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To the problem of mapping erosion processes

Goal. To substantiate the application of data on the magnetic susceptibility (MS) of soils as a diagnostic criterion for the degree of their blur (erodibility). Methods. Laboratory, mathematical-statistical, geoinformation. Results The magnetic susceptibility of the soil is highly probable due to the distribution of humus content and the index of erosion hazard. Due to the established linear dependence (based on a limited sample - the catenary number of chernozems), the use of humus depletion schemes can be recommended similarly between humus content and the investigated indicator. The water-erosion structure of the investigated slope is grounded on the basis of the spatial distribution of the values of the investigated index. Conclusions By using the statistical link of the soil MS with the index of erosion hazard and the content of humus, circuits for determining the degree of blur (erodibility) on the basis of the researched indicator can be used, similar to those based on the reduction of humus content. Due to the expressiveness and lower cost of the method for determining the soil MC, it is possible to plot and substantiate the probable water-erosion structure of the slope on the basis of a denser systematic sampling grid.

Key words: degree of blurry (erodibility) of soil, magnetic susceptibility of soil, erosion mapping of agricultural lands.

The problem of establishing the degree of blurry (erodibility) of land is quite acute in front of soil conservation specialists, land managers and business entities (during planning of crop rotation, agrotechnical measures) and potential landowners (during land valuation).

Classification schemes for the determination of the degree of fault (soil erosion) of the soil are based on the following diagnostic criteria: 2 classical ones - the capacity of the humus profile (soil profile), the humus content [19, 22], and the alternative - content of biofilic compounds (elements) and the soil parameters that they determine [2, 15]. Uniqueness of the result of the installation The layer of washed soil with the help of the above classification schemes is possible only when applied to a single elemental ground area (EGA) and the distribution of values of the soil parameter, which can be represented by the profile in the form of a strict monotone function. The distribution of factors and soil conditions on the slope forms a combination of soil combinations of the EGA with difficult due to the combination of soil values (soil potential, horizontal ratio, distribution of the profile of biofilic compounds (elements), that is, these classification schemes can be stated only by anthropogenic - but-natural structure of the soil cover of the slope. Establishment of the reference values of the soil parameters for a different degree of blur due to the weak validity of the schemes of blur (erosivity) is, unfortunately, questionable. The use of "dividing", "power", "virgin" analogues, models of the soil profile indicates that the structure of the soil cover of the slope and the formalization of the multifactorial nature of the soil are ignored [7, 9, 10, 17, 20, 21].

One of the alternative indicators for determining the degree of blur (erosion) of the soil, which offset some of the defects of the above schemes (laboriness, waste), may be the magnitude of the magnetic susceptibility of the soil [1, 13].

The study of the Soil Soil began in the 1950's and concerned the problem of classification and genesis. With the development of the equipment base of magnetometry, the efficiency, expressiveness and low cost of the method become a precondition for its application to solving more complex tasks [3, 5, 14], in particular those related to the study of erosion processes [3]. Several scientific centers appeared on the territory of the former USSR, which developed this area: Izhevsk Agricultural Institute, Moscow State University named after. M.V. Lomonosov, Yaroslavl Technical University. The Udmurt scientists even produced a patent documentation that regulates the use of data on MS soils to determine their degree of blur [1]. In Ukraine, the study of the magnetic properties of the soil began in the late 90-ies of the last century on the basis of the geological faculty of the Kiev National University named after Taras Shevchenko and NJSC "Nadra Ukrainy". Despite the pronounced geological direction of work [16], the methods of magnetic investigation used during the conduct of ecological studies, paleomagnetic studies [11].

The purpose of the research is to substantiate the application of data on the soil of the MS as diagnostic criterion of degree of their blur (erodibility). Research methods. The object of the research was a soil cover in the territory of a conditional polygon within the boundaries of the settlements council Cherkassy Tyshki (Kharkiv district of the Kharkiv region), represented by the cathedral row of chernozem. The explored land was used in field crop rotation without technological constraints. There were no complications of halomorphic or hydromorphic nature on the site. Soil samples were taken from a layer of 0-20 cm under the scheme depicted in Fig. 1. The humus content (DSTU 4289: 2004) has been set in the selected samples. The index of erosion hazard for the points of selection is calculated by the formula [10]:

$$I_e = K_p \frac{(kFI)^{0.4} J^{0.3}}{B^{0.4} n^{0.6} V_p} \quad (1)$$

where Kp - coefficient of influence of vegetation cover (agrofon) on the intensity of erosion; k - runoff factor; F - catchment area of a certain stream, m2; I - intensity of water flow, m / s; J - slope of the surface; B - flow width, m; n - surface roughness coefficient; Vp - fuzzy rate of water flow for arable land, m / s. Scale for assessing the erosion hazard of land: 0,0 - 0,5 - erosion-safe lands; 0,5 - 1,0 - conditionally erosion safe; 1,0 - 1,5 - admissible erosionally dangerous; 1,5 - 2,0 - erosionally dangerous; > 2.0 - excessively erosion-hazardous land.

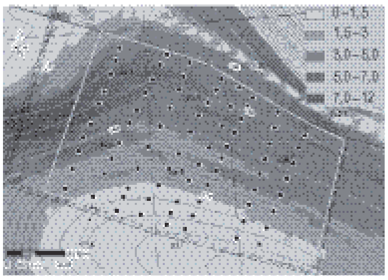

Fig. 1. Scheme of sampling and cartogram of slope steepness in degrees

Magnetic susceptibility is called the ratio of the value of the sample magnetization, which occurs in the external magnetic field, to the value of this field. This indicator depends on the concentration and mineral form of iron compounds [6]. Separate several types of MS: bulk (measured for a certain volume of substance), specific (measured for a certain mass of matter) and molar [18].

Briefly describe the course of the determination of MS soils: soil tests are carried out without the action of elevated temperatures to the air-dry state; establish a specific MS of soil samples with the help of capamilis KLY-2 in accordance with the methodology adopted in the countries of the former USSR [4].

Measurement error during operation with KLY-2 does not exceed 0.1%. The main part of the error is introduced by the weight measuring devices (for laboratory weights of the 4th class and the mass of the sample it is about 40 g it is ± 0.5%) and the difference in soil moisture content (maximum hygroscopicity for lean and lightly-clayey varieties of soil - respectively 10.0 and 5,17%, that is, the possible error is within ≈5% [12]).

Research results. On the basis of correlation and regression analysis, the possibility of direct use of MS soil as a diagnostic criterion of blurryness was determined (Fig. 2). The investigated indicator with high probability is related to anthropogenic-natural distribution of humus content (r = 0.87; R2 = 0.76) and an erosion hazard index (r = 0.87; R2 = 0.75). Due to the established linear dependence (based on a limited sample) between humus content and soil microplate, direct use of humus depletion schemes is possible. We give these schemes (according to MM Zaslavsky, SV Naumov, the linear relationship between the decrease in the content of humus and the capacity of soil, according to G. I. Schwabs - parabolic) (table).

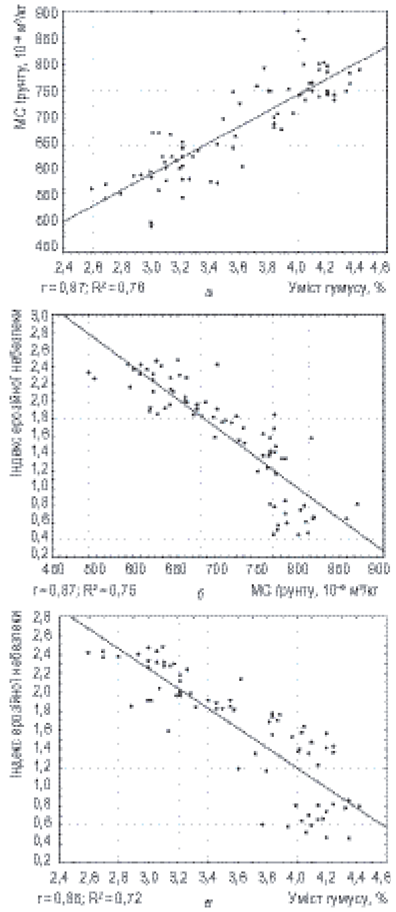

Fig. 2. Characteristics of the function of the dependence between: a - MS soil (10-9 m3 / kg) and humus content (%); B - index of erosion hazard and MS soil (10-9 m3 / kg); in - index of erosion hazard and humus content (%)

Basic classification of the soil fault of the chernozem type

The capacity of the soil profile, the content of humus, the size of the soil MC are due, on the one hand, a spatial combination of factors and conditions that form a positive dynamics of soil formation: hydrothermal regime, maternal and underlying species, etc., on the other - the distribution of factors and conditions that determine the destructive processes of soil formation: for humus (MS soil) - erosion, dehumidification; for the capacity of the soil profile - less significant: deflection, karst, suffusion, solifluction, agro-erosion; spontaneous - deflation, water erosion.

For each separate space of ecological factors and conditions there are unique combinations of values of soil parameters and the proportion of the process of accelerated erosion in the total value of soil parameters. That is, on the basis of the accepted soil samples as diagnostic criteria of blur, it is impossible to establish unequivocally the violations of the soil horizons as a result of reduced erosion.

We will analyze the deeper possible links between the index of erosion hazard, the MS of soil and the content of humus (Fig. 3). The obtained regression curves (polynomial of the third degree) can be divided into 3 segments characterized by: the optimum, homogeneity of hydrothermal conditions on the part of the hinge (the index of erosion hazard 0,5 - 1,0). The curves of the studied indices are parallel to the X axis, which indicates that it is impossible to describe their erosive index (the elasticity graph of the function takes the value close to zero); a conjugate, unidirectional change in the values of MS of soil and humus content due to changes in the hydrothermal regime in the range of the erosion hazard index 1.0 - 2.0. The elasticity function gets maximum value; suboptimal hydrothermal conditions for humus formation and synthesis of strongly-magnetic minerals in the lower part of the slope in the range of the index of erosion hazard 2.0 - 2.5.

In this segment, with the help of humus content, it is more likely to predict the index of erosion hazard, as compared to the soil MC.

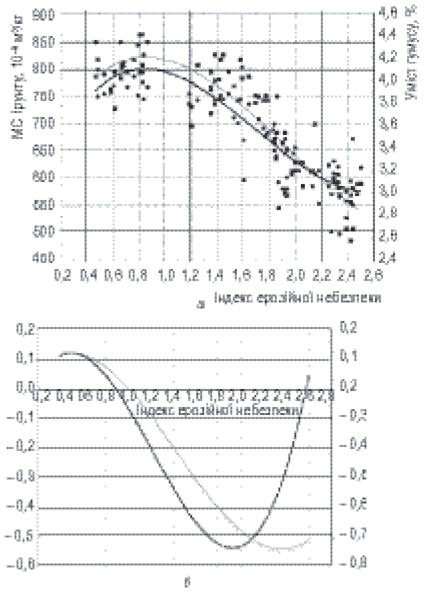

Fig. 3. a - graph of the dependence functions between the soil MS (10 - 9m3 / kg), humus content (%) and the index of erosion hazard; B is the graph of the elasticity of these functions (the elasticity of the function shows how much the function value changes, if the argument increases by 1%); - MS soil; - humus content

Let's try differently to analyze obtained data, substantiating the erosive structure of the soil cover of the slope on the basis of the propane distribution of the values of the MS of the arable layer of soil (Fig. 4, a). Divide into classes of MS soils in the middle of the 3 ranges of the index of erosion hazard 0,5 - 1,0; 1.0 - 2.0; 2.0 - 2.5 (Fig. 4, b). For this purpose, the clustering method is chosen: the distance measure is Euclidean, the rule of unification is the unweighted pairwise average. The range of the index of erosion hazard 0,5-1,5 is characterized by 2-4 classes of soil microscopy, whose average values are 794 - 750 × 10 - 9m3 / kg. By the above classification, they may belong to the weakly eroded. The heterogeneous structure of the ranges of the index of erosion hazard 1,5-2,0 testifies to the presence of current erosion. Average values of classes (4 - 8) 750 - 593 × 10 - 9m3 / kg, that is, areas with the minimum values may belong to medium-sized soils. The range of 2.0 - 2.5 of the erosion hazard index characterizes the average soiled soils with the mean values of the classes (10, 11) 621 - 503 × 10 - 9m3 / kg and soils (12th grade) - 563 × 10 - 9m3 / kg.

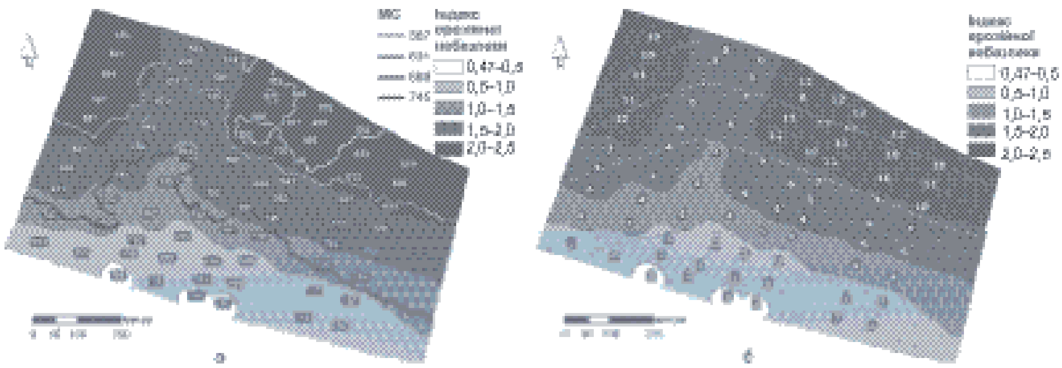

Fig. 4. Justification of the erosion structure on the basis of the spatial distribution of the MS soil: a - the point values of the soil MC; B - classes of MS soil (10 - 9m3 / kg) for the index of erosion hazard (mean MS soil ± standard deviation (number of values in the class)): 0.47 - 1.0: 1. 855 ± 10.4 (2) ; 2. 794 ± 7.4 (8); 3. 757 ± 8.5 (8) *; 1.0 - 2.0: 4. 750 ± 16.6 (16); 5. 703 ± 7.5 (5); 6. 675 ± 6.7 (5); 7. 646 ± 8.8 (6); 8. 593 ± 12.1 (5); 2.0 - 2.5: 9. 673 ± 0.0 (1); 10. 621 ± 9.0 (8); 11. 589 ± 4.8 (5); 12. 563 ± 9.8 (6); 13. 503 ± 4.8 (2)
* The statistically identical samples are marked with the appropriate tint.

Conclusions

Using the statistical link of the soil microclimate with the index of erosion hazard and the content of humus, circuits for determining the degree of blur (erodibility) on the basis of the researched indicator can be used similarly to schemes based on the reduction of humus content.

Due to the expressiveness and the lower cost of the method for determining the soil MC it is possible to plot and substantiate the probable water-erosion structure of the slope based on a denser systematic sampling grid.

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