

# Agroecological Typesis of Land–Basis for the Rational Use of Agrolldships to the Non-Surface Zone

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## Abstract:

The great length of the Perm region (from north to south - 600 km from west to east - 400 km) contributes to the manifestation of latitudinal zonality, where the landscapes of the middle taiga landscapes give way to the southern taiga and broadleaf taiga forests. A variety of soil and land resources in the Perm region, due to significant differences in environmental conditions between the northern, central and southern provinces of the soil-ecological and within them, necessitates a differentiated approach to the integration and evaluation of modern environmentally and economically efficient condition. The purpose is to determine the resource potential of agricultural enterprises. The objects of research are the territory of the agricultural organizations «Severnyi» (the northern part of the Perm region), «Rusakovskiy» (Central), "Druzhnyi» (southern part). The potential of soil and land resources is the integrated value, which includes qualitative and quantitative assessment of the state as far as possible all agriland scape elements; the closest relative influence is reflected in the soil. Low soil and land resources potential has an establishment located in the northern part of the Perm Krai due to heterogeneity of parent material, soil cover and low points of site. Companies located in the central and southern parts, despite the high degree of erosion, have a high potential of soil and land resources due to the greater magnitude of site soils and less heterogeneity of soil cover. Land use, preservation of soil fertility, and increase in the soils productive capacity is not possible without an objective assessment of their resource potential.

## Keywords:

Agricultural Enterprises, Environmental Conditions, Potential assessment, Soil and Land Resources

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## 1. Introduction

According to the strategy of social and economic development of the agroindustrial complex of Russia for the period until 2020, one of the main priorities of the agrarian

policy of the state is the greening of agro-industrial production. To solve this problem, it is necessary to introduce rational territorial organization of the environment, in which natural, economic and socio-demographic processes should be harmonized [1-4]. The idea of land types as a territory with homogeneous natural conditions of agricultural production, developed by scientists of Moscow University in the 60th years of the 20th century. In time, this concept was called agro-ecological type of land [1].

Efficient use of land and land resources involves two essential steps that lead to objective economic entities typing soil-ecological diversity, accounting, or inventory, the entire distribution of the resource and its comprehensive evaluation of the position of use [5].

In modern conditions increases the need for land-based agro-typing of land, as substantiated economic, technological and economic efficiency of farming systems that are embedded in natural landscapes role [6-13].

An adaptive approach to improving farming systems allows the development of each company to develop its agricultural strategy based on an assessment by assessing the productive capacity of land and real conditions for economic activity, selecting the most profitable option of using arable land. Land management, conservation of soil fertility, increase the productive capacity of soils is not possible without an objective assessment of their resource potential [9-14]. Modern agricultural science improved the adaptive approaches well-known in the past, offering practical applications of adaptive-landscape systems of farming (ALSF). The natural features of a particular area should be considered with the help of agro-ecological of assessment, which includes the characteristics of migration and accumulation of substances, geomorphological, lithological, agrochemicals, soil conditions, soil structure, land records and qualitative characteristics of soils, including the appraisal.

Agroecological evaluation of agricultural land is a new and relevant area in agricultural science, agronomic practice, planning and management of agricultural production. This direction is an integral part of the concept of adaptive-landscape agriculture, which is the continuation and regular development of zonal farming systems. [3, 6, 8, 14].

Natural features of the territory and the resource potential of agricultural lands vary significantly depending on the landscape conditions. The most important factor of differentiation is the relief of the terrain: the differences in altitude, the nature of the surface, the steepness, shape and exposure of slopes, the presence of forms of microrelief, etc. These factors depend on important agronomical characteristics: the heat and moisture content of soils and agrocenoses, the level of soil fertility, which in turn determine the entire technological complex of cultivation of certain crops [8, 12].

World experience shows that most modern agroecological land assessment systems are aimed at quantitative analysis of the feasibility of their basic agroecological functions.

The great length of the Perm region (from north to south – 600 km from west to east – 400 km) contributes to the appearance of latitudinal zonality, which is most clearly represented in the plains, where the landscapes the middle taiga give way of landscapes the southern taiga and deciduous-taiga forests [15]. A variety of soil and land resources in the Perm region, due to significant differences in environmental conditions between the northern, central and southern soil and ecological provinces

and within them, necessitates a differentiated approach to the integration and evaluation of their modern environmentally safe and efficient state [7, 9, 10]. In the current economic conditions should be more carefully taken into soil and environmental conditions as they may determine specialization, yield and profitability of agricultural enterprises.

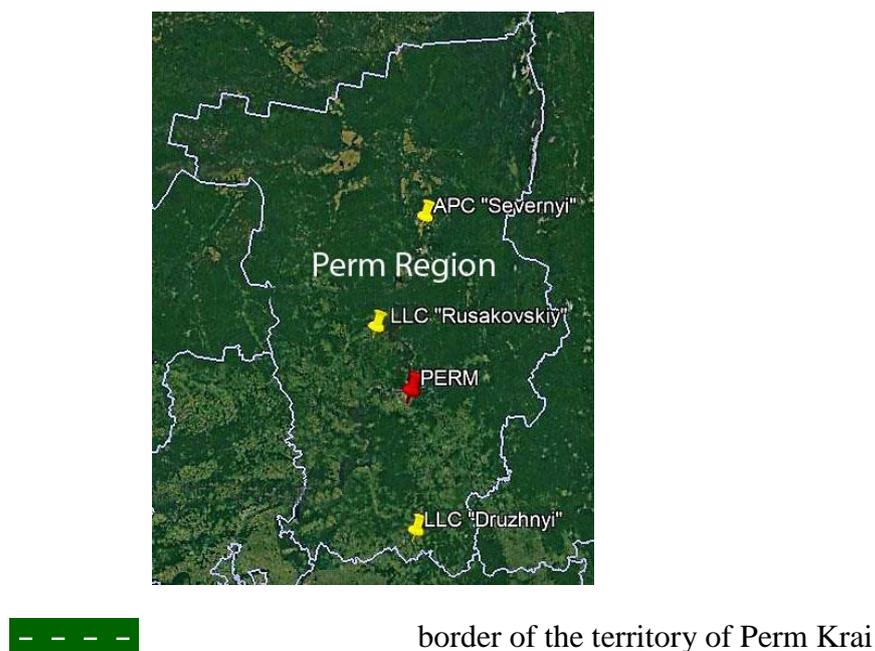
Purpose – to determine the resource potential of agricultural enterprises and to develop proposals for the rational use of land.

## 2. Materials and Methods

### 2.1. Object of Resource

The object of the study is agricultural organizations «Severnyi» of Solikamsk District, «Rusakovskiy» of Il'insk district, «Druzhnyi» of Chernushenska district of the Perm region. Agri-environmental assessment and typing of lands was carried out by the method of V.I. Kiryushin.

"Severny" is located in the southern part of Solikamsky district  $59^{\circ}38'10.90''$  N and  $56^{\circ}45'56.59''$  E. Altitude above sea level is 144 m [16, 17]. The total land use area is 13779.0 hectares, including 5361.0 hectares of agricultural land, of which 3991.0 hectares of arable land, 917.0 ha of hayfields, 353 pastures. The share of arable lands in agricultural land is 74.4%, hayfields - 17.1% and pastures - 6.6%. "Druzhny" is located in the central part of the Chernushinsky district of the Perm region  $56^{\circ}29'19.34''$  N and  $56^{\circ}13'07.28''$  E. Above sea level 195 m [16]. The area of the collective farm was 8867.9 hectares, arable land and deposits - 5639.0 hectares, hayfields - 717.0 hectares, pastures and pastures - 418 hectares, other lands - 2093.9 hectares [18]. State farm "Rusakovsky" is located in the central part of the Ilinsky district of the Perm region  $58^{\circ}33'50.33''$  N and  $55^{\circ}41'46.26''$  E. The area under study in the state farm "Rusakovsky" was 429 hectares, of which 181.7 hectares of arable land, and 230.5 hectares under the forest. The objects of the study are shown in Figure 1.



**Figure 1.** Location of the objects of the study [16].

The system of agro-ecological land evaluation includes the following items: landscape-ecological analysis of the territory, agro-ecological assessment of soil, agro-ecological classification and typing of land.

## 2.2. Natural Conditions

The territories are different under soil-geographical and agro-climatic conditions (Table 1) belong are different of agro-ecological sections: “Severnyi” – the Vyatka-Kamskiy of Middle taiga; “Rusakovskiy” – Vyatka-Kamskiy of Southern taiga, “Druzhnyi” – Ufimsko-Sylvenskiy subtaiga (coniferous broad-leaved forests).

*Table 1. Agroclimatic indicators.*

Indicators	Agricultural holdings		
	«Severnyi»	«Rusakovskiy»	«Druzhny»
Agroecological section	Vyatka-Kamskiy middle taiga	Vyatka-Kamskiy Southern taiga	Ufa-Sylvenskiy subtaiga
Coefficient of continentality	2.7		4.6
The duration of the frost-free period, days.	90-95	100-110	89-150
The duration of the period with an average daily temperature: above 5 °C, days.	150	156	157
The duration of the period with an average daily temperature: above 10 °C, days.	100	117	124
The duration of the period with an average daily temperature: above 15 °C, days.	40-45	64	74
Sum of temperatures above 10 °C	1000-1200	1600-1800	1800-2000 °
Annual rainfall, mm	502	539	561
Snowfall	in the end of April	in the end of April	on the average since April 25
Average height of the snow cover, cm	75	70-60	64
Depth of soil freezing, cm	100	110	71
Hydrothermal Coefficient	1.8	1.4	1.2

The task of agri-environmental assessment is as follows: 1) identification of homogeneous by natural conditions of territorial units; 2) determining their place in the structural-functional hierarchy of landscapes.

The relief on the territory of the studied farms is erosion-dangerous with a difference in altitudes from 20 m in the southern part of the Perm Territory to 81 and 95.5 in the northern and central part of the region, respectively (Table 2).

*Table 2. Geomorphological conditions.*

Indicators	«Severnyi»	«Rusakovskiy»	«Druzhny»
Maximum height, m	144.0	175.5	145.0
Minimum height, m	63.0	80.0	20.0
Vertical dismemberment, m	81.0	95.5	125.0
Horizontal dismemberment, km / km <sup>2</sup>	0.40	0.22	0.92
Exposure slope	Northern		North-eastern
Slope shape	Straight	Straight	Convex

On the territory of “Severnyi”, slopes are mostly of a direct form, and on the territory of “Druzhny” farm there are dominated slopes of convex and complex shapes that are found throughout the farm.

Soil-forming rocks are represented in the territory of "Severny" cover clays and loams, binomial sediments, water-glacial, alluvial deposits, eluvium of limestones and marls; on the territory of "Rusakovskiy" are represented by loesslike cover clays and loam, eluvium of bedrock, deluvial and alluvial deposits; on the territory of "Druzhny" cover clays and loams, eluvium of Permian clays, deluvial, alluvial deposits and eluvium of limestones and marls.

According to the of soils zoning Perm territory "Severnyi" included in the zone of sod-podzolic soils in the subzone of podzolic and bog soils in the area of sandy and loamy podzolic and sod-podzolic and peat soils on glaciofluvial and ancient alluvial deposits; territory of the state farm "Rusakovskiy" – In the zone and subzone of sod-podzolic soils in the area of sod-medium- and weakly podzolic and sod-calcareous soils on the eluvial-diluvial clays and eluvium marl and limestone of the Permian system; territory "Druzhnyi" included into the zone and subzone of sod-podzolic soils in the sub-area of sod-medium, light-gray forest-steppe podzolic and sod-brown of soils of heavy granulometric composition on eluvial-deluvial deposits bedrock [15].

The composition of the soil cover of farms varies and especially in the "Severnyi" (Tables 3, 4). The most serious grain size composition is soil in the "Rusakovskiy" farm.

**Table 3.** Soil cover of agricultural holdings (%).

Soils	«Severnyi»	«Rusakovskiy»	«Druzhny»
Thepodzolic	6.2	-	-
Gley-podzolic	5.7	-	-
Sod-shallow-podzolic	62.2	-	-
Sod-podzolicsoils	5.2	42.0	58.7
Sod-weaklypodzolic	-	10.0	17.2
Sod-carbonate	0.4	20.0	0.9
Sod-brown	-	-	1.5
Alluvial	14.3	12.0	6.4
BIC	6.0	3.0	13.6
Sod-gley	-	13.0	1.7

**Table 4.** The granulometric composition of soils in the Middle and Southern taiga.

Granulometriccompositionofsoils	«Severnyi»	«Rusakovskiy»	«Druzhny»
Sandy	12.2	-	-
Sandyloam	27.6	-	-
Lightloamy	9.5	-	-
Mediumloamy	29.8	12	50.9
Heavyloamy	4.7	88	42.1
Clayey	2.5	-	7.0

Erosion-dangerous relief creates conditions for the formation of eroded soils of different degree of erosion (Table 5).

**Table 5.** Eroded lands.

Degreeofflushing	«Severnyi»	«Rusakovskiy»	«Druzhny»
Theundiluted	90.7	19.1	61.7
Slightlywashed	2.2	23.8	13.5
Medium-fleecy	1.1	32.6	10.5
Stronglywashed	-	-	-
Wet	6.0	-	14.3

We were drawn by the primary cartographic basis for agro-ecological assessment of land which contains information on soil structure and soil, geomorphological,

lithological, hydrogeological, geochemical and micro-climatic conditions of the landscape and its elements. When preparing the soil-landscape maps were used: 1:10000 scale topographic map (1:25000), aerial photographs, soil materials Roszemproekt large-scale surveys, soil maps of the agricultural organizations (M 1:10000), land management plans, stock materials (soil reclamation, geologic, hydrological) data of the last round of agrochemical research, additional field studies materials, annual reports on the results of the agricultural organizations of economic activity. On the territory of households were selected key areas, for which were built the soil-geomorphological profiles.

Analysis of soil-geomorphological profiles showed that the nature of migration and accumulation of substances on the territory of farms identified three categories of elementary landscapes: eluvial, transit and accumulative. Types of soils and their properties change regularly depending on the location on the elements of the relief and the category of the landscape. This predetermines the direction of agricultural land use, taking into account limiting factors and the corresponding adaptive landscape systems of agriculture.

### 3. Results and Discussion

Potential of soil and land resources – the value of the integral, which includes qualitative and quantitative assessment of the state as far as possible all elements agro-landscape, the closest mutual influence which is reflected in the soil. Invariant of condition of the soil cover serves its structure, analysis of which is the basis for the type of inventory, evaluation and monitoring.

Landscape analysis showed that the territory of “Druchnyi” is more erosion-dangerous area than the territory “Severnyi” and “Rusakovskiy”. The territory of the farms have all categories of landscapes (eluvial, transeluvial, transit, transeluvial-accumulation, accumulation), which determines the direction of agricultural land use, taking into account the limiting factors: lithology, grain size (sandy and sandy loam for the “Severnyi” and the heavy, clay for “Druchnyi” and “Rusakovskiy”), low soil fertility, soil erosion, waterlogging the soil. Constraints are manifested in varying degrees depending on the soil-geographic and agro-climatic of conditions.

The soils of studied areas are medium of soil fertility and requiring the systematic application of organic and mineral fertilizers. There are analyses of soil cover.

Agro-ecological types of land (association areas of homogeneous under agro-ecological requirements of crops and growing conditions) possible to distinguish on the basis of the prevalence of various factors limiting the utilize of the agri land (Table 6).

**Table 6.** Agri-environmental groups and types of land in farms.

Agrienvironmental groups	Agrienvironmental types	Species	% of total area
<i>“Severnyi” of Solikamsk District</i>			
Zone	Sod-finely podzolic light loamy in a complex with soddy-brown heavy loam (no more than 10% of washed-away soils); patchiness of soddy-weakly podzolic sandy loam and sod-carbonate sandy loam	I	77.3
Erosion	Spot sandy sod-short podzolic and sod-not	II-2	3.4

	deep podzolic clay loam with varying degrees of erosion; complexes sod-not deep podzolic loam and sod-calcareous sandy loam		
Floodplain	Spotted alluvial turfy low-humus heavy loam and alluvial sod mid-humus heavy loams; tachs of alluvial meadow sandy loamy and alluvial sod mid-humus heavy loamy	III-1	14.3
Land-gulliesan dravines	Complexes soils of the gullies of the ravine-girder system: sod-medium podzolic and sod-washed	VI	6.0
<i>"Rusakovskiy "of Il"insk district</i>			
Zone	Sod-weakly and finely, and shallow podzolic heavy loam	II-1	43.1
Erosion	Sod-podzolic soils of low and medium erosion	I-2	20.3
Semihydromorphic-erosion	Sod-podzolic in combination with sod-gleyed podzolized low- and medium-humus weakly and moderately washed soils	IV	13.0
Semihydromorphic-flood	Alluvial sodic acidic, low- and multi-humus loamy	III-3	8.0
Gidromrgfno-flood	Alluvial marsh clay	III-3	4.0
Land-gulliesan dravines	Soddy washed and sod-podzolic	VI	11.6
<i>"Druzhnyi" of Chernushenska district</i>			
Zone	Sod-weakly podzolic heavy loams in a complex with sod-slightly podzolic medium loamy slightly washed away (no more than 10% of washed-away soils)	I	40.7
Erosion	Spotted sod-finely podzolic medium loamy and soddy-shallow podzolic medium loamy with different degrees of erosion	II-2	33.0
Semihydromorphic-erosion	Sod-shallow podzolic heavy loam in combination with sod-gley, (varying degrees of gleying and erosion)	III-1	10.1
Floodplain	Spots of alluvial turfy low-humus heavy loam and alluvial sod mid-humus heavy loamy	III-1	4.7
Land-gulliesan dravines	Complexes of the gullies of the ravine-girder system: sod-medium podzolic and sod-washed	VI	12.2

*Group I. Zoned land.* Agri-environmental types are characterized by non-contrast soil combinations. Earth of this type are suitable for the cultivation of more demanding crops using intensive and highly intensive agricultural technologies. This group of lands occupies the largest areas (40-77%). Zonal lands are suitable for cultivation of crops without special restrictions, and can be used in any type of crop rotation with the greatest possible saturation of tilled crops. The share of these crops together with pure steam can reach 50% of the crop rotation area.

*Group II. Erosive of the land.* The soil cover is represented by combinations of not erosive soil, low and medium erosive of the soil. As part of this group are found lithogenic soils differing grading (sands and loam sandy 3.4 % in the "Severnyi"), and clay loam, silty clay (33 % in "Druzhnyi", including 14 % medium erosive of the soil).

In the system of use of these lands is limited to the proportion of pure steam, the share of crops, it is desirable to expand cultivation of perennial grasses, the introduction of crop cultivation, soil conservation is necessary to introduce protective elements of the conservation tillage with conservation of crop residues under cereals and annual grasses, the use of slit, deepening the topsoil, agricultural activities under

regulation of surface runoff, essential holding of snow retention, planting across the slope.

Thus, the possibilities of using erosion lands are related to the limitations overcome by agrotechnical land reclamation and anti-erosion agrotechnical measures.

*Group III. Semihydromorphic-erosion of the earth.* They are confined to the apical watersheds of major gullies and ravines, the slopes of complex shape with alternating convex and concave elements and soil are very complex structures. Soil combinations have a typical tree-pattern figure and defined by a network of gullies with different depth of incision. Soils of areas had little contour and make up the soil structure, which is characterized by a large number of components, including the contrast. The predominant combinations are mosaics of sod-podzolic and sod-inwashed soils.

These lands are suitable for cultivating crops with restrictions that can be overcome by medium-cost hydrotechnical, chemical, forestry, complex land reclamation.

If the area occupied by the contrast type of land in *groups II* and *III* within the crop rotation field is sufficiently large, a production site is planned that is distinguished by certain technological features of cultivation of the crop.

*Group IV. Floodplain land* (semihydromorphic-flood, flood-gidromrgfno). Common in the floodplains and are geochemically superaqueous elementary landscapes, storage surface, subsurface, and groundwater runoff. There are present patchiness – alluvial-sod, alluvial-rich, alluvial humus and alluvial-marsh soils.

Moistened land that can be improved by draining with relatively simple drainage devices.

*Group V. Earth gullies and ravines of the complex (RGC).* Not suitable for cultivation because of the unavoidable limitations and possibilities of minor adaptations.

Within the groups are identified different agro-ecological land types specific to each farm, which determines the possibility of using the land for the specific soil and climatic conditions.

Consequently, in the farms need to redistribute land in view of the selected groups and agro-ecological land types in order to more efficiently use it and improve the growing conditions, as well as the adaptive capacity of agricultural crops, resulting in the stability of agricultural landscapes as a whole increases.

Agro-ecological assessment types of land are as follows: the original score of soil quality soil erosion and soil heterogeneity, the estimated specific score (on a scale of 1 to 5 on the severity factor) to calculate the overall average score for each type of land. The total ball of agro-ecological assessment agro-landscape obtained on the basis of interest like land in total area. Agri-environmental component of the capacity of the soil and land resources is calculated for each types of land.

Thus, the highest potential has a territory of “Druzhnyi” Chernushinska district where the average score 16. Lower potential (13.3 – average) soil and land resources is an enterprise located in the northern part of Perm kray position determine by the inhomogeneity of parent rocks, soil and low soil quality score. Businesses located in the central and southern parts of the region, despite the high degree of manifestation of erosion, have higher potential for soil and land resources due to the greater magnitude of soil and soil quality at the inhomogeneity of the soil cover.

## 4. Conclusions

Land management, conservation of soil fertility; increase the productive capacity of soils is not possible without an objective assessment of their resource potential. Assessing the potential of the soil and land resources of agricultural enterprises need for determine the possibility of organizing in their territory with a priority of environmental management for sustainable agricultural production.

To improve the efficiency of land use in farms based on agroecological land typification, we have proposed fertilizer systems for the introduction of normal agricultural technologies in “Severnyi” of Solikamsk District (instead of extensive) and intensive in “Rusakovskiy “of Il”insk district and “Druzhnyi” of Chernushenska district (instead of normal ones).

Thus, agro-ecological land typification is the basis for improving crop rotation and fertilizer systems for a particular area, using appropriate agro-technologies and crop rotations for selected types and groups of lands. The results of agro-ecological assessment and land typification can form the basis for designing an on-farm land management system taking into account landscape-ecological conditions.

## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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