A METHOD FOR EXPERIMENTAL ASSESSMENT OF HILLSLOPE SOIL EROSION CAUSED BY WATER ACTION

O METODĂ DE ESTIMARE EXPERIMENTALĂ A EROZIUNII VERSANŢILOR DATORATĂ ACŢIUNII APEI

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Abstract. *This paper present an experimental method to assessment the hillslope soil erosion caused by the water action. We present the IMERE installation and the algorithm for the work with these installation. In this paper is shown the working parameters, the experimental data and the final estimators, and so the perspective of the using of these method.*
Key words: erosion, assessment,soil, slope

Rezumat. *Articolul prezintă o variantă experimentală de estimare a riscului de eroziune datorată acţiunii apei pe versanţi. Se prezintă instalaţia experimentala IMERE, concepută la ICDVV Valea Calugarească, precum şi algoritmul de lucru folosit pentru obţinerea estimatorului final al experimentului: pierderea de sol specifica unitaţii de suprafaţă, pe eveniment pluvial, precum şi a altor estimatori.*
Cuvinte cheie: eroziune, estimare, sol, pantă

INTRODUCTION

Estimating the risk of soil erosion on hillsides located, because the action of water, was a constant concern in the scientific sphere from the first half of the twentieth century and was consolidated in the years 1990 - 2000, the representative theoretical models were perfected in this area. Even if the tools are very modern theoretical and applied, primarily due to their convenience, their mathematical models based on experimental facts and observations are made in tens of years of study. On the other hand, theoretical methods used in the mathematical apparatus, many constants that can not be estimated only experimentally, and the same kind of relationship between groups of parameters. Experiment remains, therefore, absolutely necessary, either for direct estimation of the unknown or the assessment of factors and relationships between process parameters, but also to verify theoretical relationships or in part theoretical. The more so, is within the current empirical method for erosion risk assessment, developed in 2008, [1], [2]. In previous articles about this method, we present installation IMERE, with which to do experiments, [1], and the main results obtained and to investigate applications of this plant in erosion processes, but also in other areas such as agriculture accuracy, [2]

MATERIAL AND METHOD

The results obtained were used using mobile plant for erosion risk assessment, designed and made to ICDVV Valea Călugărească .The installation of erosion experiments conducted using the "rain" artificial, with adjustable intensity.The main elements of installation are:

1. Water source. They used two water sources: one from Drinkable water pressure (5.5 bar) and a network of drinking water without pressure, in this case to use an electrically operated pressure pump having high pressure to 3.5 bar required to run sprinklers

2. The distribution. The distribution, is mounted on a workbench and is composed of a shift valve (which regulates the working pressure, which indirectly regulates the flow of water supplied), metal pipes, pressure gauge which monitors the working to maintain the desired water flow. Water is metered by a watermeter distribute (which helps us to know at any time how much water travels through cnducte), after which water is distributed on two parts This distributor has two valves, filters and sockets for quick coupling hose that carries water to the two sprinklers.

3. Wings of spraying. Oscillating sprinklers have been used for spraying on surfaces for rectangular (square or rectangular), with continuous adjustment of working width and amplitude of oscillation as determined area sprayed. Sprayed area (between 28 sqm and 350 sqm) is adjustable in offering very low rates may, within these limits, we want to get any sprayed area, along with measuring the amount of water (by watermeter), to determine the amount of distributed water per square meter.

4. Pipe sediment collection. The pipeline, which acts as a sewer is constructed by cutting in half of a plastic pipe that is chosen by design, in accordance with the expected flow flows. Collection channel and other variations may allow design and construction. It is mounted on the slope, buried in the ground, so that the edge of the pipe to be at the soil surface making it possible to collect water with sediments drilled down.

5. Recipient of sediment core collection. Material flows in the channel collecting water and sediment, fitted with a side slope, is closely meet the boat which is fitted sob collection channel. During experiments, the time until it fills cronometreaza dish, replace with another goal, let it decanters, cut the liquid remaining after that analyzes the solid parts.

6. The link (hoses, fittings, etc..). Water is brought to the mass distribution through a polyethylene pipe diameter 1 ", connected with a shift valve ¾", which feeds the distribution system watermeter reducing section of ¾ "at two branches of ½" each, pressure Work is controlled by a manometer 10 bar. From the two branches leaving two hoses ½ "up to two sprinkler installation .

Working principle. To highlight the parameters characterizing the soil (erodible soil between streams, the streams erodible soil and climatic parameters (pluviometric regime, thermal regime, during rain, its maximum intensity) was developed this system which can simulate various regimes pluviometric . It can simulate rain adjusting the main parameters: the intensity (by changing water pressure), duration and the area for distribution. Measure the time and amount of water distributed pending soil erosion.

After installing the phenomenon of detachment and sliding of soil, collected sediment transported. It can also cause soil moisture at different depths after different amounts of water distribution, resistance to penetration in soil at various depths and that moisture. To measure humidity using a device mark TDR 300. To determine the penetration resistance of soil using a device mark SC 900. System operation is based on simulation of artificial rain applied to a rectangular area in the vineyard with a particular slope, which was mounted a gutter to collect water and soil mixture drains. At the end the gutter , water and the soil transportation, running in a settling vessel where there is solid parts of the liquid separation. After separation of the water, weigh the decanted, determine moisture, and obtain the amount of dry soil.

Algorithm testing. Operations carried out in the experiments, which are measured or calculated parameters and their units appear in Table 1.

Table 1

Exp steps and parameters to be measured or calculated in algorithm testing

St.	**Technical Operations**	**Numerical data taken or calculated**	**U/M**
1	**Putting into operation:** -put in working position, starts wetting the constant pressure and flow, which remain constant throughout the deployment experience, - Determination of soil moisture in the layer from 0 to 20 cm; - Determination of resistance to penetration of soil layer up to 30 cm; - Determination of soil density in the initial humidity in the layer from 0 to 5 cm; -cover crop,%	S - wetted surface area; p - the slope of the land; p_0 - pressure water plant; t_0 - watering during the beginning; i_0 - initial index of the water meter; u_0 - initial moisture content of soil in Zone 0 - 20 cm; r_0 - resistance to penetration by the first 30 cm depth (average and variation); ρ_{u0} - soil density in the surface layer between 0 and 5 cm; V_c - cover crop m2	m^2 degres N/m^2 s m^3 % N/m^2 kg/m^3 m^2
2	Leak early registration material posted. Allow to continue watering..	t_c - is observed during the early leak posted material; i_c - index of water meter at the time of observation start material flow seconded; p_c - water pressure in the plant at the time of start material flow seconded h_{max} - maximum height of fall of drops of rain; h_{med} - the average height of fall of drops of rain; m_p - mass of an average drop of water was	s m^3 N/m^2 m m kg
3	**Measurement** - stage begins once the material flow is observed seconded. The leaking material collected in containers known capacity, preferably equal, denoted in order of filling containers (buckets). At this point allow to continue watering until filled 4 to 5 containers. Then stop watering. The collection will continue until the end of the flow of material posted, taking care to take over the pipeline or pipelines material collection.	t_f- during which water supply is stopped; i_f – index the water meter when water supply shutdown masters, t_{rii}, i=1,2,…n times the initial filling of containers; t_{rfi}, i=1,2,…n, end times filling the containers; n_f: index last closed container filled before the water supply (nf <n)	s m^3 s s
4	**Weighing the evidence:** The contents of each container is subject to a process of extraction of soil (dry) and then weigh the dry soil (0% humidity)	m_i, i=1,…,n, masses of soil contained in the containers with the same index; ρ - density kg dry soil	Kg kg/m^3

5	**Calculating specific**	**Calculation Formulas**	
5.1	The total amount of water given:	$A=i_f-i_0$	m^3
5.2	The amount of water administered until the flow::	$A_c=i_c-i_0$	m^3
5.3	Average flow of water supplied::	$Q=\frac{A}{t_f-t_0}$	m^3/s
5.4	The amount of water necessary to trigger specific unit surface flow	$a_c=\frac{A_c}{S}$	m
5.5	The amount of water specified unit area, given the entire period:	$a=\frac{A}{S}$	m
5.6	Debitul specific unitaţii de suprafaţă:	$q=\frac{Q}{S}$	m/s
5.7	The total mass of dry soil collected:	$M=\sum_{i=1}^{n} m_i$	kg
5.8	Mass of soil collected from the emergence of flow by the end of water supply	$M_1=\sum_{i=1}^{n_f} m_i$	kg
5.9	Overall loss of specific unit area per event:	$P=\frac{M}{S}$	kg/m^2
5.10	Global loss of hectare per event:	$Pha=10\cdot P$	tone/ha
5.11	Overall loss of soil specific surface unit and flow unit pluviometric:	$\phi=\frac{P}{Q}$	$kg\cdot s/m^5$
5.12	Overall loss of soil specific surface unit and flow unit pluviometric specific unit area:	$\psi=\frac{P}{q}$	$kg\cdot s/m^3$
5.13	Local variation of escape speeds posted material:	$\mu_i=\frac{m_i}{t_{rfi}-t_{rii}}$	kg/s
5.14	Chart speed variation of leakage of material posted in time: it will separate the duration of flow and appearance of water flow and supply decoupling. The coord. of the points chart are:	*Coord. point of grafic are:* $\left(\sum_{k=1}^{i}\left(t_{rfk}-t_{rik}\right)+\frac{t_{rfi}-t_{rii}}{2}, m_i\right)$	
5.15	Estimator coarse annual soil loss per hectare, for a given system pluviometric, PL, mm	$Phaa=\frac{Pl\cdot Pha}{1000\cdot a}$	t/ha pe an
5.16	The total duration of watering	$T=t_f-t_0$	s
5.17	Flow Duration watering until the emergence	$T_c=t_c-t_0$	s
5.18	Length of slope (plot watered)	L	m
5.19	Rain intensity	$I=\frac{A\cdot 1000}{S}$	mm

5.20	Hourly rain intensity	$i = \frac{A \cdot 3600}{T}$	mm/h

Experiments were performed in the vineyards of ICDVV Valley Calugareasca, provided that the work presented in Table 2.

Table 2

Working conditions in experiment

Nr.	**Experimental conditions**	Experiment					
		A	**B**	**C**	**D**	**E**	**F**
1	plot	Lizimetre	Lizimetre	Bazin apa	Ferma 4	Ferma 4	Lizimetre
2	Date exp.	03.04	13.05	04.06	25.06	26.06	16.10
3	Slope land,%	7.10	7.10	18.00	10.13	10.13	7.40
4	Times the rows	hill-valley	hill-valley	curve at hill	hill-valley	hill-valley	hill-valley
5	Distance between rows	3.00	3.00	2.00	2.00	2.00	3.00
6	Breadth of m wetted surface	6.00	6.00	6.00	6.00	6.00	6.00
7	Length of m wetted surface	14.00	14.00	8.40	9.00	9.00	13.00
8	Area wet, mp	84.00	84.00	50.40	54.00	54.00	78.00
9	Layer Humidity 0 to 20 cm,%	15.01	14.72	10.03	17.74	27.77	15.00
10	num plants / sqm	0	218	118	94	94	65
11	Selling pressure water	network	network	water pump	networ k	network	network
12	Soil type	Clay-sand	Clay-sand.	Clay-sand	Clay-sand.	Clay-sand	Clay-sand.
13	Working pressr	4.00	4.00	2.80	4.00	4.00	4.00
14	High maxim fall drops	4.66	4.66	3.70	4.66	4.66	4.66

RESULTS AND DISCUSSIONS

For use in simulation work, and capacity simulation for verification of various models and programs, is presented in Table 3 the main experimental results of experiments conducted with facility IMERE primary in 2008. Processing was done with the design software and data processing described above.

Table 3

Preliminary experimental results in 2008

	Exp. A	**Ezp. B**	**Exp. D**	**Exp. E**	**Exp. F**
Plot width, m	6.00	6.00	6.00	6.00	6.00
Length of plot, m	14.00	14.00	9.00	9.00	13.00
Length of plot, m	84.00	84.00	54.00	54.00	78.00
Initial humidity,%	15.01	14.72	17.74	27.77	15.00
water administered m3	0.627	3.3838	6.0629	1.4021	9.917

Rainfall intensity, mm	7.464	40.283	112.276	25.965	127.141
Watering duration, hours	0.41	2.30	4.00	0.98	6.63
Intensity per hour of watering, mm / hour	18.355	17.489	28.051	26.480	19.171
Loss of soil/m^2, per event, kg/m2	**0.0197**	**0.0041**	**0.0124**	**0.0097**	**0.0027**
Up until the quantity of water flow, m3	0.204	2.9778	5.8838	1.2309	9.518
Time to onset of flow, hours	0.13	2.03	3.88	0.87	6.37

CONCLUSIONS

1. The plant can estimate the risk of erosion by implementing control measures, as can be verified effectiveness of measures taken;

2. Erosion was directly influenced by land slope, the quantity of water supplied, the degree of imburuienare, rows orientation, previous work the soil and initial soil moisture;

3. Facility to estimate the risk of erosion under controlled pluviometric serve its purpose for which it was designed: it can estimate not only the quantity of soil lost by erosion, but also other parameters such as soil erosion rate of the intensity "rain" , pre-existing soil moisture influence on the intensity of erosion, other information of practical and scientific interest;

4. The plant reaches a good quality level of watering, consistency is the main parameter for assessment in this regard. The wetting capacity of the plant also allows simulation of the slow pluviometric schemes to critical events - rainfall, so that erosion can be estimated for various events pluviometric

5. The plant, with small gauge and ease of location in this device, it has characteristics of mobile facilities, easily transported in a vehicle for small dimensions, in various locations, to estimate soil loss under controlled pluviometric.

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