Soil Erosion Models Used in Romania

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Abstract: Based on the results obtained over a period of 10—15 years the first model elaborated in Romania before 1970 is by the same type as Wischmeier's model. Unlike this for rainfall factor, another index ($H\ i_{15}$) was used. This represents the product between the amount of precipitation times the maximum 15 minutes intensity for a given rainstorm. Values of the soil erodibility have been determinated by means of information from runoff plots under natural rain and measurements with the infiltrometer for the main soil types.

During the last decades, erosion experiments have been developed on small watersheds with predominant agricol or forestry land use or forestry land use. Methods of total erosion and sediment delivery estimating and hydrological computing have been elaborated.

A distinct interest is attached to the conceptual models. With that end in view, rill erosion determinations on natural scale polygons have been conducted. For different stages, such as runoff starting, forming of rills established runoff regime some parameters were ascertained.

In the last years, at the Perieni Station, two models were used to predict rainfall erosion losses: Erosion Productivity Impact Calculator (EPIC) and Water Erosion Prediction Project (WEPP).

The main problem we face when starting the model using was the specific Romanian database developing.

Keywords: soil erosion, runoff, models

1 Intoduction

Soil protection and conservation provide, generally, to go over the three stages:

(1) specifying the diagnosis by establishing the values of the soil loss tolerance, assessing the soil risk and analyzing of causes of erosion;

(2) conservation planning:

(3) Applying of two types of measures: preventive (by general order) and specific (conservation practices).

The diagnosis stage is considered very important since the analyze of priorities in establishing of erozional measures must rely on realistic data. Assessment of the risk of soil erosion can be realized by different methods according to the main purpose:

- simple methods that refer to the expedient field investigations or to the simple mathematics models; they are frequently used to rapidly inform the deciding authorities on local or regional level.
- exigent methods that include performant mathematics models, relatively simple and easy to apply; the best-known model in the world is USLE;
- very exigent methods which are related to informatical high performant programs and are, in fact, process-based models. They require a large amount of input data.

In this paper, only the last two categories which include the best-known models such USLE, and WEPP, were analyzed.

2 Materials and methods

Situated on the eastern part of Romania, on the contact line between the area with leached chernozems along the Barlad valley and the zone with forestry soils from the hills, the Perieni station has been mainly concerned with the finding out and the actual application in the field of the most efficient methods for reducing soil erosion, with a view to ensuring high and stable yields. The research focussed at first on the study of runoff and erosion on hillsides with various slope gradients and land use. Concomitantly, farm practices were approached in relation to the crop structure and sequence, tillage, use of fertilizers, pasture, etc.

Several research plots were constructed in order to determine soil and water losses under natural rainfalls. Those rectangular plots (25 m × 4 m) that were set-up in 1970 are still in use. Long-term field measurements regarding erosion / deposition are of value.

Also, the rill erosion was examined by simulating the microstream runoff with deliveries of 0.6 l/s, 1.25 l/s and 2.1 l/s (Motoc and Ouatu, 1977). The determinations were made on 500 m^2 plots (100 m× 5 m) cultivated with wheat, and corn or mere fallow, on loamy cambic chernozem. Several aspects were considered:

- the runoff front advance;
- the runoff velocity and sediment concentration in stabilized regime;
- the variation of the sediment discharge in relation to the delivery flow, the sediment concentration and the soil cover 100 m away from the delivery source.

In the last years, two models were studied (Erosion Productivity Impact Calculator - EPIC and Water Erosion Prediction Project - WEPP) having in sight their validation under Romanian natural conditions.

3 Results and discutions

As a tool for conservation planning, the most used model in the world is Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978).

In Romania, as an alternative to the USLE, an equation by the same type as Wischmeier model (M. Motoc *et. al.*, 1975, 1979) was developed. Unlike this, significance and establishing method of factors are different.

$E_s = K\, S\, L^m\, I^n\, C\, C_s$

where:

Es (to/(ha • year)) —computed soil loss per unit area and year;

K —erosivity factor (Stanescu *et al.*, 1969) obtained bymultiplying the amount of precipitation by the maximum 15-min. intensity (i_{15} - in mm per min), for a given rainstorm;

S —soil erodibility (*S* = 1 for loamy cambic chernozem with high erosion;

L^m (m) —field slope length;

I^n (%) —mean slope;

C —cover management factor that shows the influence of crops and tillage (*C*=1 for corn cultivated year by year);

Cs —support practice factor (Cs=1 for none soil erosion control measures).

There are some changes in comparison with USLE:

- the dimensional factor is no longer erodibility but erosivity;
- the topographic factor (*L* × *i*) is no longer the ratio of soil loss per unit area as measured on a standard plot but directly *L* (m) × *i* (%).

Starting with 1995, interest has focused on the need to forecast the impacts of climate and changes in land use on erosion processes. Process-based models are indicated for evaluating long-term effects of land management on runoff and erosion.

The Water erosion Prediction project (WEPP) developed by the USDA was the first approached model at Perieni Station. The correctness of prognosis performed by WEPP is directly related to quality and quantity of input data obtained in the specific conditions of Romania.

For an American user, it is relatively easy to have access to computerized climatic or pedologic database while a Romanian user has to approach several stages:

- inventory of all the input data required by the model which include:
  - —situation of measured data;

—situation of missing data.

- performing a comparative study between specific Romanian and American natural conditions to assess the missing data;
- developing step by step of a new database in required format of the model.

A hard work was necessary in order to release a proper simulation of erosion with such a complex process-based model.

The first step in the model evaluation at Perieni was performing the sensitivity of the model response to different input values. The second step was the comparison of simulated data to measured data. So, to be capable to run WEPP hillslope version it was necessary to introduce in the computer memory a climatic data set by analyzing a large number of graphic registration of rainfalls over the period 1989—1993.

Running of CLIGEN subroutine of WEPP was possible only by using climatic data provided by some meteo stations from USA which have presented similar characteristics with Barlad meteo station. Thus, recording of mean annual precipitation and temperature, provided by 1079 meteo stations were analyzed and, finally, 12 of them were graphically represented. Among all this, North-Platte Nebraska with 498 mm mean annual precipitation and 9.7ºC mean annual temperature, have been retained. Similar values only Dodge City - Kansas, Grand Island - Nebraska and Huron - Sidney were presented.

Measured data from Perieni runoff plots were revealed the following aspects:

- 49 rainfalls generated runoff and erosion, under different crops, ranging between 3.4 mm and 59.7 mm;
- the soil losses varied between 0.008 and 3.4 kg/m^2.

In Table 1, the results of statistical analyze concerning simulated and measured data are being shown.

Table 1 Linear regression of the simulations with WEPP on runoff plots at Perieni Station over the period 1989—1993

Crop	Type of phenomenon	No. of events	Correlation Coefficient *R*	Linear regression
Fallow	Runoff	49	0,796	*Y* = -0,125 + 0,744 *x*
	Erosion	49	0,741	*Y* = 0,213 + 0,881 *x*
Corn	Runoff	23	0,899	*Y* = 0,636 + 0,825 *x*
	Erosion	23	0,857	*Y* = -0,074 +0,763 *x*
Winter wheat	Runoff	19	0,347	*Y* = -0,232 + 0,079 *x*
	Erosion	19	0,712	*Y* = 0,003 + 0,192 *x*
Bean	Runoff	19	0,993	*Y* = 0,042 + 0,995 *x*
	Erosion	19	0,842	*Y* = 0,244 + 0,711 *x*
Bromgrass year I	Runoff	15	0,730	*Y* = 0,072 + 0,600 *x*
	Erosion	15	0,943	*Y* = -0,031 + 6.138 *x*
Bromgrass year II	Runoff	7	0,494	*Y* = 0,490 + 0,219 *x*
	Erosion	7	0,546	*Y* = -0,0003 + 0,379 *x*
TOTAL	Runoff	177	0,604	*Y* = 0,258 + 0,479 *x*
	Erosion	177	0,808	*Y* = 0,08 + 0,957 *x*

Figure 1 shows the graphic representation of measured and simulated data corresponding of all 177 registrations under fallow, corn, winter wheat, bean and bromgrass. The linear regression parameters (a = 0.258, b = 0.479 and r = 0.604 where a is the y-intercept value, b is regression slope and r is coefficient of correlation) indicates that the model over-predict runoff for small measured values and under predict runoff for large measured values.

In Figure 2, are presented measured versus predicted erosion values for the same events presented above. This case reveals that simulation was more accurately (a = 0.08, b = 0.957 and r = 0.808) that means a uniform distribution of points around the diagonal of the graphic.

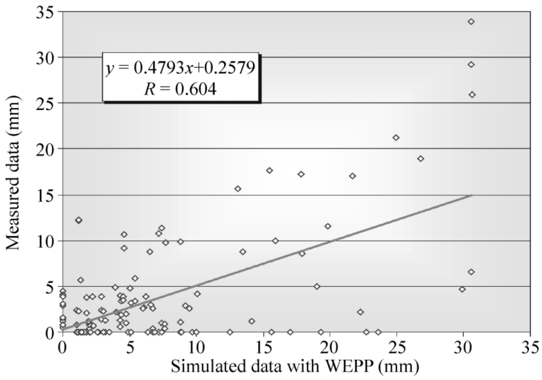

Fig. 1 Measured versus simulated data of runoff over the period 1989-1993, at Perieni Station

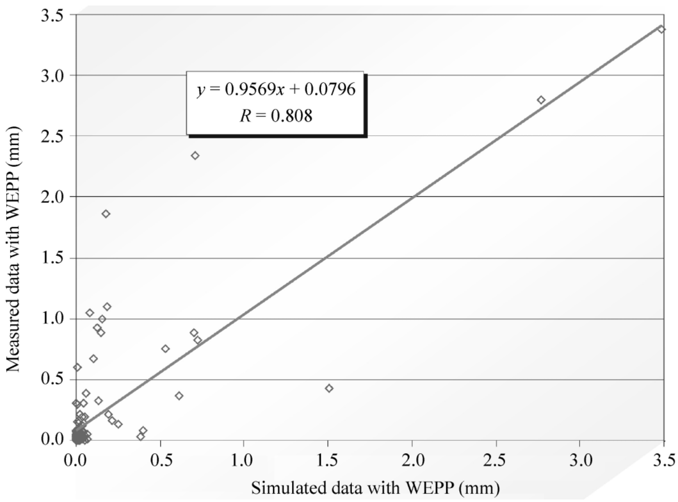

Fig. 2 Measured versus simulated data of erosion over the period 1989-1993, at Perieni Station

Running of WEPP watershed version has required some preliminary operations:

- establishing of simulation scenarios;
- dividing of watershed into homogenous areas concerning agricol exploitation and conservation practices;
- identifying the channels and the hillslopes which represent the watershed components.

To perfect the volume of work, M. Motoc *et al.* (1996) have suggested that the simulation scenarios can include only three categories of parameters: crop structure, pattern of conservation practices and fertilizing. The number of scenarios can be reduced having in sight the most used situations met in a specific area.

Table 2 shows the result of simulation with WEPP for 10 years, on a small watershed called Crangul Nou (A = 29 ha), situated in Barlad Tableland, with slope ranging between 5 % and 24% (Fig. 1).

Examination of the simulation data shows the performances of the different support practices for purposes of conservation of water and soil on agricultural lands.

The worst scenario (corn 75%, winter wheat 25%, straight-row farming up and down, no fertilization) is usually met in Romania in the hilly area, after the promulgation in 1991 of a new property law that stipulates that the land reallotment has to be usually done on the old locations. This means, in most cases, that the plots will be up-and-down hill disposed, provision which is not of a nature to create conditions for the extension of conservation measures.

Table 2 Simulation results with WEPP on Crangul Nou watershed

Scenario	runoff	Snow - melt	Erosion	A erod.	Dep.	A dep.	Sedim. yield
	mm	mm	t/ha	ha	t/ha	ha	t/ha
1.1.1. (corn 75%, winter wheat 25%, straight-row farming up and down, no fertilization)	6,39	0,63	26,92	29,0	0	0	26,920
2.1.1. (corn 50%, winter wheat 50%, straight-row farming up and down, no fertilization)	5,87	0,61	19,58	29,0	0	0	19,580
2.3.1. (corn 50%, winter wheat 50%, bench terraces, no fertilization)	3,35	0,31	9,82	27,7	6,81	1,3	9,075
2.3.2.c. (corn 50%, winter wheat 50%, bench terraces, conventional tillage, medium fertilized)	2,68	0,25	7,76	27,7	5,52	1,3	7,165
2.3.2.n. (corn 50%, winter wheat 50%, bench terraces, no tillage, medium fertilized)	1,35	0,14	2,32	27,7	0,83	1,3	2,179
3.3.2.c. (corn 33%, bean 33%, winter wheat 33%, bench terraces, conventional tillage, med.fertilized)	1,78	0,19	6,76	27,7	5,30	1,3	6,219
4.3.2.n. (corn 20%, bean 20%, winter wheat 30%, bromus 30%, bench terraces, minimum tillage, medium fertilized)	0,86	0,07	1,42	27,7	0,51	1,3	1,324

The best scenario (4.3.2.n. - corn 20%, bean 20%, winter wheat 30%, bromus 30%, bench terraces, minimum tillage, medium fertilized) has revealed that soil losses reaches 1.42 t/ha offering a very good protection.

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