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Methodology of Assessment Vulnerability of Soil Cover in Slovakia

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ABSTRACT : The paper is focused on the present state of soil protection from unwanted influences degradation through a process of water erosion. Agricultural land and forest land are a major component of the environment and it is therefore important to find tools for their protection. The paper presents empirical model used to determine the intensity of water erosion. We also will be presented options GIS tools in identifying areas threats with water erosion.

Keywords - *soil cover, water erosion, assessment, USLE, GIS*

I. INTRODUCTION

Climate change last period greatly affect our quality of life. We become witnesses of significant global warming, which brings rapid extreme weather changes, which we have not been accustomed. Intensive short-term rainfall and subsequent periods of extreme drought leave their mark on the soil cover, which is the influence of the phenomenon itself predestined to degradation. The process of soil degradation is a global problem with increasing degree of their importance. Soil erosion is the most serious soil degradation. Soil erosion is the process of removing the uppermost layers of soil and parent rock mechanical action of agents characterized by kinetic energy, which are mainly rain, flowing water and wind, while the most important group of water erosion caused by water in the liquid form [1].

II. SOIL STRUCTURE FUNDS IN THE SLOVAK REPUBLIC

Soil cover is a key natural resource and at the same time also economical and eco-social potential of the Slovak Republic. Allows the production of food and raw materials such as (wood, fibers, oils) recycles wastes. Constitutes the forest and agricultural land, filter and retain water in our area, enables you to use and enhance the solar energy. Provides cycle and ecologically a balanced balance of substances in nature, maintain the diversity of plant and animal species and forms a primary quality of the environment is a source of raw materials and cultural heritage. Agricultural land and forest land are a major component of the environment and are a natural source of national wealth [2]. The structure of the territory of Slovakia did not record the last 10 years significant changes. Summary of area in land use and analysis of changes in soil fund for the year 2012 provides the following Table.1

Tab. 1Comparison of area land use the years 2011- 2012

	Agricultural land (ha)	Arable land (ha)	Forest land (ha)
Year 2011	2 414 291	1 416 633	2 011 250
Year 2012	2 410 812	1 415 653	2 012 336

Source: Geodesy, Cartography and Cadastre Authority of Slovak Republic

From the above information it is clear that the year 2012 shows a loss of some land resources. When agricultural land resulted in a loss were 3479 ha, arable land amounted to a loss of 980 ha forest land and reported a loss of 1086 ha to 2011. It is prerequisite that the prognosis of the next years is unfavorable. As one of the causes include the impact of water erosion on agricultural land. The soil generally has a relatively high ability to resist unfavorable environmental influences. Despite the above mentioned occurs to the degradation processes is through hydropower. The most effective way to protect the land area of vulnerability estimates this process [3].

The current state of land use for the selected area presents the following Figure.1.

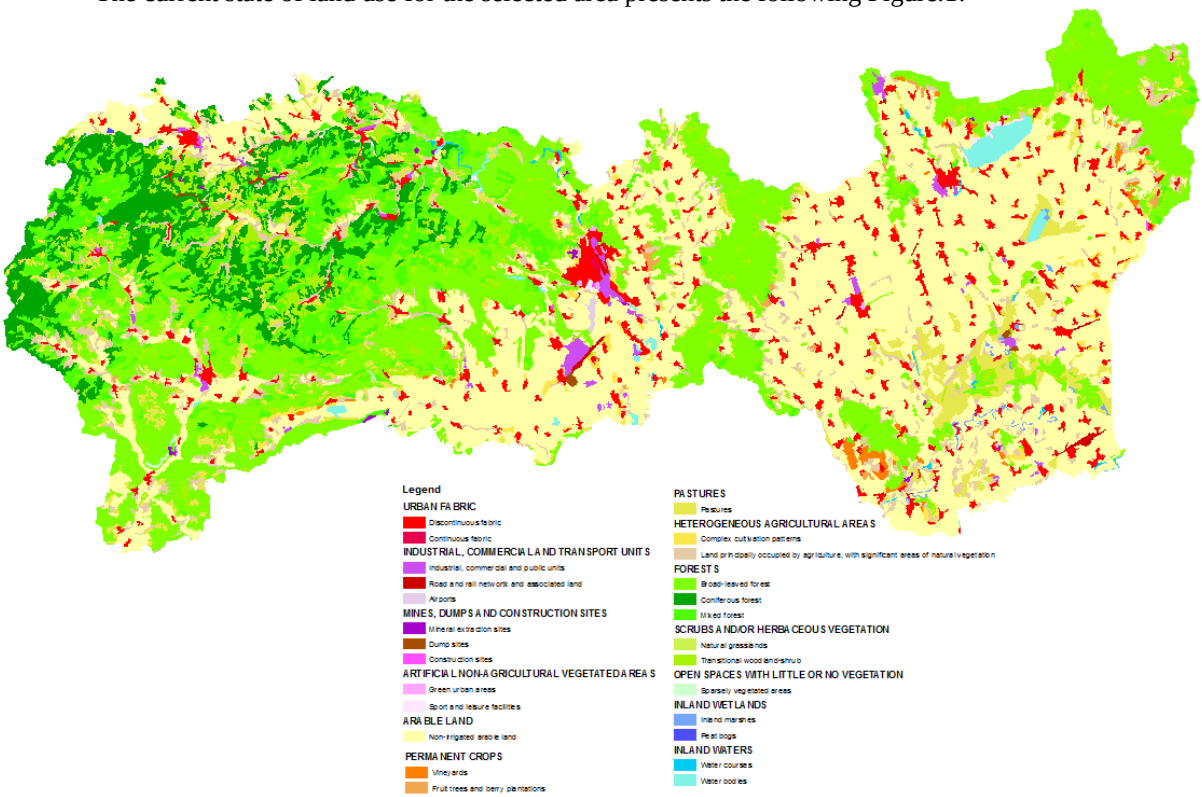

Fig. 1 Land cover of Kosice self governing region

Source: [4] (own processing by European Environment Agency**)**

For water erosion, which is one of the most widespread forms of erosion can consider two levels:

- ✓ the potential erosion
- ✓ erosion of the real (actual, expressed the intensity of soil loss)

Percentage of agricultural land and forest land to the total area of the Kosice self – governing region for year 2011 provides Figure. 2

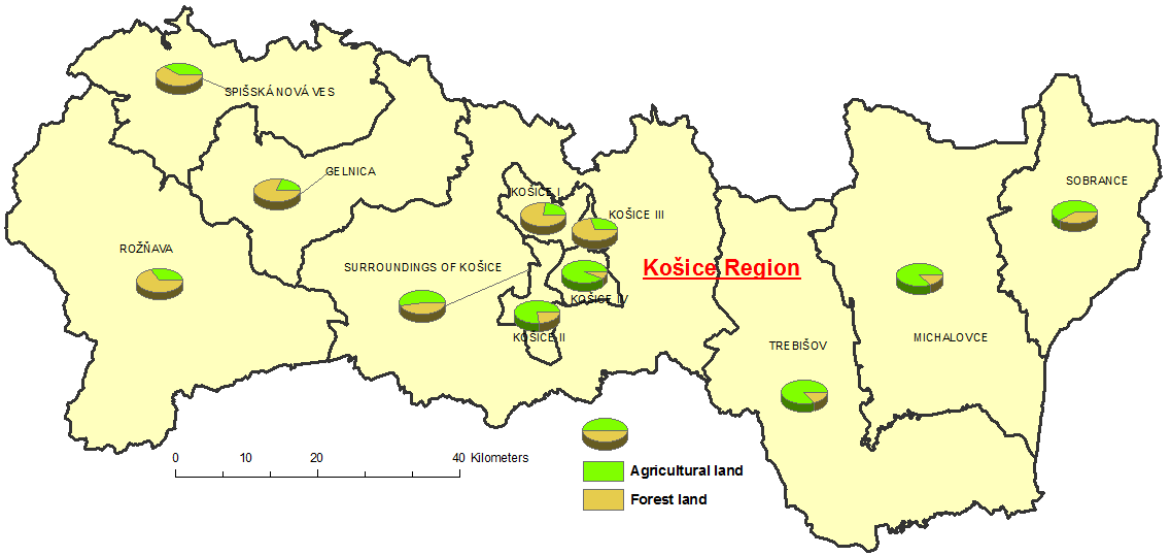

Fig. 2 Percentage of agricultural land and forest land to the total area

Source: own processing by Statistical bulletin of Geodesy, Cartography and Cadastre Authority of Slovak Republic 2011

III. CHARACTERISTICS OF THE MODEL USED TO DEFINE INTENSITY OF WATER EROSION

Constant research in the field of monitoring of soil erosion, has led to the search for and creation of a method to quantify this aspect. Have been developed in a variety of different ways to calculate the erosion of soil erosion [5]. Determining the intensity of water erosion can carried out of several methods. By following the procedure of implementation is divided to:

- ✓ Direct (determining the intensity of erosion direct field measurements)
- ✓ Indirect (determining the intensity based on the evaluation of available documents) [6]

Several years of research erosion processes has been compiled and created universal soil loss equation, known as the USLE. For the authors, are referred Walter H. Wischmeier and Dwight D. Smith [7]. Since formation, USLE has undergone several additions and changes. Various authors have implemented it for the solution process of water erosion on different areas of their research. In Slovak conditions with the assessment of water erosion are dealing relatively wide range of authors. Among the most important are [8], [9], [10]. The conditions of use USLE in the SR regulate Methodology No.5/1992. [11].

Empirical USLE model used to calculate the potential water erosion can be expressed in the following form:

$$Sp = R \cdot K \cdot L \cdot S \cdot C \cdot P \quad (1)$$

Sp – average annual soil loss in $t.ha^{-1}.year^{-1}$
R – erosion efficiency factor of rain
K – factor of the soil's susceptibility to erosion
L – factor of length slope
S – slope factor
C – factor of protective effect of vegetation
P – impact factor of anti-erosion measures

An important finding is that the equation of land vulnerability of water erosion cannot be used to determine soil loss for a period of less than one year, and also to determine the loss of soil erosion caused by rain or slush. For the calculation of soil loss equation USLE is necessary and ensure the application of the following assumptions:

- ✓ Determining values from the factor R.
- ✓ Determining values from the factor K, directly based on soil and landscape ecology unit [6], [12].
- ✓ Determining values from the factor S,
- ✓ Determining values from the factor L,
- ✓ Determining values from the factor C,
- ✓ Determining values from the factor P.

According to calculations by [13] were specific for the 86 stations in Slovakia for selected period specified value R factor. For selected stations located within the territory of the Kosice self – governing region are shown in Figure. 3, the values are used for the final calculation. The values of R factor reach values from 5, 46 to 37, 87.

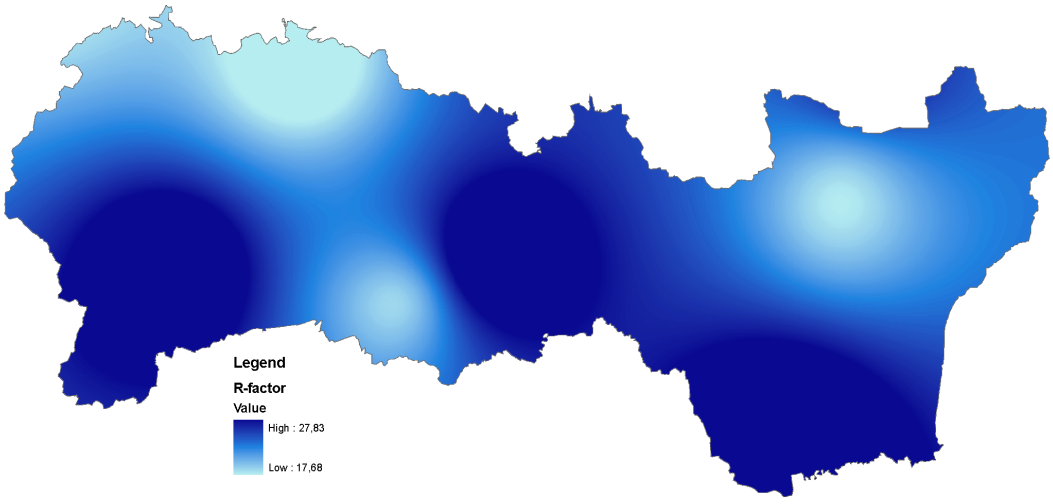

Fig. 3 Calculation of R factor

The susceptibility of soil to erosion is greatly influenced by soil parameters which are granularity, structure, organic matter content and permeability. They form capacity of soil infiltrate rainwater into the profile and resistance before breaking soil aggregates kinetic energy of raindrops and surface drainage. K - factor expresses porter age the land (in the case of black fallow) per unit R-factor from the standard are inclines 9% and with length 22,13 m [8]. For K - factor were according to the methodology [12] default values, which indicates Table.1 and Figure. 4.

Tab. 2 Table of values - the factor for the selected main soil units (MSU)

MSU	K
00	0,72
01	0,20
02	0,31
03	0,31
08	0,26
09	0,26
10	0,13

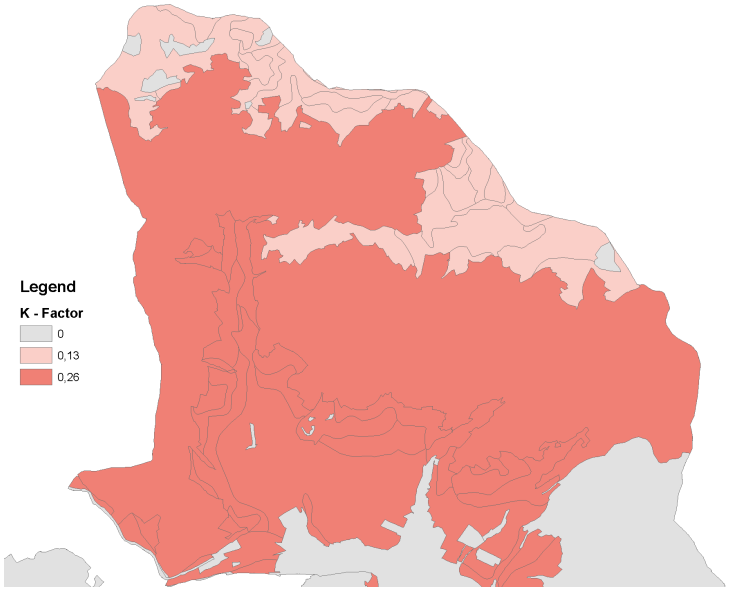

Fig. 4 Calculation of K factor

Protective effect of vegetation - fixed or completed on the soil surface lies in the fact that, depending on their involvement. Table of values of C - factor for the selected crop species listed in Table. 2

Tab. 3 The values of C factor by [12]

Name	**Value of C factor**
potatoes	0,60
clover	0,015
sugar beets	0,53

Limit values for soil erosion by water erosion are given by law No. 220/2004 Coll. [14]. The report shows the following Table 3.

Tab. 4 Limit values for water erosion

Soil depth	**Carrying ton for1 ha per year**
Shallow soil (0,3 m)	4
Medium deep soils (0,3-0,6 m)	10
Deep soils (0,6-0,9 m)	30
Very deep soils (over 0,9 m)	40

Vulnerability assessment of water erosion for the selected area was proposed decision schema presented by Figure.5.

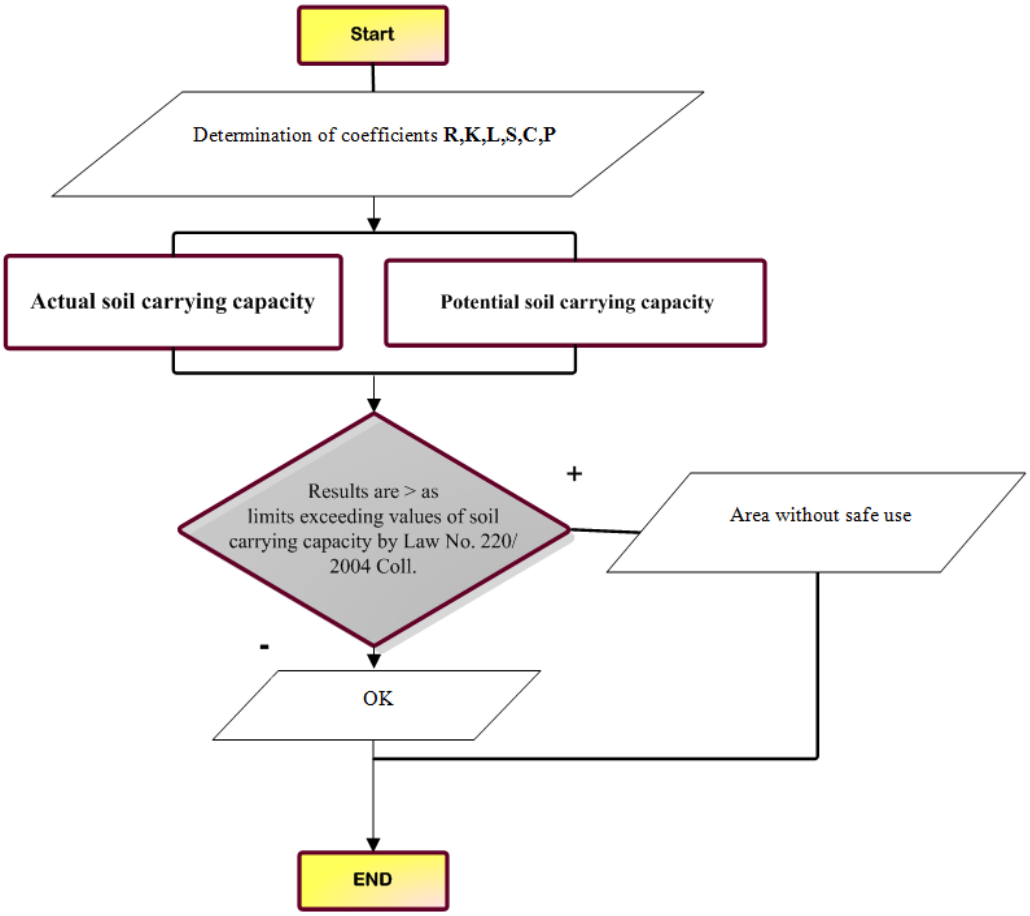

Fig. 5 Decision schema of evaluation process of water erosion

IV. PREPROCESSING OF POSIBLE ANALYSIES IN GIS ENVIRONMENT

The process of evaluating potential water erosion focus on an implementation of geographical information systems (GIS) by using all available analytical tools. GIS is appropriate to use in analyzing the arrangement of land resources and the effectiveness of the proposed anti-erosion measures and processing of field data on the streamside zone of the watercourse and also for the calculation of USLE. GIS provides the tools required for all phases of erosion research in the country such as:

- ✓ Identification.
- ✓ Mapping.
- ✓ Analysis.
- ✓ Synthesis.
- ✓ Modeling.
- ✓ Simulation.
- ✓ Optimizing the spatial structure of the country.
- ✓ Evaluation of alternative protection measures [15].

Calculation longstanding soil loss is expressed USLE can be the most complex process in GIS environment. Based on the results presented in Fig. 6 can be identified territory with the lowest and highest impact erosion effect. The calculation itself takes place in an environment of ArcGIS (ArcMap interface) principle of map algebra, calculation of the individual layers, which content page has been mentioned above.

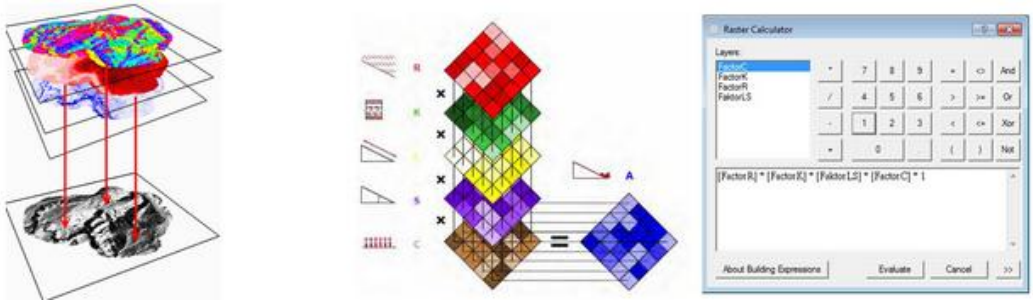

Fig. 6 Calculation process of water erosion by using GIS tools [16]

V. CONCLUSION

Present shows significant with global climate change action. Extreme weather events associated with torrential rainfall with extensive surface drainage also lead to degradation of soil cover. The above facts about the state of the natural environment also relate to Slovakia. Therefore, it is necessary to find and develop ways to prevent such situations. One of the possibilities is GIS systems which can be observed incidence and symptoms of water erosion. Contribution offered a section of basic information of USLE model, which concepts possibilities of implementation in the GIS environment. GIS tools can identify vulnerable area. In the paper are presented the possibilities of calculation of water erosion by using GIS tools at a general level.

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