

CADASTRAL ACCOUNTING OF LAND PLOTS AS INFORMATION BASIS FOR SOIL MONITORING

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Abstract. This article analyses land accounting as part of the State Land Cadastre of Ukraine. It has been proven that, under modern conditions, cadastral accounting can become a reliable basis for soil monitoring in Ukraine. The indicators of land quality accounting and regulations in the field of land protection and reproduction of soil fertility are analysed. The article proposes criteria for land cadastral accounting based on a study of the qualitative state of agricultural lands in a separate region. Factors for ensuring sustainable land use are singled out, taking into account the needs of agricultural production. It has been proven that regular monitoring of land use helps identify problems in time for effective management and optimal use of land. The purpose of the study was to create a system of land cadastral accounting indicators based on best practices and available indicators. The main purpose of this mechanism is to compare and evaluate the land accounting criteria of Ukraine. The materials of the research are land cadastral data built on methodical methods of synthesis and analysis of individual elements. The research methodology consisted of three stages: 1) identification of a number of factors characterizing land quality accounting as a basis for effective monitoring of land; 2) analysis of the methodical basis of land accounting, determination of cadastral accounting indicators; 3) identification of the most optimal land accounting criteria for rational use and land protection using correlation-regression analysis. As a result of the conducted research, it was established that there are a significant number of approaches to accounting for the quality of land in Ukraine, but there is still no unified system of them. The proposed model of accounting for the quality of land in Ukraine will provide a solution to problems of the components of land cadastral accounting as a basis for effective land use.

Keywords: cadastre, accounting of land plots, soil quality, agricultural land, rational use of land.

Introduction

Full-value, reliable information about quantitative and qualitative indicators of the condition of lands should become the basis of their rational use and effective management. Considering the difficult situation in Ukraine caused by the war, it is important to conduct a detailed analysis of the state of the lands. Lisova T., Novakovska I., Tykhenko O., Tretiak A., point to the problem of filling the State Land Cadastre with information on the quality of land [1-4]. The Polish land cadastre contains data on land use and soil quality. In the process of generation the land cadastre, in addition to geodetic measurements, soil maps at a scale of 1:5,000 were also created. The data directly included in the land cadastre include soil classes based on soil quality [5]. Since filling the cadastre with up-to-date data on soil cover is a very time-consuming and financially costly process, some researchers propose alternative research methods. Thus, according to Kohan S. et al. interpolation as a component of geographic information mapping can be effectively used to reduce the cost of agrochemical surveys by optimizing the number of samples [6]. Research by Maksimenko N. [7] found that the share of agricultural land in the structure of the regional land fund within the country varies from 49% in the Carpathian economic district to 81% in the Dnipro region. The average share of agricultural land in the country is 67% of its area. In general, the soils of the administrative regions of Ukraine are characterized by significant differences. The weighted average content of humus in the soil ranges from 1.6% in the Volyn region to 4.32% in the Donetsk region, while the national average is 3.1%. Instability in agricultural land use determines the need to study the socio-economic functions of the agricultural ecosystem [8].

The purpose of this research is the scientific substantiation of ensuring effective accounting of lands in the Kyiv region. The need for the functioning of up-to-date and reliable accounting of land quality is the primary basis for the introduction of a highly effective multi-purpose cadastral system.

Materials and methods

The materials of the research are land cadastral data built on methodical methods of synthesis and analysis of individual elements. A review of legislative acts and scientific publications on land quality accounting was conducted, and the main criteria for soil monitoring at the regional level were identified. This study was conducted on the lands of the Kyiv region. In the analysis of land quality accounting indicators, norms in the field of land protection were used [9]. The definition of degraded land is based on the generally accepted methodology for identifying signs of common qualitative indicators of land

based on the generalization of land management funds, administrative data, and the results of agrochemical certification of fields. Theoretical and methodological approaches were used in the research, namely: collection and description of facts, their analysis. Conducted research is based on the State Geocadaster data.

Results and discussion

Soil accounting in the cadastre is a component of the qualitative characteristics of lands and is carried out by agro-production groups of soils. In the land cadastre of Ukraine, as shown in Fig. 1, indicators are accounted for by qualitatively distinct groups of indicators. Since the first stage of the study was to identify factors characterizing land quality accounting as a basis for effective land monitoring and protection, the criteria characterizing the extent of spread of environmentally unfavorable land degradation processes were taken as a basis. Some scientists [10; 11] point out that such criteria should be complex indicators that reflect a generalized assessment of fertility, taking into account its efficiency and evolution. In the current system of land cadastre, soil accounting is an element of the qualitative characterization of land, in which soil units are combined into enlarged groups on the basis of commonality of certain qualitative indicators.

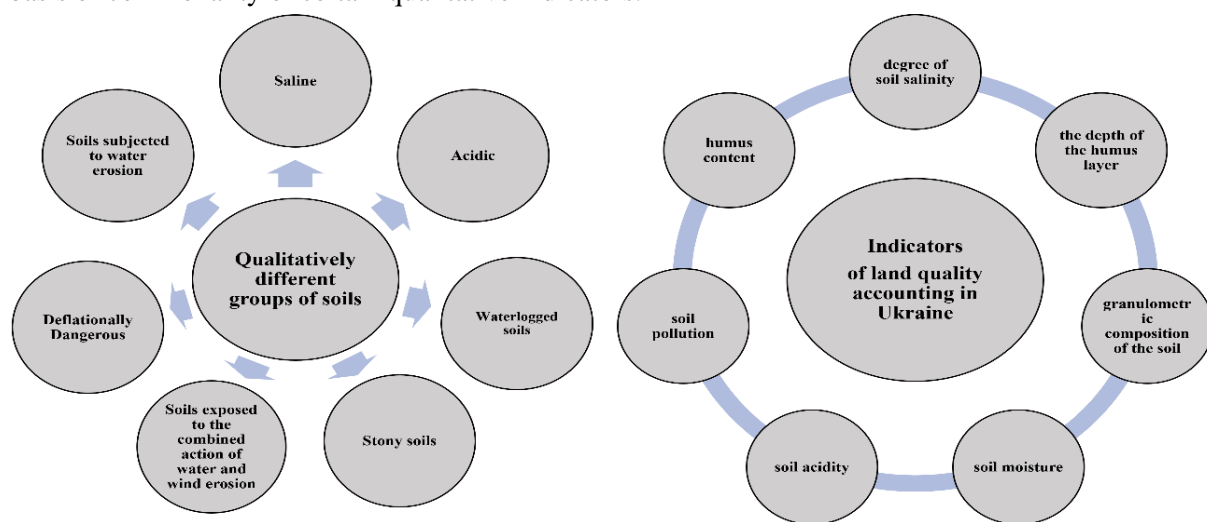


Fig. 1. Qualitatively distinct groups and land quality accounting indicators (compiled by the authors on the basis of reporting data of the State Geocadastre of Ukraine)

The second stage of the study was to analyze the normative and methodological basis for land accounting and determine cadastral accounting indicators. Land quality accounting reflects data characterizing land by natural and acquired properties, affecting their productivity and economic value, as well as by the degree of man-made soil pollution [12]. In accordance with the Law of Ukraine “On Land Protection” [9], the following standards are set for land protection and soil fertility conservation: maximum permissible soil pollution; soil quality; optimal ratio of land; and indicators of land and soil degradation. The ecological imbalance of the composition of the land determines the need for land protection [13], as it impairs the reproduction of soil fertility and reduces the efficiency of functioning of agro-landscapes.

The Kyiv region is located within two geostructural regions – the Ukrainian crystalline shield and the Dnipro-Donetsk depression. Predominant in the Kyiv region are sod-podzolic, gray forest, chernozem with podzol, typical chernozem, meadow-chernozem, meadow, swamp and peat and sod soils (Fig. 2).

The soil cover of the Kyiv region forms complexes, is characterized by fine contours, a high degree of differentiation of areas of soil types, significant soil contrast. About 16% of the total area of agricultural land is covered by sod-podzolic unglazed and glaciated soils on ancient alluvial, water-glacial deposits, moraines and loess loams, about 10 percent – chernozems and dark gray podzolized soils on loess rocks, and the least amount is grassland – chernozem soils on loess rocks.

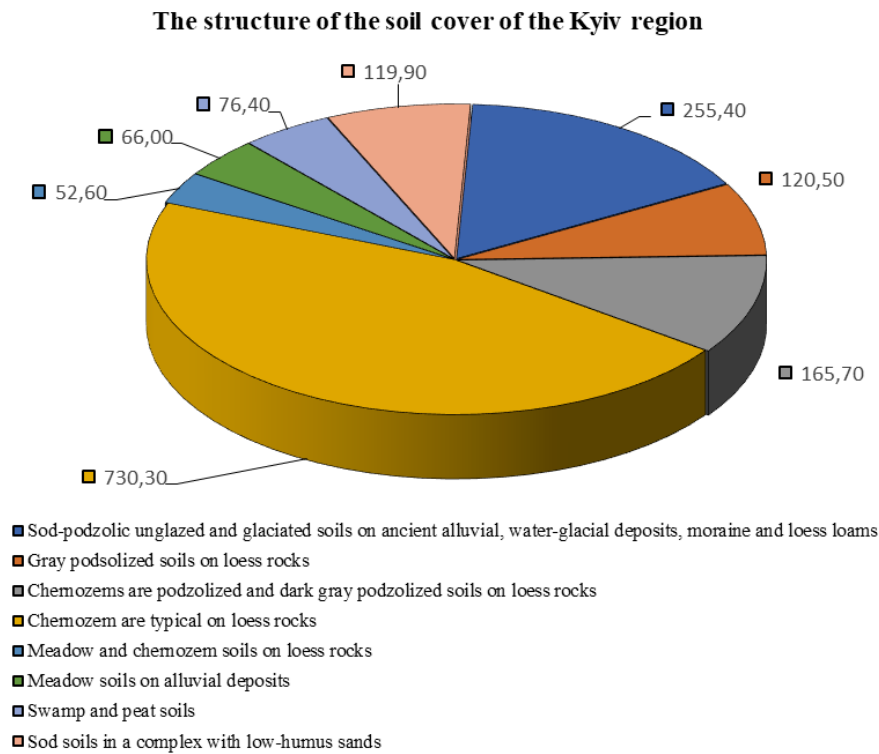


Fig. 2. Main soil types of the region (compiled from the materials of the State Institution “Institute of Soil Protection of Ukraine”), 2018

Long-term results of soil fertility monitoring studies indicate a decrease in its main indicators and an increase in the area of acidic and saline lands [14]. The absence of specific indicators of soil fertility in the cadastral system complicates state control over the use and protection of land, as a result, there are no grounds for compensation for damages caused by irrational use of land [15]. Assignment of land plots to certain categories of suitability, classes and types of land is carried out according to signs and properties that most significantly affect the nature and specificity of their possible and appropriate use as part of certain lands. In Fig. 3 the areas under qualitatively different groups of lands that were affected by degradation in the studied region are presented. Deflationally dangerous agricultural lands occupy 44.39% of the total area, and 34.18% – agricultural lands with acidic soils.

The area of land affected by degradation in the Kyiv region, thousands of hectares

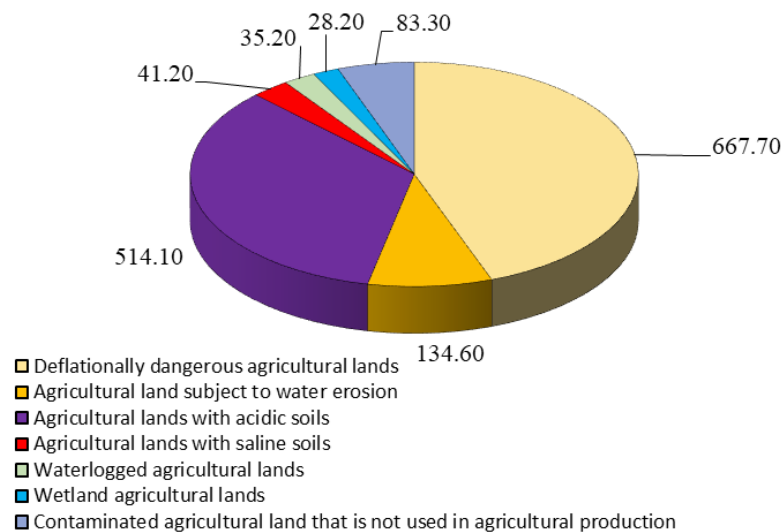


Fig. 3. Land degradation in the region (determined by the authors based on the data of the “State Geocadastre of Ukraine”)

In order to fill the State Land Cadastre of Ukraine with information about the qualitative state of the land, it is important to conduct a timely assessment of the state of soil productivity. In Ukraine, the regulatory document regarding fertility indicators of a land plot is the Agrochemical passport of a field, a land plot. Monitoring of degraded, polluted lands and unproductive lands makes it possible to prevent the negative processes of the destruction of the soil cover and to detect their development in a modern way.

Table 1 shows the areas of degraded lands of the Kyiv region according to the degrees of their manifestation. Thus, in the area of 746.005 hectares, deflation-dangerous lands are widespread, which, in our opinion, is connected with a large area of soils of light granulometric composition. Thus, the area of sandy soils is 253.296 ha, bound sandy soils – 9.693 ha, light loam soils – 777.526 ha, while heavy loam soils are only 5.457 ha.

Table 1

Characteristics of the quality of agricultural land in the Kyiv region

Land quality accounting indicators	Degree of manifestation of the indicator	Area, ha	Land quality accounting indicators	Degree of manifestation of the indicator	Area, ha
Saline soils	total	72652	Waterlogged soils	total	35871
	weakly	71901		floodplain	3168
	average	499		non-flooded	32703
	strongly	252	Wetlands	total	83703
Solonetz	total	2122		weakly	63949
	weakly	1834		average	4918
	average	287		strongly	14836
	strongly	1	total	746005	
Soils with saline complexes	total	3046	Deflation-hazardous soils	weakly	642241
	from 10 to 20-30%	2218		average	92636
	from 20-30 to 50%	543		strongly	11128
	more than 50%	285	Soils subjected to water erosion (washed away)	total	173700
Acidic soils	pH > 5.6	271584		weakly	98424
	pH 5.15.5	196059		average	38370
	pH 4.6-5.0	81413		strongly	36906
	less than 4.5	23639			
Granulometric composition of soils	heavy loamy	5457	Granulometric composition of soils	sandy-loam	253296
	medium loamy	276948		sandy-linked	96934
	light loamy	777526		sandy	14525

Source: calculated by the authors based on the data of the “State Geocadastre of Ukraine”

The basis of the classification of lands in Ukraine is their condition and possibility of use in agriculture. When accounting for the quality of land, seven categories of land suitability are identified, and especially valuable land is identified within them. Soil degradation is the main factor that worsens the condition of the land. Therefore, it is very important to single out specific indicators of land quality accounting and establish a connection with land productivity. Based on the results of the correlation analysis of agricultural land quality indicators, a strong correlation was noted between the areas of deflation-dangerous territories and areas with soils of light granulometric composition ($R^2 = 0.9148$). We carried out a correlation analysis between fertility indicators of agro-production groups of soils. Thus, a strong relationship was found between humus content and acidity index ($R^2 = 0.8207$). A weak relationship was recorded between the content of humus and the content of physical clay ($R^2 = 0.3419$) (Fig. 4).

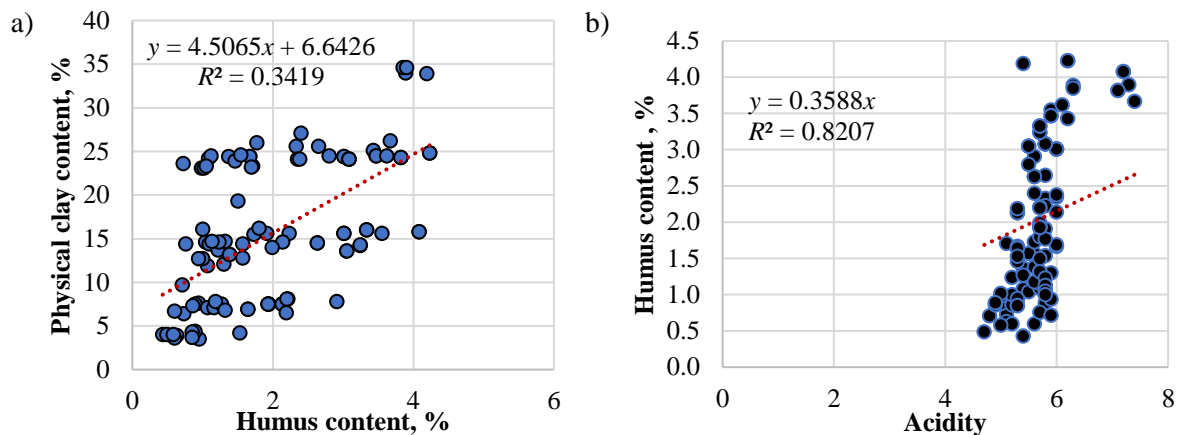


Fig. 4. Relationship between land quality indicators in the Kyiv region, arable land:

a – relationship between humus content and physical clay content;

b – relationship between humus content and acidity

There were no dependencies between other indicators. The conducted correlational analysis of land quality accounting criteria in Ukraine proves a weak connection between the main indicators of fertility. This proves the need for detailed study within individual natural-agricultural regions by agro-production groups of soils, which are objects of land quality accounting and assessment of agricultural land plots.

Conclusions

1. For highly effective land monitoring, it is necessary to carry out systematic accounting of land quality. In Ukraine, it is necessary to conduct a full-scale survey of the soil cover, which, unfortunately, is impossible in the near future, both financially and technically. Therefore, we recommend creating a database of indicators of agro-production groups of soils at the levels of territorial communities, natural-agricultural districts, regions.
2. Monitoring of degraded lands in the Kyiv region proves that, according to the degree of manifestation, significant areas are exposed to wind erosion, much less to water erosion, significant areas of soils with acidic soils, 72652 hectares are covered by saline soils, which is about 5% of the total area of the region land. Acidic soils account for 38% of the total area of surveyed land in the region. Since land quality accounting data should become the basis for monitoring the use of agricultural land, we recommend forming a full-fledged cartographic and attributive base of indicators of agricultural groups, especially indicators of soil degradation.

Author contributions

Conceptualization, Olha Tykhenko; methodology, Olha Tykhenko and Ruslan Tykhenko; formal analysis, Olha Tykhenko and Andrii Martyn; investigation, Olha Tykhenko, Andrii Martyn, Ruslan Tykhenko and Ivan Openko; writing – original draft preparation, Olha Tykhenko and Ruslan Tykhenko; writing – review and editing, Andrii Martyn and Ivan Openko; visualization, Olha Tykhenko and Ruslan Tykhenko; project administration, Olha Tykhenko; funding acquisition, Ivan Openko. All authors have read and agreed to the published version of the manuscript.

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