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Comparative characteristics of the cadastral value of agrolandscapes of the Siberian Federal District (as exemplified by Irkutsk and Tomsk oblasts)

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Abstract. The differentiation in the cadastral value of soils in Irkutsk and Tomsk oblasts is presented. The soils of the agricultural zone of Tomsk oblast are characterized by higher indicators of the cadastral value, and, consequently, have higher values of the agroclimatic potential. The sensitiveness of calculating the cadastral value of lands to various soil and geographical conditions is shown. With the development of erosion and gleying processes the reduction in the cadastral value can reach 40 and 63%, respectively, and even 60% under conditions of soil alkalinity.

1. Introduction

The state cadastral valuation of lands is an integral procedure for the successful functioning of the system of land relations in our country. The cadastral valuation is necessary, first of all, for taxation and calculation of rent. The source of information for calculating the cadastral value of agricultural land is the characteristic of soil quality. These data are based on the large-scale soil studies carried out in all constituent entities of the Russian Federation in the mid-1990s [1]. The cadastral value and the land tax, which is a local tax and remains in the constituent entity of the Russian Federation, depend on the characteristics of the soil quality (humus content, thickness of humus horizon, physical clay content, and negative factors affecting soil fertility). Soils of different agroclimatic conditions will be differentiated in different landscape elements by cadastral value. The study of the pattern of such differentiation is a very urgent task of practical (economic) significance. This work is extremely relevant now, since the state budgetary institutions (SBU) in the regions of Siberia are planning to evaluate the cadastral value. The scientific novelty of this work consists in the methodological development of approaches for calculating of the cadastral cost in various agroclimatic conditions, ranking of the cadastral value indicators based on the presence and degree of influence of negative signs, affecting to soil fertility.

Agricultural lands of the Siberian Federal District should be evaluated according to the accepted rules for cadastral valuation of agricultural lands. In the guidelines "On state cadastral valuation" [2], approved by order of the Ministry of Economic Development of the Russian Federation No. 226 as of May 12, 2017, the cadastral valuation includes evaluation of agricultural land, soil properties that affect land fertility, climate characteristics and terrain. Methodical guidelines recommend to evaluate the cadastral value of agricultural lands on the basis of the National Register of Soil Resources [3], the crop productivity and technological expense projection. These sources provide the soil types and indicators of their fertility, as well as include characteristics of other natural conditions [4].

It should be noted that there is no practical experience in the use of new guidelines for the state cadastral valuation of agricultural land in the Siberian Federal District. We can calculate the cadastral value for specific cadastral plots by calculating the specific indicators of the cadastral value (SICV), and being aware of the area that these soils occupy. The existing cadastral materials do not contain such information; they provide data on the cadastral value of land plots without taking into account the quality of land and the area of specific soil types. The data obtained can be used by the SBU officers in the evaluation of the cadastral value of agricultural land. This work is based on the official data as a matter of the state cadastral valuation of land.

2. Objects and methods

The soil cover of Irkutsk and Tomsk oblasts is represented by a variety of types and subtypes of natural soils, as well as modified and anthropogenically transformed soils. However, we will not analyze all this wide natural diversity taking into account the specifics of our work, but settle only on the soils that were identified as the most common for this territory when compiling the National Register of Soil Resources [3] and which are presented in the Land Classification Scales developed by the planning and design center VISKHAGI for all constituent entities of the Russian Federation (2005). The classification scales were compiled taking into account the agroclimatic zoning of territories according to the list of evaluation groups of the land evaluation districts of the subject of the Russian Federation for each agroclimatic subzone. These scales have been agreed in the Rosreestr Departments and represent the regional lists of soils.

Irkutsk oblast is divided into three agricultural zones according to the natural features: steppe, forest-steppe and subtaiga-taiga. More than 50% of cropland of oblast is located in forest-steppe, 20% in steppe and the rest in taiga. The steppe zone is located in the Ust-Orda Buryat Okrug and consists of two areas: Alarsko-Nukutskii and Ust-Orda-Bayandai.

The Cheremkhovo and Ol'khon districts also belong to the forest-steppe zone which is located along the Transsiberian railway from Irkutsk to Tulun, as well as on the right bank of the upper reaches of the Angara (Bokhan – Ust'-Uda). This is the main agricultural zone in oblast, supplying almost 60% of the total regional agricultural production. It has the most favorable climatic conditions.

The subtaiga zone is the northern agricultural area of oblast, located along the spur line Taishet-Lena, the western section of the BAM and the upper reaches of the Lena river. The territory is characterized by undersupply of heat provision for agricultural crops, and good and medium moistening in the growing season.

Agricultural lands in Irkutsk oblast occupy 3.6% of the territory, including 62% of croplands, 1.1% of perennial plantings, 13.9% of hayfields and 22.9% of pastures.

Agricultural lands in Tomsk oblast occupy 4.5% of the territory, in their structure there are arable land (49%), perennial plantings (0.7%), hayfields (35%) and pastures (15%). A comparison of the structure of agricultural land in Irkutsk and Tomsk oblasts revealed a higher percentage of cropland and a lower percentage of forage lands in Irkutsk oblast. Soil and climatic conditions enable full-scale farming only in the southeast of Tomsk oblast. 80% of croplands are concentrated there and the main harvest of grain crops is carried out there. About 45% of the total area of agricultural lands is in the Kozhevnikovo, Shegarskii, Tomsk and Zyryanskoe districts. The Aleksandrovskoe, Tegul'det, Kargasok and Verkhneketskii districts have little agricultural land [5, 6].

According to the reference book of agroclimatic zoning of the constituent entities of the Russian Federation Irkutsk oblast is divided into 4 agroclimatic subzones [7]. The value of the agroclimatic potential, which includes both the indicators of the sum of the effective temperatures over 10 degrees (∑t˚ > 10 ˚C) and the moisture coefficient, ranges from 2.3 to 3.6.

In the northern regions of oblast the mean annual temperature ranges from 4 to 8.6 °C, the absolute temperature minimums vary from 59 to 64 °C, and ∑t° > 10 °C ranges from 1200 to 1500 °C. The frost-free period lasts from 55 to 95 days. Precipitation per year is approximately 400–470 mm. In these areas grain crops are not grown due to the low values of agroclimatic indicators (∑t° > 10 °C does not exceed 1400 °C) and continuous permafrost spreading. The agricultural lands in this subzone are mainly used as hayfields and pastures.

The southern regions of oblast are characterized by mean annual temperature from 1.2 to 2.6 °C. ∑t° > 10 °C varies from 1500 to 1700 °C. The frost-free period lasts 105–112 days. The annual precipitation varies within 380–440 mm. The value of the agroclimatic potential of Tomsk oblast ranges from 4.4 to 5.2.

For the northern districts of oblast (the first agroclimatic zone) ∑t° > 10 °C is 1440–1523 °C, and for the second agroclimatic subzone – 1540–1650 °C. In the first and second agroclimatic subzones the area of agricultural land is 152.6 and 327.8 thousand hectares, respectively. Agricultural lands in these subzones, as well as in the northern regions of Irkutsk oblast, are suitable only for the cultivation of forage crops (hayfields and pastures). Cropland in these agroclimatic regions is extremely scarce.
The main cropland fund in Tomsk oblast is located in the third agroclimatic subzone, where the sum of effective temperatures is 1670–1780 °C. The area of agricultural land is 876.9 thousand hectares, i.e. almost twice as much as in total in the first in the second agroclimatic subzones. This agroclimatic subzone contains the most fertile soils – chernozems, dark gray forest and sod-carbonate soils. A.G. Dyukarev [8] comes to a similar conclusion and asserts that agriculture is possible only in the very south of Tomsk oblast. The comparison of agroclimatic resources of Irkutsk and Tomsk oblasts indicates higher values of the agroclimatic potential for Tomsk oblast. Research methods are based on the calculation of the cadastral cost of various types of soils of agricultural lands according to their indicators of standard yield and standard cost, taking into account of the soils' properties and negative signs, affecting to soil fertility.

3. Results and discussion

The main soils were identified and their characteristics were calculated on the basis of the Scales for the agricultural land classification according to their suitability for agriculture for Irkutsk and Tomsk oblasts. The Scales include information on the humus content (%), thickness of the humus-accumulated horizon (cm), the physical clay content (%), negative properties of soils and the ruling gradient of the terrain (^{o}) and different types and subtypes of soils in Irkutsk and Tomsk oblasts. Codes of parent rocks and negative soil properties were also used in these Scales. It should be noted that the basis for the creation of these Scales was the information obtained during the fourth round of land appraisal in Russia (1980–1986).

In the first agroclimatic subzone of Irkutsk oblast grain crops are not cultivated due to the low values of agroclimatic indicators (∑t° > 10 °C does not exceed 1400 °C) and continuous permafrost spreading. Agricultural lands are used mainly for hayfields and pastures.

These territories (Katanga, Bodaibo, Mamsko-Chuiskii, and Kazachinsko-Lenskii municipal districts) are characterized by low cadastral values of various soils. The lowest indicators of 0.1–0.3 RUB/m^2 were observed for sod-podzolic and sod-alluvial layered soils (table 1).

The reason is the low humus content in these soils and the low thickness of the humus-accumulated horizon. In sod-carbonate soils the SICV range from 2.5 to 2.7 RUB/m^2. The highest indicators of the cadastral value were recorded for sod-alluvial saturated and for alluvial meadow saturated soils (3.3–3.0 RUB/m^2). We observed the same pattern in the Republic of Sakha (Yakutia) [5].

In the second agroclimatic subzone, the maximum values of the standard yield were recorded for chernozems podzolic and meadow-chernozems. It should be noted that the values of the standard yield for these soils are low and do not exceed 17 dt/ha (table 2). For the same soils the maximum indicators of specific cadastral values (2.8–3.4 RUB/m^2) were registered.

Table 1. Standard yield of agricultural crops and cadastral cost in Irkutsk oblast.

System of soil classification in the USSR, 1977 *[WRB]*	Standard yield, dt/ha	Cadastral value, RUB/m^2
Land evaluation district 1		
Sod-podzolic [Albic Folic Luvisols (Cutanic, Differentic)]		0.1
Sod-carbonate [Cambic Calcaric Umbrisols]		2.5
		2.7
Sod-alluvial saturated layered [Mollic Fluvisols (Orthofluvic Amphifluvic)]		0.3
Sod-alluvial saturated [Mollic Fluvisols]		3.3
Alluvial meadow [Mollic Endofluvic Endogleic Umbrisols]		2.1
Alluvial meadow saturated [Umbric Endofluvic Endogleic Umbrisols]		3.0
Land evaluation district 2		
Sod-carbonate leached [Cambic Calcaric Umbrisols (Luvic)]	13.7	2.2
Grey forest [Greyzemic Luvic Phaeozems / Cutanic, Differentic]	12.4	1.6
	12.8	1.9
Dark gray forest [Umbric Phaeozems]	14.9	2.6
Chernozems podzolic [Rentic/ Phaeozems]	15.7	2.8
	15.6	2.8
Meadow-Chernozems	15.8	3.1
[Chernic Phaeozems	16.4	3.3
(Endocalcic)]	16.1	3.4
Molic Stagnic Umbrisol Meadow [Meadow–Chernozem-like]	10.3	2.9
	8.7	2.1
Sod-alluvial saturated steppe-like [Molic Fluvisols (Epicalic]	1.3	2.0
Land evaluation district 3		
Chernozems leached [Umbric Calcic Luvic Phaeozems]	17.6	3.1
Ordinary chernozems [Mollic Calcic Chernozems]	16.6	2.9
	10.3	1.2

Notwithstanding the rather high values of the humus content and the thickness of the humus-accumulated horizon (table 1), the soils in Irkutsk oblast are characterized by low values of the standard yield and the SICV, which do not exceed 3.5 RUB/m^2. The reason is the low values of the agroclimatic potential, which range from 3.5 to 3.6. It should be noted that in the European part of Russia (Kursk oblast) the value of the agroclimatic potential is 7.7, and the values of the SICV of various subtypes of chernozems range from 8.3 to 14.2 RUB/m^2 [10]. The higher indicators of cadastral value were also noted in Tyumen oblast, in areas with a high value of the agroclimatic potential [11].

Table 2. Standard yield of agricultural crops and cadastral value in Tomsk oblast.

Soil (humus content; thickness of humus horizon; physical clay content)	Standard yield, dt/ha				Cadastral value, RUB/m^2
	Cereals	Potato	Perennial herbs	Annual herbs	
Podzol (1.3; 14; 34)	10.8	90.4	27.4	20.1	1.0
Podzol (sandy) (1.9; 21; 3)	6.5	60.0	12.2	12.1	0.1
Retisol (2.7; 22; 58)	14.7	120.0	36.5	29.6	5.7
Retisol (medium eroded) (2.3; 20; 54)	14.0		34.7	28.2	4.4
Retisol (sandy) (2.1; 22; 5)	6.7	61.6	12.7	12.6	0.2
Umbrisol (6.0; 47; 35)	21.3	179.2	49.1	42.1	8.9
Umbrisol (superficially slightly gleyic) (5.1; 33; 24)	19.1	163.5	44.0	36.4	7.4
Umbrisol (deep gleyic) (2.7; 28; 52)			31.3	15.9	3.3
Grey-luvic Phaeozem (5.0; 35; 46)	18.6	151.4	46.1	37.4	7.9
Grey-luvic Phaeozem (medium washed) (4.3; 25; 46)	16.8		41.7	33.0	6.2
Grey-luvic Phaeozem (strongly washed) (2.0; 23; 56)	14.1		35.1	28.5	4.62
Grey-luvic Phaeozem (6.0; 40; 33)	20.6	17.7	47.3	38.5	8.3
Grey-luvic Phaeozem (superficially gleyic) (6.0; 40; 35)	18.5	168.0	46.9	37.4	7.2
Grey-luvic Phaeozem (deep gleyic) (6.0; 40; 35)	17.6	165.5	47.7	36.8	7.1
Chernozem podzolic (6.0; 0; 33)	23.5	166.9	45.7	37.2	10.5
Chernozem podzolic (4.6; 34; 2)	22.9	163.0	44.6	36.3	9.9
Histosol			17.1		0.26
Histosol			24.9		0.37
Fluviso] (4.3; 33; 44)	20,3	170.2	46.6	37.9	7.7
Fluvisol (3.9; 34; 30)	17.9	150.2	41.1	33.5	6.8

In the third agroclimatic subzone given alkalinity conditions decrease the SICV of ordinary chernozems up to 60%.

The highest standard yield of grain crops in Tomsk oblast is characteristic of sod-carbonate, dark gray forest, chernozem and alluvial soils and ranges from 17.6 to 21.3 dt/ha (table 2). On gleyic varieties of these soils the grain crop yield depression can reach 20%. For medium and strongly washed sod-podzolic and light gray forest soils the grain yield depression reaches 12 and 24%, respectively.

In 2019 the actual grain yield in Tomsk oblast averaged 22.4 dt/ha and was one of the highest in Siberia. It should be noted that the actual grain yield is 15% higher than the standard yield in Irkutsk oblast, which testifies the high degree of agricultural production development in Tomsk oblast.

In the first agroclimatic subzone (the north of Tomsk oblast), podzolic and sod-podzolic soils prevail. As noted above, the area of agricultural land in this subzone is small, and it is used only for forage crops. The SICV of sandy podzolic and sod-podzolic soils do not exceed 0.16 RUB/m^2 (table 2). The maximum values for heavy loam sod-podzolic soils with a humus content of 2.7% are 5.7 RUB/m^2 [12]. For medium washed soils the decrease in the SICV varies in the range of 21–23%, and for strongly washed soils this value decreases to 40%. Histosols are characterized by low values of the SICV – from 0.26 to 0.37 RUB/m^2 [13, 14]. Almost the same cadastral values of peaty soils are shown for Tyumen oblast [5].

In the second agroclimatic subzone the area of agricultural land and cropland is increasing. For light gray forest soils with high humus content (5%) and a significant thickness of the humus-accumulated horizon (35 cm), the cadastral value reaches 7.87 RUB/m^2. The maximum values for dark gray forest and sod-carbonate soils are close and amount to 8.29–8.93 RUB/m^2.

With the development of the gleying process of these soils we observed a decrease in the cadastral value. For superficially slightly gleyic and gleyic soils the decrease is 13–17%, and for deep gleyic soils it can be more significant – up to 63%. The range of the cadastral value of fluvisols of the Ob river is characterized by an interval from 6.81 to 7.7 RUB/m^2.

In the third agroclimatic subzone of Tomsk oblast the largest agricultural areas with high values of agroecological potential and the maximum amount of highly fertile lands are observed. It is perfectly natural to assume that in the municipal districts of this agroclimatic subzone (Asino, Zyryanskoe, Kozhevnikovo, Krivosheino, Molchanovo, Pervomaiskoe, Tomsk and Shegarskii) the maximum cadastral values can be registered. For podzolic chernozems of Tomsk oblast, the SICV are characterized by maximum values in the range from 9.86 to 10.53 RUB/m^2.

Thus, a pattern of differentiation of the cadastral value of agricultural land in Irkutsk and Tomsk oblasts from north to south becomes clear. The northern territories of the regions show the minimum indicators of the cadastral value; the lands of these agroclimatic subzones are generally suitable only for forage crops. The second agroclimatic subzone is characterized by transitional values, and the maximum indicators of the cadastral value are observed in the third agroclimatic subzone. In addition, this subzone has the largest cropland area.

4. Conclusion

Thus, the cadastral value of agricultural land and the standard yield of various soils of Tomsk oblast significantly exceed the values in Irkutsk oblast, due to the higher value of the agroecological potential.

The sensitiveness of calculating the cadastral value of lands to various soil and geographical conditions is shown.

Under erosion and gleying processes the cadastral value can be reduced by up to 40% and 63%, respectively, and even 60% under conditions of soil alkalinity.

The materials obtained enable using the cadastral valuation data to optimize both land use and planning land management.

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