 mm min-1 · beyond what they called the critical limit and result in the initiation and development of erosion on slopes (DÎRJA, 2000).

Soil formation process is lengthy, estimates, indicating an average rate of between 0.05 and 0.5 mm · year^{-1} (EEA, 1999 cited by GOBIN, 2004) and soil loss of more than 1 t · ha^{-1} yr^{-1} in some areas (JONES et al., 2003).

MATERIAL AND METHOD

Data from simulated rain were recorded using hydrometer depending on soil moisture and hydrology leakage after similar heavy rains the nucleus in the middle and at the end, as noted generic dry soil and wet soil.

Summarized in figure 1 are shown the values obtained in the field, on the volume of total leakage (leakage of water and soil) recorded from the simulated rainfall intensity of 0.8 and 1.5 mm • min^{-1}, determined in experimental plots in the area of improving Bonţida - Gherla.

Research on drainage, erosion and infiltration with simulated rain plots ecologically restored area ameliorative Bontida-Gherla objectives were established:

- Determine the flow of water and soil;
- Determining discharge coefficient;
- Determination of soil water infiltration;
- The speed of infiltration.
- Pursuing the factors graduations number as follows:

Factor A - rain intensity: a_1 - intensity 0.8 mm · min^{-1}; a_2 - intensity 1.5 mm·min^{-1}.

Factor B - soil moisture for hydrology leakage, similar to heavy rains the nucleus in the middle and at the end: b_1 - dry soil; b_2 - moist soil.

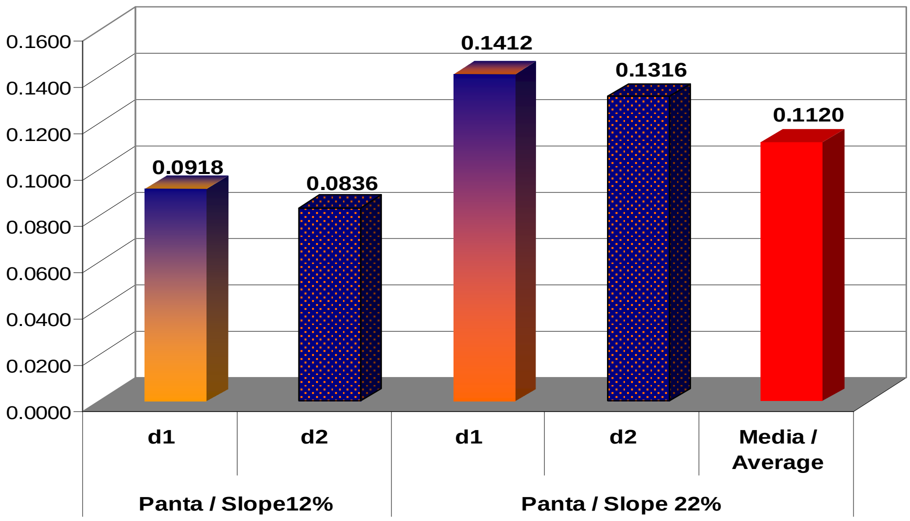
Factor C - slope: c_1 - 12% slope; c_2 - 22% slope.

Factor D - control surface:d_1 - good grass (pasture moderately degraded); d_2 - with under three plantation forest (ecological reconstructed surface.

Hydrometers wired to produce droplets are used to measure infiltration and resistance to soil erosion on small areas less than 1 m^2. I built hydrometer staff within the discipline of "land improvements" of UASVM Cluj - Napoca, existing model S.C.C.C.E.S. - Perieni, Vaslui County and after DÎRJA (1998).

Water and soil runoff resulting from rainfall simulated intensities (0.8 mm · min^{-1} and 1.5 mm · min^{-1}) were determined by the direct method of measuring volume flow, as determined amount of soil eroded, making it the g · m^{-2}, t · ha^{-1}. Measurements and determinations were made for each experimental variant in three repetitions. Discharge coefficient, soil water infiltration and infiltration rate were determined by indirect methods. The method used in obtaining data using the direct method and formulas used for stage dedicated data obtained by indirect methods were detailed in section working methods. Data on the results of water and soil runoff, determining discharge coefficient, determining soil water infiltration and infiltration rate determination is rendered as an average of three repetitions performed for each determination.

RESULTS AND DISCUSSION



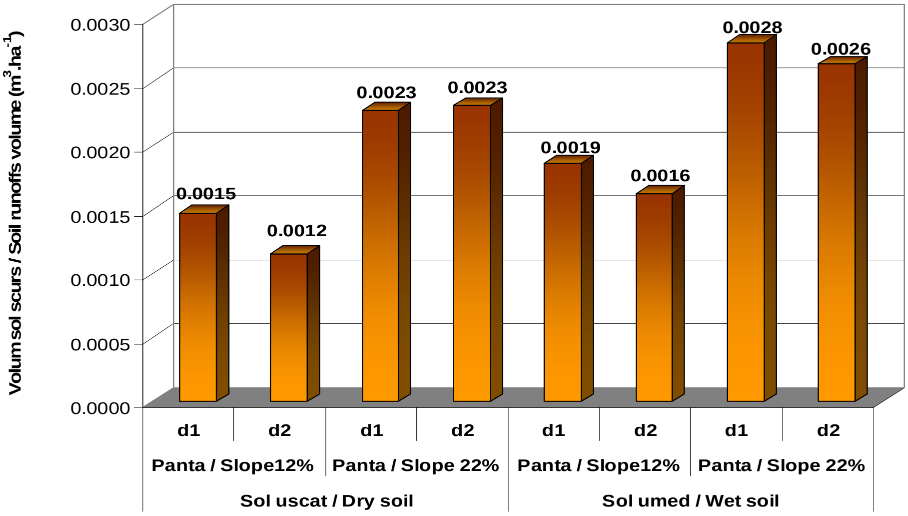
Note: d1 - *Moderated degraded pasture;* d2 –*Ecological afforested surface*.

Fig. 1. Mean values of total runoffs registered through 0.8 mm· min^{-1} simulated rains on experimental plots from Bonţida – Gherla perimeter (m^3 · ha^{-1})

In figure 1 is graphically presented mean values of total runoffs (m^3 · ha^{-1}) after the simulated rainfall intensity of 0.8 mm · min^{-1}, the values are average soil moisture status similar heavy rains in mid-core and finally (average dry land soil and wet soil).

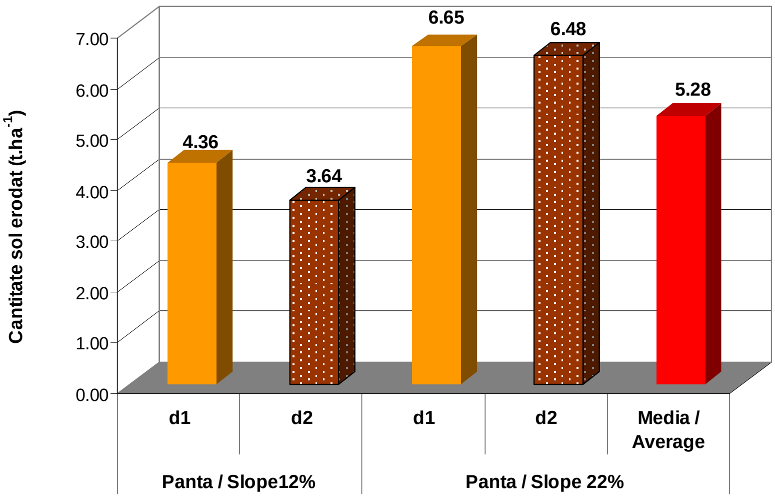
Figure 2 graphically presented eroded soil volume (m^3 · ha^{-1}) after the simulated rainfall intensity of 0.8 mm · min^{-1}, the values are average soil moisture status similar heavy rains in mid-core and finally (average dry land soil and wet soil).

In figure 1 is graphically presented mean values of soil eroded quantity (t· ha^{-1}) after the simulated rainfall intensity of 0.8 mm · min^{-1}, the values are average soil moisture status similar heavy rains in mid-core and finally (average dry land soil and wet soil).



Note: d1 - *Moderated degraded pasture;* d2 – *Ecological afforested surface*.

Fig. 2. Mean values of eroded soil volume ($m^3 \cdot ha^{-1}$) registered through 0.8 $mm \cdot min^{-1}$ simulated rains on experimental plots from Bonţida – Gherla perimeter



Note: d1 - *Moderated degraded pasture;* d2 –*Ecological afforested surface*.

Fig. 3. Mean values of soil eroded quantity ($t \cdot ha^{-1}$) registered through 0.8 $mm \cdot min^{-1}$ simulated rains on experimental plots from Bonţida (Cluj) perimeter

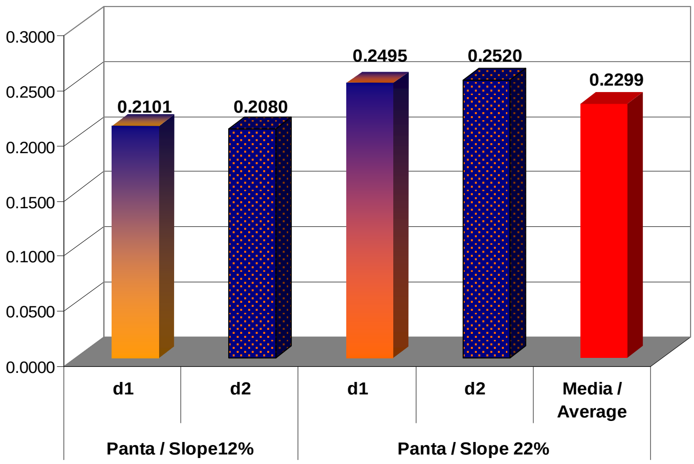
In Table 1 are given values for infiltration rate ($l \bullet min^{-1}$) and soil water infiltration (l per plot) and established experimental plots of the three stationary after simulated the rain intensity 0.8 mm • min^{-1} for 45 minutes).

Table 1

Water infiltration in soil and infiltration speed registered throug simulated rains with 0.8 mm · min^{-1} intensity on dry and wet soil, from Bonţida - Gherla plots

Variant		Surface type	Total runoffs	Water fall	Total water infiltration in soil	Infiltration speed
			(l· *plot*$^{-1}$)			l·min^{-1}
Slope side 12%	Dry soil	Moderated degraded pasture	85.98	360	275.50	6.12
		Ecologic afforested surface	76.56		284.60	6.32
	Wet soil	Moderated degraded pasture	97.57		264.30	5.87
		Ecologic afforested surface	90.63		271.00	6.02
panta / Slope side 22%	Dry soil	Moderated degraded pasture	130.28	360	232.00	5.16
		Ecologic afforested surface	120.02		242.30	5.38
	Wet soil	Moderated degraded pasture	152.21		210.60	4.68
		Ecologic afforested surface	143.14		219.50	4.88

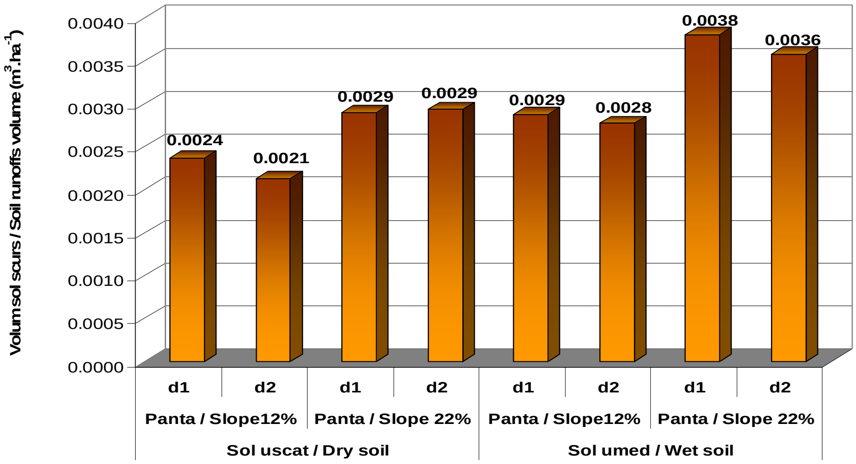
Figure 4 summarizes the values obtained are given land on the volume of total leakage (leakage of water and soil) recorded from the simulated rainfall intensity of 1.5 mm • min^{-1}, determined in experimental plots in the area of improving Bontida - Gherla.



Note: d1 - *Moderated degraded pasture;* d2 –*Ecological afforested surface*.

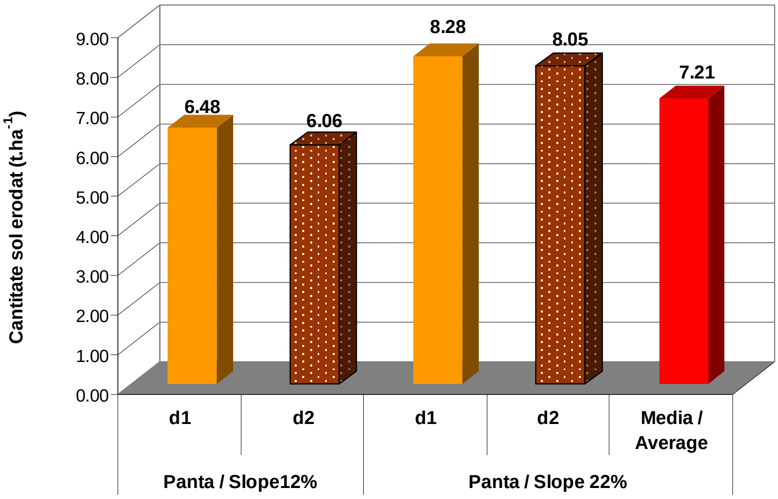
Fig. 4. Mean values of total runoffs registered through 1.5 mm·min^{-1} simulated rains on experimental plots from Bonţida - Gherla perimeter

Figure 5 graphically presented eroded soil volume (m^3 · ha^{-1}) after the simulated rainfall intensity of 1.5 mm · min^{-1}, the values are average soil moisture status similar heavy rains in mid-core and finally (average dry land soil and wet soil).



Note: d1 - *Moderated degraded pasture;* d2 – *Ecological afforested surface*.

Fig. 5. Mean values of eroded soil volume ($m^3 \cdot ha^{-1}$) registered through 1.5 $mm \cdot min^{-1}$ simulated rains on experimental plots from Bonţida - Gherla perimeter



Note: d1 - *Moderated degraded pasture;* d2 – *Ecological afforested surface*.

Fig. 6. Mean values of soil eroded quantity ($t \cdot ha^{-1}$) registered through 1.5 $mm \cdot min^{-1}$ simulated rains on experimental plots from Bonţida - Gherla perimeter

Based on the above data was calculated from simulated rainfall intensity to 1.5 mm • min^{-1}, the coefficient of discharge by indirect methods, soil water infiltration (liters per plot) and infiltration rate (l • min^{-1}) .

In Table 2 are given values for infiltration rate (l • min^{-1}) and soil water infiltration (l per plot) and established experimental plots of the three stationary after simulated the rain intensity 1.5 mm • min^{-1} for 45 minutes).

Table 2

Water infiltration in soil and infiltration speed registered for 7% slope side throug simulated rains with 1.5 mm · min^{-1} intensity on dry and wet soil, from Bonţida - Gherla plots

Variant		Surface type	Total runoffs	Water fall	Water infiltration in soil	Infiltration speed
			(l· plot^{-1})			l·min^{-1}
Slope side 12%	Dry soil	Moderated degraded pasture	211.87	675	465.50	10.34
		Ecologic afforested surface	216.73		460.40	10.23
	Wet soil	Moderated degraded pasture	208.37		469.50	10.43
		Ecologic afforested surface	199.27		478.50	10.63
panta / Slope side 22%	Dry soil	Moderated degraded pasture	238.49	675	439.40	9.76
		Ecologic afforested surface	250.44		427.50	9.50
	Wet soil	Moderated degraded pasture	260.41		418.40	9.30
		Ecologic afforested surface	253.58		425.00	9.44

CONCLUSIONS

The environmentally reconstructed surfaces (current brood over three years) was collected total leakage volume (water and soil) lower 0.0111 m^3 · ha^{-1} dry soil conditions, a larger volume of 0.0029 m^3 · ha^{-1} in the wet soil conditions, the average obtained from plots located in stationary conditions I - Bonţida - Gherla.

The environmentally reconstructed surfaces (currently with seedlings less than three years) were collected volume of total leakage (water and soil) lower 0.0164 m^3 · ha^{-1} dry soil conditions, a larger volume of 0.0067 m^3 · ha^{-1} in the wet soil conditions, the average obtained from plots located in stationary conditions II - Bonţida - Gherla.

The total volume of leakage was determined by weighing the mass of soil eroded subsequently drained soil volume from simulated rainfall intensity of 0.8 mm at · min^{-1} was obtained by the ratio between the amount of soil eroded, transformed from g · m^{-2}, in t · ha^{-1}, and soil density test plots (2.61 g · m^{-3}).

Average for reconstructed surfaces ecological experimental plots located on the side slope 22%, is 8.28 t ha^{-1}.

The highest values recorded on the amount of soil eroded (t · ha^{-1}) were determined from plots of degraded surface of all three stationary (denoted by d1 on schedule), yielding an average difference of higher total · 0.80 t ha^{-1}. The environmentally reconstructed surfaces (currently with seedlings less than three years) were collected volume of total leakage (water and soil) lower 0.0021 m^3 · ha^{-1} in average conditions of wet soil, dry soil, compared the overall average obtained from plots located in three bands stationary conditions.

REFERENCES

1. Baartman J. E.M., G.W.J. Van Lynden, M.S. Reed, C.J. Ritsema and R. Hessel (2007). Desertification and land degradation: origins, processes and solutions - A literature review. DESIRE report no. 4, Netherlands.

2. Biali G. and N. Popovici (2006). Amenjări pentru protecţia şi conservarea solului. Ed. Performantica, Iaşi.

3. Boardman J. (2006). Soil erosion science: Reflections on the limitations of current approaches. Catena, 68:73-86.

4. Dîrja M. (2000). Combaterea eroziunii solului. Editura Risoprint, Cluj-Napoca.

5. Gobin A., R. Jones, M. Kirkby, P. Campling, G. Govers, C. Kosmas and A.R. Gentile (2004). Indicators for pan-European assessment and monitoring of soil erosion by water. Environmental Science&Policy, 7:25-38.

6. Ionescu V. (1972). Combaterea eroziunii solului. Sinteză documentară. Consiliul Naţional pentru Ştiinţă şi tehnologie. ICDT, Bucureşti.

7. Morgan R.P.C and J.N. Quinton (2001). Erosion Modelling. In: Harmon&Doe III (eds), Landscape erosion and evolution modeling. Plenum Publishers, New York.

8. Jones R.J.A., Y. Le Bissonnais, J. Sanchez Diaz, O. Duwel, L.Oygarden, P, Bazzoffi, V. Prasuhn, Y. Yordanow, P.Strauss, B. Rydell, J. Berenyi Uveges, G. Loj, M. Lane and L. Vandekerckhove (2003). EU Soil Thematic Strategy, WP@: Nature and extend of soil erosion in Europe. V.3.31, 27pp.

9. Rojanschi V. (1997). Protectia si ingineria mediului. Editura Economica, Bucureşti.

10. ***JRC Report (Joint Research Centre) a Comisiei Europene ”Addressing soil degradation in EU agriculture: relevant processes, practices and policies”, 2009.