BIBLIOGRAPHIC PAPER REGARDING MONITORING OF SOIL EROSION USING GEOGRAPHIC INFORMATION SYSTEMS TECHNOLOGY

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Abstract. One of the most dangerous forms of ecological imbalance is the problem of soil erosion with large economic effects and impact on the environment. For this reason particular importance should be given to monitoring a territory, monitoring the main purpose best estimate of the possibility of erosion processes and soil loss calculation. This can be achieved by using Geographic Information Systems (GIS) that allows the creation of models on the occurrence of erosion processes, estimation of results by continuously changing the input parameters easy, storage and spatial-temporal data analysis and evaluation. Monitoring and evaluation processes of soil erosion is of particular importance as this may be established ways of preventing and combating erosion processes to eliminate economic, environmental and bringing these lands through the improvement works aside. Following the erosion occurs as a series of consequences: diminishing agricultural production, disrupting the ecological balance, fouling ponds and reservoirs, changing water pathways, changing land to be turned into productive lands, increasing flood risks etc.

Keywords: agricultural production, soil erodability, degraded land

INTRODUCTION

General aspects regarding soil erosion processes. Research on the evolution of agricultural soils reveal negative trends, agriculture is both cause degradation element and victim degradation caused by other socio-economic activities. Soil supports most powerful accelerated changes due to anthropogenic interventions in agriculture and erosion have direct or indirect effects on other environmental sources. Erosion is the process of removal (detachment, entrainment), transport and deposition of soil particles under the action of exogenous agents, such as water and wind [5], [6], and human activity. The literature mentioned various criteria on the classification of types of soil erosion [6]: (1) After the causal factor (water erosion - rain or fluid, wind erosion); (2) speed after the trial (natural, geological, accelerated anthropogenic) [6]; (3) after how the soil is removed (surface erosion, gully erosion). Soil erosion process produces large barriers in the use of land. The surface erosion brings aboveground the lower horizons with physical characteristics less favorable than the humus horizon and which are characterized by heavier texture or hard rock, being a great inconvenience in the execution of soil conservation and a reduction of capacity useful water.

The decrease of agricultural production is caused by very low soil fertility and because of overland flows reveals plant roots or detaches plants from ground. Also, erosion produces decreasing soil density per unit area. Following heavy rains or sudden snowmelt occurs seasonal erosion mainly manifested through a network of rills on the land when the soil is light and without vegetation cover. Soil erosion is determined especially by: relief, climate (air temperature, wind, rainfall, atmospheric pressure, humidity, duration of sunshine, cloud cover, weather phenomena), soil, parent rock, vegetation and land use etc.

Soil erosion is studied using the methods of forecasting and optimization based on many factors involved in triggering this process (factors which manifests itself with varying degrees of intensity) and interdependence between them. For this reason, there is need to integrate them into a numerically-existing relationships correlative properly adopted.

Factors influencing soil erosion can be grouped as follows:

1. Climatic factors: (a) the impact of raindrops diameter droplet kinetic energy, speed fall, camber, aggression rain; (b) characteristics of rains: intensity, duration, amount, core torrential rain the previous; (c) leakage characteristics: maximum flow, duration, hydrographic aspects, time of concentration;

2. Basin characteristics: (a) relief: slope, slope length, degree of kneading, the slopes, the curvature slope (in profile, in plan); (b) vegetation: root system, leaf volume, degree of protection, the state of vegetation; (c) the culture and land: agricultural technique, crop systems, planning systems, types of hydraulic works, crop rotations;

3. Ground erodability: (a) morphological: structure texture, porosity, soil compaction, sensitivity to crust; (b) acquiring hydro: infiltration, moisture momentary capacity, grain, specific gravity, surface roughness; (c) acquiring geomorphology: the parent rock; (d) chemical characteristics: pH, humus, colloidal complex, NPK, Ca;

The highest percentage of the erosion that occurs in Romania, is the manifest erosion on agricultural land (of which the largest amount of soil is lost from the pasture, which they occupy the most of the degraded lands) and unproductive lands. The most significant form of land degradation in our country is manifested by water erosion on about 50% of agricultural land and arable land [7]. All land located in the slope are influenced by soil erosion by water intervention if they are not protected by vegetation. The influence of water on the soil erosion occurs if the slope of the land is greater by 2-3%. Research conducted by GLASOD (GLOBAL ASSESSMENT OF HUMAN-induced degradation SOIL) on the severity of erosion risk in Europe, indicates that our country is hilly in class land erosion risk of extreme severity. In Romania, after erosion, crop losses occur about 10% of weakly eroded land, over 25% moderate erosion on land with strong and exceeds 50% very strongly weathered surfaces and excessive erosion.

MATERIAL AND METHODS

Soil erosion estimations with GIS. Geographic Information Systems are based on creating mathematical models that require knowledge of relations between active factors (on one side) that causes erosion and resistance factors (the other) that limit soil loss. Each factor is a numerical estimate of a condition that affects the severity of erosion in a given area [8]. The dependency analysis of the links between factors that influence the onset and intensity of erosion is very important to establish real relations of dependency between: factorial characteristics and features of the result. Dependency ratio correlation/result, must express real as far as the factor characteristics (rain, soil, slope, vegetation) contribute to the resulting features (leakage, erosion). Morgan note that the following causal analysis highlights three important factors involved in the process of water erosion: soil susceptibility to erosion, erosive rainfall and potential leaks, soil protection offered by vegetation cover. Studying correlations between the characteristics and the consequential factor, aim at: (1) obtaining representative values which respect the natural law of occurrence of phenomena, to some isolated values, which would lead to random arrangement more expensive solutions; (2) determining the order of priority and importance of factors involved, specific to each endpoint; (3) optimization of soil conservation programs by accepting risk allowance.

In order to establish the method for estimating the risk of erosion is recommended standardization of calculation models, data entry, classes, ensuring an accurate absolute similarity of the results obtained in different areas. It is noted that although many of the methods have similar effects and could not be applied universally in any region, the results being diverted because methods of calculating parameters (factors), composition input data model due to differences in reacting subjective examination, etc. The approaches of soil erosion evaluation can be grouped: (a) approaches based on expert systems: quick assessment of soil erosion, reduced number of data requiring a disadvantage with the uncertainty of results; (b) approaches based on mathematical modeling. In the process of soil erosion due to water action on the slopes, they were established several methods to estimate soil loss methods aimed at establishing flow of sediment basin drained slopes. Many methods have been standardized for low impact areas - small basins. Currently research is conducted for large areas and provides estimates as accurate and true and can be successfully used as widely as possible.

One of the most commonly used mathematical models on estimating soil erosion is the model USLE (Universal Soil Loss Equation) developed by WISCHMEIER & SMITH (1978). USLE model was developed based on experimental measurements on small plots of land being limited to cropland. Equation "reasonable" estimate of erosion is:

$$A = C \times S \times L \times K \times P \quad \text{where:} \qquad (1)$$

A = annual average soil loss;
C = annual average loss factor marking the ground for clay soils, a certain rotation and slope length;
S = slope inclination;
L = slope;
K = soil erodability;
P = scoring factor influence anti-erosion works.

In terms of Romanian conditions, observing the structure equation USLE, modifying the assessment and the method of setting land Academisian Motoc and collaborators propose relationship for calculating soil loss by water erosion in the area, resulting model ROMS (SOIL EROSION MODEL ROMAIN):

$$E_s = K \times S \times L^m \times i^n \times C \times C_s \quad \text{where:} \qquad (2)$$

E_s= given the amount of sediment surface erosion (soil loss) as an annual average (t/ha x an);
K= Rainwater aggressiveness of soil-loss areas of aggression storm settled on the index of aggression rain - H_{15}; determine with the elements extracted from torrential rains that cause erosion pluviograms:
H= the amount of rainfall during the rain (mm);
I_{15}= mean intensity during 15 minutes of torential core;

In this context rainfall aggressiveness is expressed through aggressiveness coefficient erozivitatea rain storm and simultaneously defines and effect on soil eroded (in Romania reference parcel had dimensions L=25m and i=15%).

$$K = \frac{\sum H \times I_{15}}{\text{references parcel soil losses}} \qquad (3)$$

Based on average annual values zoning map was drawn aggressiveness rain Romania.

L= slope lengt for the relief homogeneous units (m);
m = 0.4 for L<100 m

m = 0.3 for L>100 m

i = slope ground for the relief homogeneous units (%);

$$i = 1,36 + 0,97i + 0,138i^2 \qquad (4)$$

S = correction factor depending on soil erodabilitatea (soil type and subtype, degree of erosion and soil texture);

C = correction factor depending on the use and crop structure with values ranging from 3 (no vegetation cover), from 2 (with partial vegetation cover) to 0.001 (with congealed cover vegetation).

C_s = correction factor depending on the measures and anti-erosion works.

The influence of anti-erosion work and the relationship can be quantified:

$$C_s = p \text{ x } (1- e^{-1,31 \text{ x } i^2}) \text{ where:} \qquad (5)$$

p = 1,30 contours culture;

p = 1,00 crop and soil management level curve erosion;

p = 0,70 crops in strips or grass strips;

p = 0,50 crops on terraces;

p = 0,15 crop on soil walls.

C_s have adopted new farming conditions, namely: (1) the associations and private farms with large areas of 100 ha (applying equation shown above); (2) the agricultural lots - parcels requiring inventory numbers and their orientation with respect to topography and then to calculate the share parcels oriented in contour line and the greatest slope, according to them stabilized C_s coefficients [5].

In order to validate the method for estimating soil loss through erosion, by using Geographical/Territorial Information Systems [1]. They compared the results obtained by applying the model equation USLE (8) with the results of a study undertaken on the degree of clogging of reservoirs Antoneşti and Găiceanca by „Centru de Cercetare-Dezvoltare pentru Combaterea Eroziunii Solului", Perieni, Vaslui County). The purpose of art G.I.S. the monitoring of soil erosion is to acquire, store and process data describing at a time erosion and state on which to analyze many factors involved in the process and finally to obtain results that as accurately characterize the process of soil degradation and forecasting conduct its territory under study. The acquisition represents one of the GIS data consuming time and resources of a project budget. For this reason special attention should be paid to collect only those data which are required for their intended and are most accurately and timely.

In order to integrate the complex pattern of slopes runoff mechanism, it is necessary spatial information on geomorphological conditions, soil, climate, crop improvement work, vegetation, etc. be structured in layers (layers), each layer being associated attribute (table). The database underlying spatial analysis model is developed using primary database structures and databases derivatives. Primary database is created on the basis of map material, topographic and thematic. Such terrain mapping provides representation in plan-altimetry of the territory (hydrography, relief, settlements, ways of communication). Thematic Cartography is focused on describing phenomena (changes, evolution) geomorphological areas affected by land degradation types (erosion, landslides flood, pollution, soil types, rainfall, climatological information temperaturi- soil, vegetation, land cover, crop) socioeconomic dynamics land improvement works, soil erosion control, drainage [3].

All these layers are structured release (geo-information layers) each having attached alphanumeric database in order to be combined to generate new maps underlying mechanism analysis and their integration in describing soil erosion. Depending on project objectives G.I.S. and available data format, they can be obtained as follows [1], [2]: (1) graphic data (maps, plans) created by various methods (classical or topographic surveys using GPS, photogrammetry, remote sensing, satellite images etc); (2) existing data on paper (maps, plans purchased through scanning, digitization) to be stored that must be converted into digital format, resulting digital maps. Cartographic material (both spatial and statistical data units) assigned coordinates in geo-referenced real world. The analysis may at any time assess the effects of these changes on the land and make the best erosion control measures to reduce soil losses (implicit and nutrients) and crop loss effects of economic, social and environmental. Finally finding the optimum solution for bringing the field into production by improvement works [4].

Use GIS software makes possible:

• purchase storage and processing facilities, computerized spatial and alphanumeric data from various sources. By using GIS, increase the detail of the data entry so that estimation method used to increase accuracy;

• data storage layers of information (full listing on soils, crops, soil nutrient levels etc.);

• GIS enables spatial data manipulation easily and obtaining data analysis combining layers of different scans;

• GIS toolbox offers a complex spatial analysis, dissemination of results and viewing platform;

• GIS allows continuously update the database (by obtaining real time information), include daily data on type and quantities of rainfall, using detailed maps and digital maps of the landscape with high resolution measurements with data updating electronic theodolite or GPS, use of field experiments in order to calibrate and validate the model). Accurate results are obtained in a short time to achieve the underlying forecasts and predictions of erosion phenomenon timely and taking the most appropriate safeguards and soil conservation;

• after modeling accurate results are obtained which ensures a permanent control on the slopes surface leakage and leakage in the network concentrated torrential formations;

• Knowing the consequences of the erosion, farmers can choose the optimum land use category, systematization and crop rotation, use of technological system of plant, identifying incipient manifestations of surface erosion process and intervening through measures to stabilize the phenomenon.

CONCLUSIONS

Using GIS software to monitor surface erosion due process, the advantage of purchasing, storing and processing large amounts of spatial data and attribute type, from various sources, to obtain patterns on large tracts of land. Ease of handling spatial data has made the implementation of GIS in the design and operation of land improvement, to provide accurate and rapid solutions in monitoring erosion and finding the optimal agro-pedo-improvement measures in anti-erosion work location and establishment of crops, so the erosion process is minimized. To date mathematical models aimed at predicting soil erosion due to water, were based on experimental determinations due to the effect immediately felt the decrease in agricultural production agriculture.

Development accelerated lately GIS software has allowed increased performance interposed research on soil degradation processes erosion, the emergence of mathematical models (hydraulic) recent assimilation of the same phenomenon of erosion, such as WEPP, EPIC GRASS, AGPNS, having and advantages of results showing the relationship between the factors that characterize the geomorphology of the slope, during and after the end of the case (rain), and the drain process is complete, it is known that the action of water, soil consistency changes by thinning, moving on the slope, the amount eroded soil is variable in time and space.

All this allows to obtain a wider range of information, results from analyzes using GIS softwares that support the agricultural engineering specialists, environmental land reclamation, hydraulic engineering.

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