The transformation and dynamics of land resources in the Trans-Baikal Territory

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Abstract. We investigated the structure of land resources in the Trans-Baikal Territory and considered the dynamics of various land categories from 2000 to 2019. There are no significant shifts in the distribution of land between land users. Over the past decades, there has been an increase in the lands of specially protected natural areas and the forest lands at the expense of agricultural lands and land reserve. The total area of agricultural land is 7,985.8 thousand hectares or 18.5% of the region's area. The results of the analysis allow us to conclude that in the Trans-Baikal Territory, the possibilities for a significant increase in arable land are very limited. According to our estimates, approximately 65% of the area in the region is elevated areas, and 67.1% of the area is slope areas. Moreover, most areas in the municipal districts can be classified as zones with erosion-prone conditions for agriculture. The analysis of the land resources in the Trans-Baikal Territory using geoinformation technologies revealed the terrain features of the municipal districts in the context of the slopes. The existing economic and environmental risks of land involved in the industrial and agricultural production require a transition to adaptive landscape land-use systems.

1. Introduction
Land, as the most important natural resource for multi-purpose uses, is, in particular, the main economic resource, the territorial basis for the planning types of economic activity of an area where the primary environmental benefits are formed. The state of the land is decisive for the success of agricultural production, the location of settlements and transport routes. This is one of the significant factors affecting the quality of life, well-being and economic prosperity of rural areas. This is especially acute in the border regions of the East of Russia, where the agricultural land state problems (their degradation, etc.) turn into social desertification of rural areas [1].

Under the conditions of a mid-mountainous terrain, the land quality depends, among other things, on the steepness of slopes [2]. In Transbaikalia, the properties of soils on the slopes differ in many respects from those in the plains [3]. Erosion processes combined with long-term cyclical fluctuations in climate, triggering droughts [4], reduce the stability of agricultural production. The concept of agricultural development in the region should include a strategy for adapting land use to climatic cycles, its consistency with the features of the terrain, which ultimately will be of decisive importance in preserving the productive longevity of agricultural landscapes.

This study aims to identify the features of the regional structure of land use, assess the changes in the structure and nature in the use of the land fund (LF) of the Trans-Baikal Territory that occurred over the period from 2000 to 2018, identify areas most susceptible to erosion processes and further
anthropogenic transformation, and conduct a qualitative and quantitative analysis of their spatial distribution in the municipal districts of the region.

2. Models and methods
The object of the research is the surface of the Trans-Baikal Territory. The Rosreestr data, statistical data and other information sources were used to analyze the structure of land use. As a source of data on the surface topography, we used a digital elevation model of the study area represented by the freely available SRTM4 data with a resolution of 3 arcseconds ~ 90 m [5].

The terrain analysis of the Trans-Baikal Territory and analysis of the spatial distribution of the studied characteristics in the context of municipal districts was carried out in the ArcGIS Desktop using the functionality of the ArcGIS Spatial Analyst extension.

3. Results and discussion
The area of the land fund of the Trans-Baikal Territory (TLF) is 43,189.2 thousand hectares. This is 6.2% of the area of the Far Eastern Federal District (FEFD). In FEFD, the Trans-Baikal Territory ranks 6th in terms of the total area.

The nature of the LF use can be judged by the categories of land and its structure, which has formed by now under the influence of the historical, geopolitical, ecological and geographical conditions of nature management. In the TLF structure, there is a significant predominance of forest lands; agricultural land is the second in dominance (table 1).

Table 1. The structure of the land fund of the Trans-Baikal Territory by land category (thousand ha).

| Land category                               | 01 Jan 2000 | 01 Jan 2019 | Growth | Share in the total area of the region, % |
|---------------------------------------------|-------------|-------------|--------|----------------------------------------|
| Agricultural lands                          | 8,146.59    | 7,985.8     | -160.7 | 18.5                                   |
| Lands of settlements                        | 238.4       | 235.3       | -3.1   | 0.5                                    |
| Lands for transport, communications and other industries | 1,293.7 | 1,328.1 | +34.4 | 3.1                                    |
| Lands of specially protected areas and objects | 261.4 | 401.4 | +140  | 0.9                                    |
| Forest lands                                | 31,801.1    | 31,936.5    | +135.4 | 73.9                                   |
| Water resource lands                        | 120.3       | 121.8       | +1.5   | 0.3                                    |
| Land reserve                                | 1,327.6     | 1,180.3     | -147.3 | 2.8                                    |
| Total land in the Trans-Baikal Territory    | 43,189.2    | 43,189.2    | -      | 100                                    |

There are no significant shifts in the distribution of land between land users. Over the past decades, there has been an increase in the lands of specially protected natural areas (PNA) and the forest lands at the expense of agricultural lands and land reserve. In the structure of the land fund of FEFD, the lands of the Trans-Baikal Territory of different categories occupy different positions. For example, the lands of the Trans-Baikal Territory account for more than a third of the FEFD industrial lands, a significant proportion of the settlement and agricultural lands, an insignificant proportion of the forest and water resource lands and an extremely low proportion of lands in PNA (table 1).

Previous studies have shown that the existing structure of land use for most of the territory of Transbaikalia has a low level of ecological and economic tension. A higher level of tension is
characteristic of the central and southern districts of the region. These differences are zonal in nature due to the landscape structure, the level of industrial development and the size of the population. Therefore, the steppe and forest-steppe districts in the region are more populated and, thereby, their lands are more developed [6].

Agricultural land is a particularly valuable land resource for the regional agro-industrial complex development, ensuring the food security of the region. Its total area is 7,985.8 thousand hectares or 18.5% of the TLF total area. More than 10% of all agricultural land in FEFD is located in the Trans-Baikal Territory. The region is the leader among the subjects of the FEFD in terms of the hayfield areas, pastures and fallow lands, and ranks fourth in terms of arable land. Thus, in the FEFD, the region has a relatively advantageous position in the context of opportunities for the agricultural industry development, in particular, meat and meat and wool cattle breeding [7,8].

The agricultural land structure reflects the livestock specialization of agriculture in the region (figure 1). The dynamics of the areas shows that the share of arable land is constantly decreasing in the composition of agricultural land. Compared to the Soviet period, the area of arable land in the region has become 5.8 times lower (from 2,795.6 thousand hectares in 1980 to 484.1 thousand hectares in 2019). The main segment of arable land and pasture land is located in the southeastern and central parts of the region. These are the steppe and forest-steppe areas. The largest areas of arable land have been preserved in the Priargunsky, Krasnokamensky, Chita, Aginsky, and Mogoytuisky districts.

Figure 1. The dynamics of agricultural land distribution in the Trans-Baikal Territory.

The disposal of agricultural land from agricultural use occurs in all districts of the region. The arable land that has not been used for three or more years is converted to fallow. The main reason for the reduction of arable land in the area is the termination of the activities of enterprises and organizations, peasant (farmer) households and the transfer of vacated land mostly to the land redistribution fund. Another reason is the expiration of the right to lease land and its non-renewal by agricultural producers. Thus, most of the unused arable land was converted to fallow land. In some districts of the region, the areas of plowed land returned to the period of pre-virgin development (1950-60s). At the same time, the rate of reduction of arable land is very different; in some districts, it had decreased several times during 2000-2018 (figure 2).

The Trans-Baikal Territory is a complex geomorphological structure with a relief dominated by middle mountains; more than 100 ridges mostly of northeastern trending form highlands in combination with depressions and intermontane basins. The relief is the primary cause of the spatial
heterogeneity of the soil cover in the area; there is the dependence of the agrochemical properties of soils on the angle of inclination and orientation of the slope [3]. The mountainous and hollow terrain, light texture of soils, the periodic spring droughts combined with storm winds, heavy rainfall in the late summer period as well as the low projective vegetation cover of the Southern slopes are prerequisites for the development of erosion processes in a significant part of the steppe and forest-steppe areas, which are the main resources of agricultural land.

Figure 2. Changes in the areas of arable and fallow lands during 2000-2018.

Anthropogenic impacts, such as plowing, mining, etc., aggravate the negative impact of natural and climatic conditions on the state of agricultural land. According to the estimates of the Office of the Federal Register for the Trans-Baikal Territory, there are 1500 thousand hectares of eroded lands in the region, of which 439.3 thousand hectares are subject to erosion; 521.7 thousand hectares are predisposed to deflation, and 454.1 thousand hectares are under the simultaneous influence of two erosion processes. Eroded soils, due to the simultaneous deterioration of their agrochemical and agrophysical properties, meet the requirements for growing cultivated plants to a lesser extent. In general, more than 10% of agricultural land in the region is subject to water erosion. The processes of water erosion develop most intensively on arable land; thus, approximately 78% of arable land in the region is subject to water erosion. This is largely due to the predominance of slopes of various steepness in the topography of the area.

The analysis of the Trans-Baikal Territory terrain carried out in the ArcGIS Desktop using the functionality of the ArcGIS Spatial Analyst extension has allowed us to evaluate some of its characteristics that have a significant impact on the land state and its susceptibility to erosion processes. According to our estimates, approximately 65% of the area in the region is elevated areas (more than 800 m above sea level), and 67.1% of the area is slope areas (with a steepness of more than 4°) (figures 3-4). At the same time, slopes up to 4° are characteristic both of the bottoms of depressions and the valleys of watercourses as well as watershed tops.
The results of a spatial analysis revealed the heterogeneity in the distribution of slopes with different steepness in the context of the municipal districts in the region (table 2). Slope classification is made according to [9].

As a rule, Arable lands are located on flat areas of intermountain depressions and occupy the lower gentle slopes of mountains. In agriculture, flat and gently sloping non-stony plains of diluvial aprons and fans of small rivers and streams (up to 4°) are of special value. In areas with slopes of 0-2°, agricultural machinery can be used in compliance with the basic land-use rules to prevent the development of land degradation. Lands with slopes of 2-5° are considered suitable for the mechanized cultivation but in compliance with anti-erosion technologies. Lands with slopes of 6° or more are used mainly as pastures and hayfields, which also does not exclude the danger of the erosion development [10].
The largest areas of land with slopes up to 4° are in the Ononsky (86.4% of the district area), Zabaikalsky (82.5%), Borzinsky (66.2%), and Priargunsky (63.2%) districts of the territory (table 2).

Table 2. The distribution of the land fund in the Trans-Baikal Territory by the steepness of the slopes, % of the district's area.

| District                | Very gentle slopes | Gentle slopes | Moderately steep slopes | Steep slopes |
|------------------------|--------------------|---------------|-------------------------|--------------|
|                        | 0-2°               | 2-4°          | 4-6°                    | 6-8°         | 8-10° | 10-15° | 15-20° | 20-25° | 25-30° | 30-35° |
| Aginsky                | 36.4               | 23.5          | 16.0                    | 10.2         | 6.3    | 6.5     | 1.1    | 0.1    | 0.0    | 0.0    |
| Akshinsky              | 18.6               | 12.3          | 13.5                    | 12.9         | 11.1   | 19.0    | 8.4    | 2.9    | 0.9    | 0.2    |
| Alexandrov-Zavodsky    | 23.8               | 19.1          | 16.5                    | 13.9         | 10.8   | 13.0    | 2.6    | 0.4    | 0.0    | 0.0    |
| Baleisky               | 11.7               | 16.3          | 18.7                    | 16.3         | 13.2   | 18.1    | 4.8    | 0.8    | 0.1    | 0.0    |
| Borzinsky              | 46.0               | 20.2          | 13.3                    | 8.8          | 5.4    | 5.2     | 1.0    | 0.1    | 0.0    | 0.0    |
| Chernyshevsky          | 15.9               | 25.5          | 20.6                    | 13.6         | 9.3    | 11.4    | 2.9    | 0.6    | 0.1    | 0.0    |
| Chitinsky              | 21.5               | 21.3          | 18.5                    | 13.5         | 9.5    | 12.1    | 3.0    | 0.5    | 0.1    | 0.0    |
| Duldurginsky           | 14.1               | 17.6          | 19.8                    | 15.7         | 11.3   | 15.4    | 4.8    | 1.0    | 0.2    | 0.0    |
| Gazimuro-Zavodsky      | 10.2               | 14.1          | 17.5                    | 16.7         | 13.7   | 19.7    | 6.2    | 1.5    | 0.3    | 0.1    |
| Kalarsky               | 11.3               | 11.1          | 11.0                    | 9.8          | 8.4    | 16.1    | 11.0   | 7.6    | 5.9    | 4.5    |
| Kalgansky              | 17.7               | 19.8          | 17.7                    | 14.4         | 11.5   | 15.2    | 3.1    | 0.5    | 0.1    | 0.0    |
| Karymsky               | 10.4               | 17.4          | 20.8                    | 17.3         | 13.0   | 16.8    | 3.7    | 0.5    | 0.1    | 0.0    |
| Khiloksky              | 17.8               | 18.0          | 18.2                    | 15.1         | 11.3   | 14.9    | 3.9    | 0.6    | 0.1    | 0.0    |
| Krasnochikoiysky       | 6.6                | 7.0           | 9.4                     | 11.7         | 12.9   | 28.4    | 15.5   | 6.0    | 1.9    | 0.5    |
| Krasnokamensky         | 36.3               | 24.4          | 17.6                    | 10.7         | 5.8    | 4.7     | 0.5    | 0.0    | 0.0    | 0.0    |
| Kyrinsky               | 12.6               | 10.3          | 12.3                    | 12.2         | 10.9   | 21.0    | 12.1   | 5.7    | 2.2    | 0.6    |
| Mogochinsky            | 8.8                | 18.2          | 19.9                    | 16.7         | 12.6   | 17.1    | 5.1    | 1.3    | 0.3    | 0.1    |
| Mogoytuiysky           | 30.1               | 29.7          | 19.2                    | 10.5         | 5.6    | 4.4     | 0.6    | 0.1    | 0.0    | 0.0    |
| Nerchinsko-Zavodsky    | 12.3               | 16.8          | 18.7                    | 16.5         | 12.8   | 17.0    | 4.7    | 1.0    | 0.2    | 0.0    |
| Nerchinsky             | 13.8               | 23.1          | 20.7                    | 14.5         | 10.1   | 13.4    | 3.7    | 0.6    | 0.1    | 0.0    |
| Oloyvanninsky          | 26.9               | 20.5          | 17.6                    | 13.2         | 9.0    | 10.3    | 2.1    | 0.3    | 0.0    | 0.0    |
| Ononsky                | 71.8               | 14.6          | 5.8                     | 3.4          | 2.1    | 1.9     | 0.3    | 0.0    | 0.0    | 0.0    |
| Petrovsk-Zabaykalsky   | 10.3               | 13.1          | 15.4                    | 15.9         | 14.3   | 23.0    | 6.8    | 1.1    | 0.1    | 0.0    |
| Priargunsky            | 40.6               | 22.6          | 14.7                    | 9.4          | 6.1    | 5.7     | 0.9    | 0.1    | 0.0    | 0.0    |
| Shelopuginsky          | 11.9               | 21.6          | 21.7                    | 16.5         | 11.6   | 13.4    | 2.8    | 0.4    | 0.1    | 0.0    |
| Shilkinsky             | 12.8               | 20.5          | 22.3                    | 17.2         | 11.8   | 12.7    | 2.3    | 0.3    | 0.0    | 0.0    |
| Sretensky              | 6.4                | 15.2          | 19.2                    | 17.5         | 14.2   | 20.4    | 5.7    | 1.2    | 0.2    | 0.0    |
| Tungiro-Olekinsky      | 14.2               | 17.1          | 18.6                    | 15.9         | 12.2   | 16.1    | 4.6    | 1.0    | 0.2    | 0.0    |
| Tungokochensky         | 11.8               | 22.2          | 21.6                    | 15.5         | 10.4   | 13.0    | 3.8    | 1.1    | 0.4    | 0.1    |
| Uletovsky              | 15.5               | 13.6          | 15.1                    | 14.3         | 12.0   | 18.7    | 6.9    | 2.5    | 1.0    | 0.3    |
| Zabaikalsky            | 50.5               | 32.0          | 12.1                    | 3.7          | 1.1    | 0.5     | 0.0    | 0.0    | 0.0    | 0.0    |
| The Trans-Baikal       | 15.9               | 16.9          | 16.6                    | 13.7         | 10.6   | 15.6    | 6.0    | 2.3    | 1.2    | 0.7    |
| Territory as a whole   |                    |               |                         |              |        |         |        |        |        |        |

The areas of slope sites (with a slope of more than 4°) range from 13.6% (in Ononsky) to 86.4% (Krasnochikoiysky) of the district area. The leveled areas are confined to the basins and the southern districts of the region (figure 3). In the districts most suitable for agriculture, slopes from 4° and steeper occupy 39.3% of the Krasnokamensky district, 40.3% of the Mogoytuiysky, 40.1% of the
Aginsky, 52.6% of the Olovyaninsky, 56.4% of the Chita, 62.5% of the Kalgan, 63.1% of the Nerchinsky, and 71.0% of the Uletovsky districts.

At the same time, in the northern mountain and taiga districts of the region (Kalarsky, Tungokochensky, Tungiro-Olekminsky, and Mogochinsky), which are not suitable for agriculture, the areas with slopes of 0-2° are 30.2% of the total area with this steepness in the region, and with slopes of 2-4° – 40.5%. They are mainly occupied by swampy landscapes: dwarf birch thickets and marshes [11].

According to the generally accepted agroclimatic zoning, the Trans-Baikal Territory is divided into four natural agricultural zones, i.e. the forest-steppe, steppe and dry-steppe the northern mountain taiga zones [12]. The share of eroded agricultural lands is significant in the southern and southeastern districts with the highest production potential due to heat supply (Krasnokamensky, Aginsky, Ononsky, Priargunsky). Some significant shares of eroded lands are observed in Uletovskiy, Duldurginskiy and Akshinskiy districts (table 3).

Table 3. The distribution of accessible and used land in the steppe and forest-steppe districts of the Trans-Baikal Territory

| District             | The percentage of the most accessible lands (with slopes less than 6°) | The percentage of land occupied by agricultural landscapes, settlements and infrastructure | The percentage of eroded agricultural land |
|----------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------|
| Aginsky              | 75.9                                                                   | 66.5                                                                                       | 33.1                                       |
| Akshinsky            | 44.5                                                                   | 36.6                                                                                       | 23.6                                       |
| Alexandrovo-Zavodsky | 49.4                                                                   | 55.7                                                                                       | 13.9                                       |
| Baleisky             | 46.7                                                                   | 34.9                                                                                       | 37.5                                       |
| Borzinsky            | 79.2                                                                   | 75.4                                                                                       | 13.2                                       |
| Chernyshevsky        | 62.0                                                                   | 26.5                                                                                       | 8.7                                        |
| Chitinsky            | 60.5                                                                   | 19.9                                                                                       | 27.6                                       |
| Duldurginsky         | 51.5                                                                   | 33.6                                                                                       | 29.9                                       |
| Kalgansky            | 55.2                                                                   | 61.1                                                                                       | 10.7                                       |
| Krasnokamensky       | 78.6                                                                   | 90.4                                                                                       | 32.9                                       |
| Mogoytuiski          | 79.0                                                                   | 85.1                                                                                       | 29.9                                       |
| Nerchinsko-Zavodsky  | 48.8                                                                   | 34.9                                                                                       | 7.6                                        |
| Nerchinsky           | 57.6                                                                   | 43.3                                                                                       | 19.4                                       |
| Olovyaninski         | 65.0                                                                   | 72.7                                                                                       | 11.7                                       |
| Ononsky              | 91.0                                                                   | 76.2                                                                                       | 32.5                                       |
| Priargunsky          | 77.9                                                                   | 87.2                                                                                       | 28.3                                       |
| Shelopuginsky        | 55.2                                                                   | 27.2                                                                                       | 23.4                                       |
| Shilkinsky           | 55.6                                                                   | 54.4                                                                                       | 20.4                                       |
| Uletovsky            | 44.2                                                                   | 12.5                                                                                       | 26.1                                       |
| Zabaikalsky          | 94.6                                                                   | 98.8                                                                                       | 14.2                                       |

The leveled areas of intermontane basins and river valleys are a potential for the location of not only agricultural but also other types of industries, highways and settlements. The share of the most accessible lands (with slopes less than 6°) for the placement of such objects differs significantly across the districts of the region: from 94.6% in Zabaikalsky district to 23.6% in Krasnochikoisksy and 30.8% in Sretensky districts. Moreover, these areas that bear the greatest anthropogenic load are littered and
polluted. This is largely due to the fact that the most convenient territories for placement are already occupied by various types of land use and infrastructure facilities and have a long history of use. In some districts, “non-sloping” land plots are not sufficient for the spatial placement of new objects. The share of land occupied for agricultural landscapes, settlements and infrastructure exceeds or is equal to those available for development in Zabaikalsky, Krasnokamensky, Priargunsky, Oloyanninsky, Kalgan, Shilkinsky districts of the region (table 3).

The development of agriculture in the region within the framework of the state programs “Development of Rural Areas in 2020-2025”, “Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025” and “Far Eastern Hectare” implies that a significant part of fallow lands should be involved in circulation. However, uninvolved and abandoned lands are subject to dehumification and erosion processes. The Agrochemical Service of the Trans-Baikal Territory provides data that out of 859 thousand hectares of fallow lands surveyed in 2013, 3.4% of the fallow area has a high humus content, and 18% – an increased; the rest of fallow has an average (41%) and low (28%) humus content [10]. Thus, fallow lands lose their agronomic value without taking agrotechnical measures. Making a decision to expand the area of farmland, including plowing fallow lands, with a poor soil supply with organic matter [13] will lead to even greater loss of humus in soils in the southern dry steppe districts of the region as well as the progression of erosion processes.

The difficult economic situation of agricultural producers led to the minimization of the use of mineral and organic fertilizers, and the work on chemical reclamation was completely stopped, which also negatively affected the quality of agricultural land. Thus, in the region, there is a problem of inconsistency in the quality of the agricultural lands declared for the possible development and their real value and expediency for its involvement in circulation. In these economic conditions, agricultural producers should take advantage of the experience of involving unused arable land in the production of organic products [14, 15].

The lands of the forest fund occupy 73.9% of the total area in the region and are represented by the areas covered mainly with light coniferous larch and pine plantations as well as areas not covered with forest vegetation but intended for its restoration (felling, burning, etc.). This also includes non-forest lands intended for forestry (clearings, roads, etc.). In the structure of forest lands, the area of land occupied by tundra, stone runs, disturbed lands, etc. makes up a significant share (27%). The share of lands of the forest fund of the Trans-Baikal Territory in the corresponding land category in the FEFD is insignificant and amounts to 5.8%.

The settlement lands occupy 0.5% of the region's area. There are 10 cities in the Trans-Baikal Territory (Chita, Baley, Borzya, Krasnokamensk, Petrovsk-Zabaikalsky, Nерчинск, Mogocha, Sretensk, Shilka, and Khilok), 41 urban-type settlements and 748 rural settlements. The settlement land area is one-tenth of the land area of this category in FEFD.

The industrial lands are intended to support the activities of organizations and the operation of industrial facilities, energy, transport, communications, radio broadcasting, television, and defense facilities. On these lands in the region, there are enterprises of the mining and fuel and energy industries, railways and highways, objects and enterprises of the defense complex. In general, these lands occupy more than 3% of the Trans-Baikal Territory, which is 37% of the lands of the corresponding category in FEFD. According to this indicator, the region is the leader among the FEFD subjects. Furthermore, over the past decades, there has been an increase in this category of land in the region (table 1).

The share of protected areas in the Trans-Baikal Territory is less than 1%. On 01 January 2019, the natural reserve fund in the region includes 93 protected areas of different categories, of which 8 are of federal significance and 85 are of regional significance. It should be noted that most protected natural areas are located on the lands of the forest and water resources, and their lands are not included in the category of nature protection lands in the region. In FEFD, the region is among the outsiders in terms of the land area of specially protected natural areas, ranking only the ninth.
4. Conclusion
The analysis of the state and use of land resources revealed the territorial features in the structure of
land use, some trends and negative processes in the current practice of the regional land use.

With the transition of Trans-Baikal Territory to FEFD in November 2018, the position of the
Territory relative to neighboring regions in comparative assessments of its land resources has changed.
Among the FEFD subjects, the Trans-Baikal Territory has relative advantages in terms of the
agricultural industry development.

Due to the natural and climatic characteristics, the terrain of the Trans-Baikal Territory, being a
zone of risky farming, has significant resources of natural pastures that make up the fodder base for
meat and meat and wool cattle breeding [7]. There are natural restrictions for a significant increase in
arable land because, in most areas slope terrains predominate, and they are classified as areas with
erosion-prone conditions for agriculture.

The Trans-Baikal Territory has moved from the seventh to the first rank in terms of industrial land
area, which, on the one hand, ”strengthens” its position and indicates the importance of the region, but,
on the other hand, the tendency to increase industrial and infrastructure lands with an insignificant
share of PNA lands will contribute to land degradation. To level the processes of land degradation of
different categories, it is necessary to increase the share of protected lands and create a network of
“compensatory” PNA that will protect the most valuable areas before the active development of the
territory begins.

The existing economic and environmental risks of land involved in the industrial and agricultural
production require a transition to adaptive landscape land-use systems [16-19].

The analysis of land resources using geoinformation technologies allowed us to identify and
display the features and possibilities of spatial development in the municipal districts of the region.

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