SPATIAL REPRESENTATION OF SOIL QUALITY AFFECTED BY SURFACE EROSION USING GIS TECHNOLOGY

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Abstract. Regardless of farming systems practiced, fertility, inherent agricultural land, is the core of these systems. The quality of soils, seen as a measure of their fertility, presents regional differences. The main objectives of this study are, on the one hand, spatial representation of soil quality and analysis of eroded soil quality and on the other hand, show the influence of culture on the development of quantitative of surface erosion. Cartographic materials used were obtained using ArcGIS software and based on topographic maps, vector map of soil and erosion vector map. Determining the average amount lost by erosion at the surface is based on the relation derived from the Universal Soil Erosion Equation, which sets the contribution of each factor. For each soil unit affected by erosion processes was calculated average annual soil loss in two types of crops (wheat and maize) at different values of the slope and slope length. For each soil unit, using ArcGIS software, the average slope was calculated, value being subsequently introduced into the relation computing. Soils in the territory Traian Vuia falls a large percentage in classes III and IV quality. The quality of eroded soils, at the category of use "arable", corresponds also mostly the classes III and IV quality. Under the wheat crop, the average annual amount lost through erosion at the surface is significantly lower than under the maize. Agricultural land planted with corn lose an average annual soil 4.67 times higher than in those cultivated by wheat.

Keywords: quality, soil, erosion, crop, control.

INTRODUCTION

Since remote periods of history, man has felt the ground as the main source of food and thus an essential element of survival. Regardless of farming systems practiced over time, either traditional or modern, fertility, inherent agricultural land, is the core of these systems.

Soil quality, and particularly eroded soils quality, seen as a measure of their fertility, presents regional differences imposed by the action of intrinsic and/or extrinsic factors, which leads to the idea that the improvement and maintenance, impose a holistic approach, which take into account all the factors and processes involved.

MATERIALS AND METHODS

The main objectives of this study are, on the one hand, spatial representation of soil quality on the administrative territory Traian Vuia and eroded soil quality analysis and on the other hand, show the influence of culture types on the development of quantitative surface erosion.

Cartographic materials used in this work were obtained using the software ArcGIS 10.0 and based on topographic maps used for determining the Digital Elevation Model, soil vector map (which is based on analogue maps developed by the Office for Soil and Agrochemical Studies Timisoara (Timisoara OSPA) and surface erosion vector map [4], adapted and filled with fields containing data on the quality of soil units, resulting in other cartographic representations.

Identification of soil units and their classification into quality classes was made by Timisoara OSPA and was used for calculation of areas ArcGIS software.

Quantitative determination of surface erosion per each soil unit was based on calculation methods taken from the literature [3]:

$$E = K \quad S \quad C \quad Cs \quad L^{0.3}\left(1.36 + 0.97i + 0.138i^{2}\right) \qquad (1)$$

where: E - average annual soil loss (t/ha/year); K - aggression factor climate; S - erodability factor based on the erosion resistance of the soil; C - factor accounting for the influence of vegetation; Cs - factor represents the influence of erosion control measures; L – slope length (m); i – slope of the hillside (%).

The values of coefficients K, C and Cs were taken from the literature, is calculated for Romania, depending on the area. For each soil unit affected by erosion processes was calculated average annual soil loss in two types of crops (wheat and maize) at different values of the slope and slope length. For each soil unit, using ArcGIS software, the average slope was calculated, value being subsequently introduced into the relationship computing.

RESULTS

The administrative territory Traian Vuia is located in the eastern part of Timis county, in Bega river basin, under a hilly, with altitudes between 113 - 494 m (Figure 1).

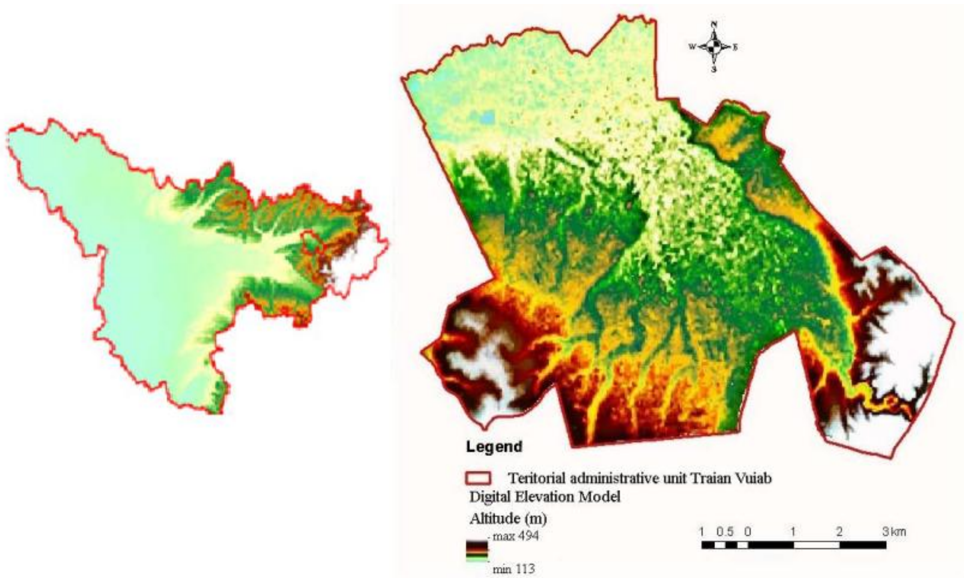


Fig. 1. The administrative territory Traian Vuia - geographical location

The highest altitudes are in sub-areas of the south-east and south-west of the country, respectively Lugojului Hills, altitude values are all lower to the north (Figure 1), for Făgetului Depression and Bega Plain. Accordingly relief - with direct implications pedogenetic processes - has formed a wide range of soils (Figure 2), with weight and spatial distribution varied according to geographical conditions.

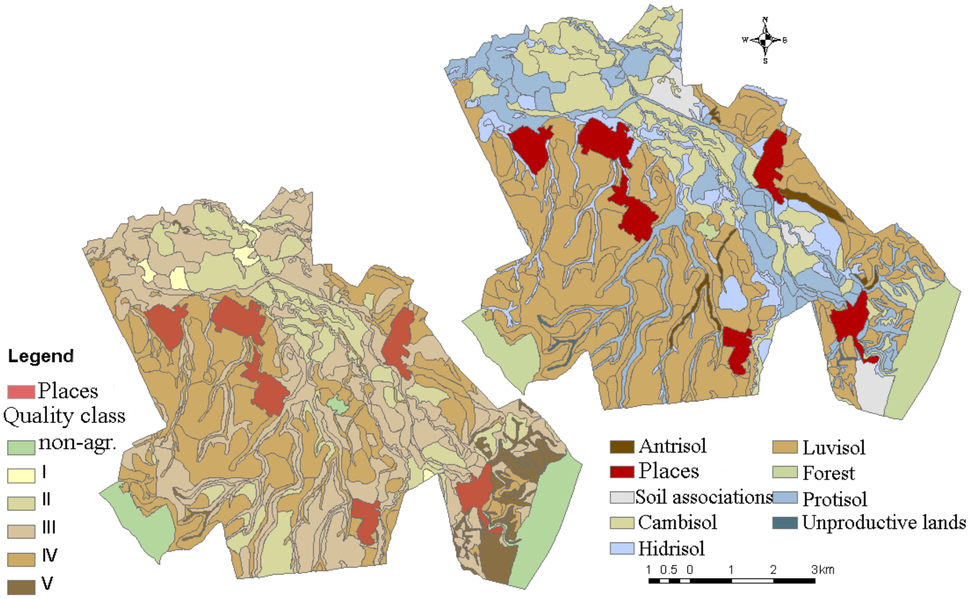


Fig. 2. Frame land quality classes and classification of soil-level classes

Soils were classified in 5 classes and 11 soil types [4]:

- Luvisols (preluvosoil, luvosol, planosol, alosol) - 51.32%
- Cambisols (eutricambosoil) - 17.04%
- Hidrisols (gley, stagnosol) - 10.14%
- Protisols (litosol, regosol, aluviosol) - 17.5%
- Antrisols (antrosol) - 1.12%.

Under the action of factors internal and/or external, soils quality show differences, as a class of soil to another and in the same class (Figure 2).

Agricultural land quality classes was made by Timisoara OSPA [6] and related areas were calculated by data processing software ArcGIS 10.0.

Since the category of use "*arable*" is the most "demanding" to edaphic conditions, in what follows we will refer to soil quality as required by this category (Figure 2).

In the study area, soil quality situation (Figure 2) is as follows:

- class I quality, on 65 ha (1.06%), includes only protisoils class soils (type aluviosol)
- class II quality, on 910 ha (14.86%), soils grouped in classes protisol, luvisols and cambisols; majority is eutricambosoil type, soil with good natural fertility
- class III quality, on 2711 ha (44.29%), includes soils of all classes; large areas is explained by the fact that the majority are luvisols, which have a medium to low fertility [1]
- class IV quality, on 2140 ha (34.96%), falls also in all classes of soils (luvisols, regosols, planosoils, anthrosols, etc.)
- class V quality, on 294 ha (4.80%), were included in classes protisols (litosol), cambisols (eutricambosoil), hidrisols (gley) and antrisols (antrosol).

So, soils analyzed territory falls largely in grade III and IV quality, totaling 79.25% of the agricultural area, as a result of geographical conditions.

The soil units from areas with higher altitudes, with relief gradient greater degree, are subject to erosion processes. Surface erosion occurs as a factor limiting agricultural productivity, so the soil quality over an area of 1614 ha or 26.36% of the agricultural area [4].

In this paper we analyzed 25 soil units that are affected by this phenomenon and totaling an area of 1518 ha, representing 24.80% of total agricultural area.

Aggression surface erosion, regarded as the limiting factor, is supported by other factors (excess moisture to the surface, unevenness of the terrain, port, compaction, depth erosion, slope, low reserves of humus, acid reaction), which, generally act with intensity increasing with the increase in the intensity of erosion surface [5].

In 30.78% of cases, surface erosion is associated with 6 other limiting factors, in 38.46% of cases still exists 5 factors, in 23.07% of units still operating 4 factors and only 7, 69% of the examined cases, surface erosion is accompanied by 3 other limiting factors [5]. Under these conditions, the quality of soils, at category of use "*arable*" is reduced (Figure 3).

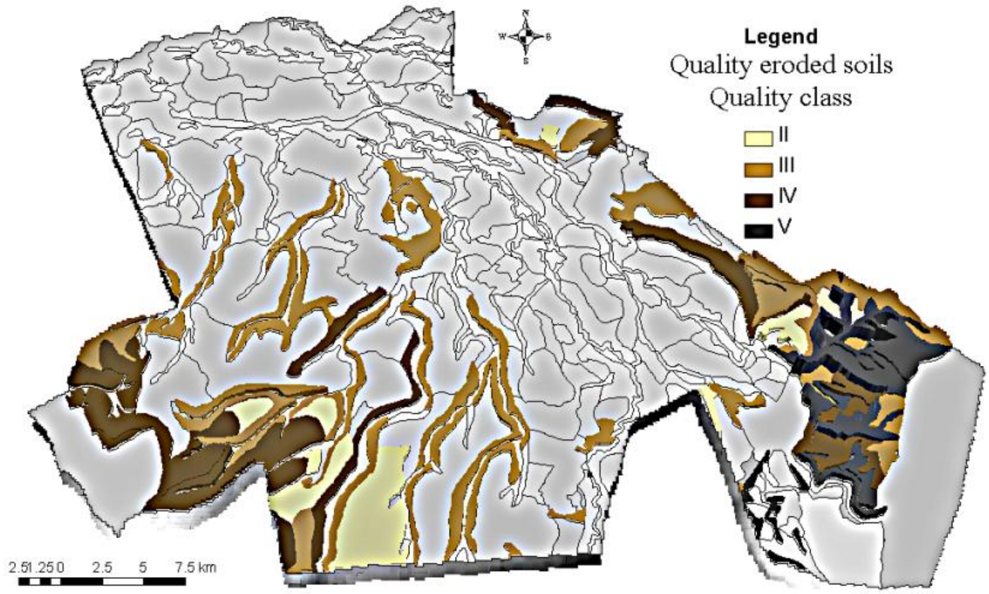


Fig. 3. Assignment to quality classes eroded land

Agricultural land in class II quality on small areas overlap, ie 14.36% of soils (218 ha), being some subtypes preluvisols and luvisols. Class III quality lies a large area of 45.12% of the total area of soils (685 ha), represented by types of luvisols and preluvisols with varied distribution (Figure 3). Class IV quality extends to 28.26% of the total area of soils (429 ha) are mostly eroded soils, located on the slopes with high gradients (luvisols, alosoluri, regosols, anthrosols). Land in class V quality surface amounts to 12.25% of (186 ha); soils included (eutricambosoil, litosol, antrosol) are located in hilly areas with higher altitudes and therefore the higher slope gradient, surface erosion acting on them severe intensity.

Similar to soil classification in quality classes, in the whole territory affected by erosion in surface soils fall largely into quality classes III and IV (Figure 3).

In determining quality classes use "*arable*" part 5 types of cultures [6]. In the following, we present comparative quality soils for wheat and maize (Figure 4).

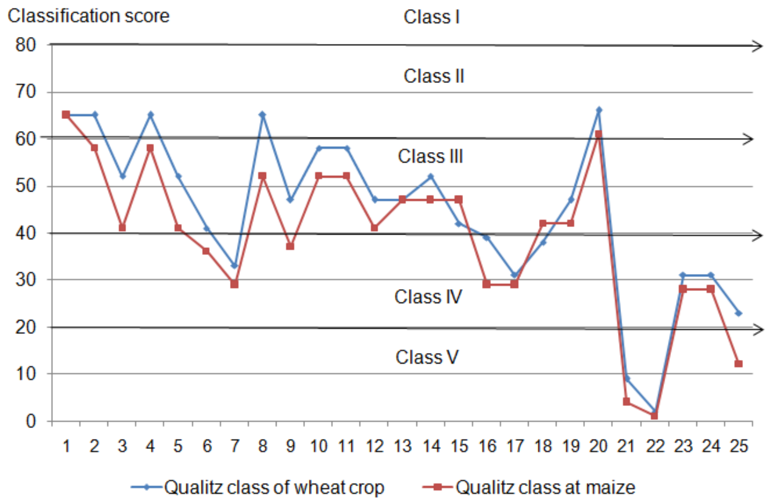
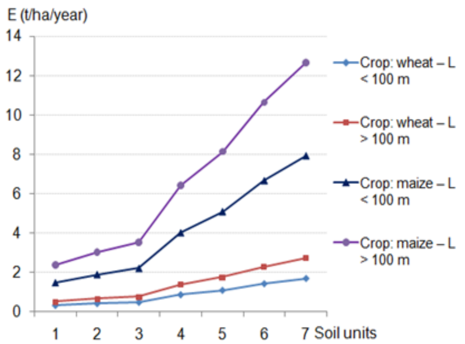


Fig. 4. Framing eroded soils in quality class at wheat and maize [6]

The analysis of Figure 4 does not show significant differences between the quality of soils for growing wheat and corn, but in most cases, agricultural lands bounding scored significantly lower for corn crop. From the visual analysis of Figure 4 built on the score for admission to quality classes for the two cultures, one can say that eroded soils can be grown equally with both types of cultures. This idea is supported by other information from the literature, according to which, for example, luvisols, the majority in the analyzed area can be cultivated with wheat, corn, oats, clover, less with orchards or vine [1].

The data presented show no significant differences between the two cultures, in terms of "claims" quality, but being analyzed soils with varying degrees of erosion, it is necessary to adopt measures to prevent and combat this phenomenon, thus reducing amount of soil lost due to the action of erosion processes, so choosing highly protective culture.

Previous research conducted in this area have shown that the average annual cultural influence on the amount of soil lost by erosion area is significant [4]. To validate this claim was determined by the amount of soil lost through erosion of the surface, in both cultures, on the basis of the relation (1), the results were shown in Figure 5.



SU	i (%)	E (t/ha/year)			
		Wheat		Maize	
		L < 100 m	L > 100 m	L < 100 m	L > 100 m
1	5.15	0.319	0.509	1.490	2.378
2	6.25	0.408	0.652	1.907	3.044
3	6.99	0.474	0.757	2.215	3.536
4	10.57	0.862	1.376	4.025	6.423
5	12.32	1.092	1.744	5.100	8.139
6	14.57	1.429	2.280	6.668	10.642
7	16.20	1.700	2.713	7.935	12.664
US – soil unit; i – average slope; L – slope length; E – amount of eroded soil					

Fig. 5. Quantitative assessment of surface erosion

In the case of factor "slope" of the relation computing (1) through software ArcGIS, average slope was calculated for each soil unit (Figure 5).

Comparative analysis of the data summarized in Figure 5, to bring the following statements:

- the amount of eroded soil increases with slope and slope length in all cases analyzed
- under wheat crop, the average annual quantity of soil lost due to surface erosion is significantly lower than under maize crop, regardless of the length of the slopes
- regardless of the length of slopes, land cultivated with maize lose an average annual soil of 4.67 times higher than in those grown wheat
- in both cultures, slope length increases the amount of soil eroded: the slopes longer than 100 m, the amount of soil lost more than 1.6 times compared to land located on slopes with a length less than 100 m.

So, between the two cultures, there are significant differences in terms of the amount of soil eroded, differences can be explained by the fact that wheat crop (winter cereals) is listed as a good crop protecting the soil coverage between 50 - 75% and maize crop is considered weak protection, with coverage below 25% [2].

CONCLUSIONS

Soils in the territory Traian Vuia falls extensively in classes III and IV quality classes that comprise 79.25% of the agricultural area as a result of physical and geographical conditions that led to the formation, the large areas of Luvisols, medium to low fertility soils.

So, 25 soil units were analyzed in the area affected by erosion, superimposed on an area of 1518 hectares, or 24.80% of total agricultural area. The quality of eroded soils, at category of use "*arable*" is low, it fits, mostly in classes III and IV quality classes representing 73.34% of the eroded soils.

In the case of of wheat and corn crops, the score for admission to class quality is largely similar (slightly lower corn), which means that soils can be grown equally to both cultures, but being analyzed soils with varying degrees of erosion and knowing the cultural influence on the amount of soil eroded culture should be chosen with the highest level of protection. Under the wheat crop (good crop protecting the soil coverage of 50 - 75%), average annual surface soil lost due to erosion is significantly lower than under maize, maize cultivated farmland lost an amount annual average of 4.67 times higher ground than in those grown wheat (weak protective culture with soil coverage below 25%). So, although included in the same class quality and can be applied in similar environmental conditions, the two cultures analyzed offer different levels of protection of soils.

For preventing and/or reducing the destructive action of surface erosion and soil conservation default, caution should be exercised in choosing the type of crop, following a holistic approach, based on analysis of all the factors involved.

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