

Research Article

**Analysis of the Spatial Characteristics of agricultural Land diversity
Based on the Tomsky District Materials**

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ABSTRACT.

The article presents the results of analysis of the spatial characteristics of 3,931 agricultural land plots of the Tomsky District of the Tomsk Region. It was established that the majority (about 43%) of land plots has an area of 15-20 hectares, fewer plots (30%) are 20-25 hectares in area and an even smaller number (14%) of land plots are 10-15 hectares. The prevalence of plots of complex shape (38%) and of irregular shapes with a homogeneous internal structure (31%) was revealed; the main causes of irregular shapes are the presence of borders with woodlands (outliers). The internal structure of land plots is also determined by their presence or absence within the borders of land plots. The minimum number of outliers is found in the east of the region with the smoothest terrain. The maximum number of outliers is concentrated in the south, where the slopes with the greatest elevation differences with an incline of up to 15° are located. Land use deficiencies (interspersions, broken and indented borders) complicate the production of agricultural products and necessitate the development of proposals and measures for their minimization in the process of organizing rational land use.

Keywords: Agricultural land diversity, Land plots, Interspersions, Outliers, Terrain, Land use deficiencies.

INTRODUCTION

Sustainable development of agricultural production is possible only with the rational use of land [1], particularly when using land plots of a rational size and shape, which creates conditions for the application of advanced technologies [2], expensive machinery, fertilizers, chemical plant protection products and for effective competitive production in general. In global practice, the irregular shape of a plot is regarded as a significant deficiency of territorial location, which impedes the effective use of labor, land, technical and other means of production, increasing transport and other costs [3]. It is necessary to eliminate land use

deficiencies and to make targeted changes in their area, structure, and boundaries in order to bring the configuration closer to the standard – an ideal square shape. Optimization of land use, elimination of the elevation pattern of the area, wedges, outliers, protection of soil from erosion and increasing fertility, and protection from weed vegetation [4] are among the main approaches to improve the organization of agricultural land use. The lack of comprehensive information on these land use and land property deficiencies and their reasons complicates land management, causes a decrease in yields, increases production costs and reduces the

effectiveness of land protection. This topic is particularly relevant in the zone of risky farming and in regions with a sharply continental climate [5], where agricultural land should be considered as a vital natural (land) resource.

MATERIALS AND METHODS

The studies were performed in the territory of the Tomsky District located in the subtaiga zone and in the part of the northern forest-steppe. The agricultural lands of the region are characterized by low heat supply, spring and early-autumn

frosts, leading to the shortening of the crop growing season, over-moistening, crust formation, low aeration and late tilth process, low humus content and weak humus horizon capacity, increased acidity of soil, agricultural land elevation pattern, biogenic pollution of farm ecosystems [5].

The study used materials from the Rosreestr website, public cadastral map, Google Earth. In order to analyze the structure of 100 land plots with an inhomogeneous structure, the terrain profiles were considered (Fig. 1).



Fig. 1 Location of objects for the analysis of terrain profiles.

Statistical data processing was carried out in the “Statistica” package and in the “Excel” program.

RESULTS

The total number of land plots in 25 farms of the district is 3,931 units. The maximum area of one farm was 9,885.5 hectares, the minimum area – 240.4 hectares. On average, one farm has 157.24 plots (maximum – 502 units, minimum – 19 units; per 1 hectare of land – 0.0530 units/ha (maximum – 0.198 units/ha, minimum – 0.01223 units/ha). The average land plot area in the Tomsky District is 20.4 ha, with a maximum of 81.4 ha and a minimum of 19 ha. Most agricultural land plots in the Tomsky District cover the area of 15-20 ha (about 43% – 1,420 plots), a smaller number of plots cover 20-25 hectares (30% – 980 plots) and even fewer plots cover 10-15 hectares (14% – 460 plots). The minimum area is occupied by land plots of the State Seed Testing Station (SSTC) – 13.2 hectares and the experimental state farm department of Tomsk Agricultural College – 5 ha (Fig. 2).

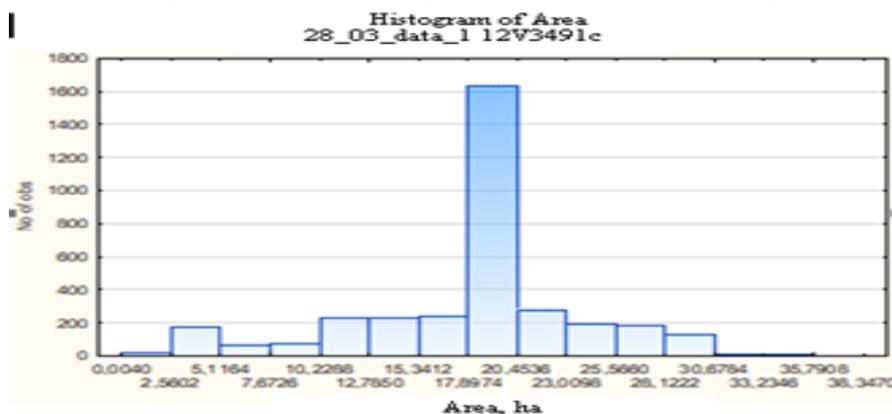


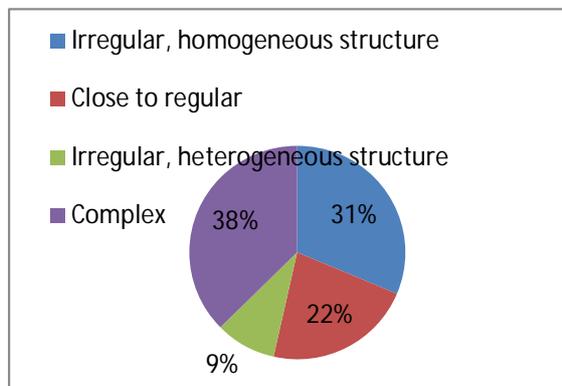
Fig. 2 Territorial characteristics of 25 farms of the Tomsky District. Area (ha) and the corresponding number of plots (units).

Tomsky District land plots analysis showed that their high diversity in form and internal structure can be divided into four groups (Table 1).

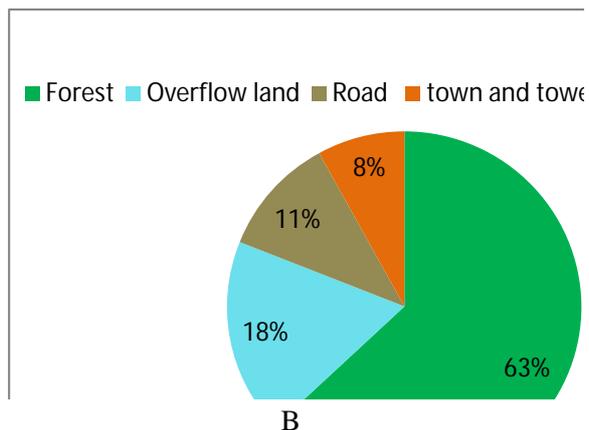
Table 1: Classification of land plots forms and internal structure diversity in the Tomsky District

Group	Form	Inner structure	Example
1	Close to regular	Homogeneous	
2	Irregular		
3		Complex	
4			

The ratio of land plots of various forms and structures, as well as the causes that determine them, is presented in Fig. 3. The predominance of plots of complex shape (38%) and irregular shapes with a homogeneous internal structure (31%) was revealed in the Tomsky District. Less common are areas with a shape that is close to regular (22%) and irregular in shape, with characteristic outliers, interspersions, broken edges, and irregular borders (9%). The main cause of irregular shape is bordering on forests (63%), water bodies (18%) and roads (11%).



A

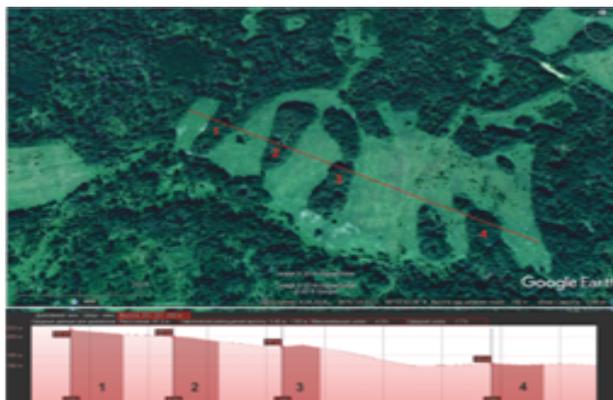


B

Fig. 3 Form and internal structure of land plots in the Tomsky District (A) and the causes that determine them (B). Analysis of changes in the structure of land plots indicated the presence of outliers within their borders. Plants overgrowth is characteristic for slopes with sharp drops in altitude of 1-2 m. Fig. 3 shows that elevation changes by 1 meter at the segment length of 32-105 m, at the segment length of 161 m – by 2 meters.



A



B

Fig. 3 A – Outliers in the field; B – space image of the field with outliers and corresponding height difference chart.

DISCUSSION AND CONCLUSIONS

The minimum number of outliers is observed in the east of the Tomsky District territory with the smoothest terrain, while the maximum number is indicated in the south of the region, where the slopes show the greatest differences in height with an incline of up to 15°, with massive

overgrowth of forest vegetation and the greatest boundaries curvedness seen in the north. The complex technological properties of land plots (terrain, broken boundaries, low forest cover) complicate the production of agricultural products and must be taken into account when placing crops. When organizing rational land

use, land management as a system of measures aimed at eliminating deficiencies in land use and also establishing its rational forms and providing land protection acts as a mechanism for shaping and establishing the boundaries of land plots [6]. In case of agricultural use, slopes with an incline of up to 5-7° are recommended for use as crop lands, those with 7-9° incline – for organizing haymaking and pastures, slopes with 9-15° incline – for limited grazing of cattle. Lands of slopes are recommended for forest cultivation. Regulation of water regime is necessary in flooded areas. Thus, as a result of the research, the main territorial characteristics of Tomsky District farms and land plots were established. The main spatial deficiencies are highlighted and measures for their minimization are proposed.

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