Agrolandscapes of the East Sayan Mountain Province of Eastern Siberia and the Far East of Russian

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Abstract. According to the data of the agro-landscape and ecological zoning of Eastern Siberia and the Far East, conducted by the authors, the spatial distribution of biological and ecological patterns in the East Sayan Mountain province was established. The province is located in the Eastern Sayan mountain system within the Southern Taiga zone. Its area is 17022.5 thousand hectares. Mountains occupy 76% of the province's territory, plains – 24%. In the structure of land, forests occupy more than 68% of the area of the province. Other land (mainly rocks and glaciers) occupies 20%. Under water is 3.4% of the area, swamps occupy 2.8%. Shrubs occupy less than 1%, mountain deer pastures – 0.8% of the area of the province. Agricultural land occupies 4.5% of the total area of the province. Including arable land – 0.9%, pastures – 2.6%, hayfields – 1%. The structure of natural forage lands (NFL) is dominated by mountain pastures on mountain soils (76%). The plains and foothills of the province are dominated by dry southern taiga meadows (13%). Floodplain meadows (5%) and swampy meadows (5%) are also represented. The ecological state of the province's landscapes is good and satisfactory. In particular, NFL – good and satisfactory, forests – good and satisfactory, mountain deer pastures – good. The ecological state of arable land is tense. The established patterns are the necessary information basis for the development and implementation of innovative technologies for sustainable agricultural development, rational nature management and environmental protection in the East Sayan Mountain Province of Eastern Siberia and the Far East.

Keywords: agro-landscape-ecological zoning, patterns, structure, state.

1. Introduction
The most important basis for the rational use of natural resources in agriculture, the preservation of agricultural land and soil fertility, and the improvement and protection of the environment is the information support created on an interdisciplinary basis. It should include agro-landscape and ecological zoning, integrated soil and geobotanical survey, mapping, monitoring of the state, accounting and evaluation of natural and economic resources with the purpose of environment and sustainability [1-3].

Information support is especially relevant for the vast territory of Siberia and the Far East, which occupies more than half of the territory of Russia. In addition, with the increasing exploitation of its
richest raw materials, information support is necessary for reorientation to innovative development, issues of rational nature management, food and environmental security of this vast region [4-6].

Modern technologies, created on such a complex interdisciplinary information basis, are essential for the creation of highly productive and environmentally friendly agriculture, sustainable development of territories, rational use of natural resources and environmental protection.

2. Materials and Methods

In order to study the spatial distribution of biological and ecological patterns on the territory of the East Sayan Mountain Province of Eastern Siberia and the Far East, we conducted an agrolandscape-ecological zoning of the region using various information sources (ecological-geographical, geobotanical maps, state land registration data, natural-agricultural, agro-climatic, landscape-ecological, soil-ecological, biogeochemical zoning) [7-10].

The conceptual and methodological foundations of agricultural landscape and ecological zoning are the concepts of soil fertility conservation (Federal Williams Research Center of Forage Production & Agroecology), ecological and geographical analysis (Faculty of Geography of Lomonosov Moscow State University) and landscape-ecological balance (Institute of Geography of RAS).

The article is the result of many years of interdisciplinary research. It is based both on the data obtained by the authors as a result of agro-landscape-ecological zoning, in the course of field research, and on the analysis of remote data, statistical information, literary and stock sources.

3. Results and Discussion

The East Sayan Mountain Province is located in the East Sayan mountain system within the Southern Taiga Zone. The area of the province is 17022.5 thousand hectares. Here is a mountain-glacial relief. There are about 100 glaciers in the highlands. In the east of the province, there is permafrost and associated permafrost landforms. Mountains occupy 76% of the province's territory, plains – 24% (Figure 1).

![Figure 1. East Sayan Mountain Province](image)

The climate is sharply continental, with long harsh winters and cool summers. At altitudes of 900–1300 m, the average temperatures in January range from -17 to -25° C, in July from 12 to 14° C. Precipitation falls 400–700 mm per year.

According to the data of agricultural landscape and ecological zoning, it is established that forests occupy more than 68% of the province's area in the structure of land. Other land (mainly rocks and glaciers) occupies 20%. 3.4% of the area is under water, while swamps occupy 2.8%. Shrubs occupy less than 1%, mountain deer pastures – 0.8% of the area of the province.
Agricultural land occupies 4.5% of the total area of the province. Including arable land – 0.9%, pastures – 2.6%, hayfields – 1%.

Mountain pastures on mountain soils predominate in the structure of natural forage lands (NFL) (76%). The plains and foothills of the province are dominated by dry southern taiga meadows (13%). Floodplain meadows (5%) and swampy meadows (5%) are also represented.

The ecological state of the province's landscapes is good and satisfactory. In particular, NFL – good and satisfactory, forests – good and satisfactory, mountain deer pastures – good. Only the ecological state of the arable land is tense.

The East Sayan Mountain Province consists of 4 mountain districts (Prieniseysky, East Sayan, Khamar-Dabansky, Tunkinsky), the last of which is a mountain basin.

The Prienisei district of landscapes of folded-block and blocky mountains, elevated plains and plateaus, ridges and ancient alluvial landscapes is divided with the main area of the province by a flat territory. The terrain of the district is dominated by ridge-hill mountains, steeply sloping, less massive mountains. In the north of the district, the terrain is represented by plateaus with steep and large hills. The maximum altitude is 688 m.

The soil cover consists of sod-taiga soils, alfegumus podzols, and sod-podzolic soils. The river network is not very developed, mainly consisting of the upper reaches of tributaries of larger rivers. The main Kan River is a tributary of the Yenisei.

Forests cover almost 80% of the territory of the district, birch, birch-aspen forests predominate, less spruce-cedar-fir forests. In the structure of land, other land occupies about 2%, and 1.2% of the area is under water. Swamps occupy 0.5%, and shrubs – less than 1%.

Agricultural land occupies 16.4% of the area of the district. Of these, arable land occupies 10.3%, NFL – 5.9% (pastures – 3.6%, hayfields – 2.3%). They are mainly concentrated in the northern part of the district.

The structure of the NFL is dominated by dry meadows (more than 60%). Among them, the most common are high-grass and Langsdorff-leaved herb stands in sparse small-leaved forests. These lands are used for grazing, the quality of feed here is below average. Significantly smaller areas are occupied by meadows of good quality, often these are former seeded grass stands and their pasture modifications.

Mountain lands occupy half the area in the structure of NFL compared to dry land (29%). Here, large-grained grass stands with low yield and lower-than-average feed quality are common along the corridors and slopes. At altitudes exceeding 600 m, there are meadows with a hedgehog team, meadow fescue, short-legged feathery, giving good quality hay. But frequent grazing on the growing grass leads to the transformation of the grasslands of these meadows into pasture with a large participation of weed species.

Floodplain meadows in the structure of NFL occupy 6%. In the floodplains of small rivers, high-level meadows are used for grazing, and low-level meadows are mowed down. Lowland and wetlands occupy a small area (4%).

The ecological condition of the district's landscapes is satisfactory. In particular, the NFL is satisfactory, the forests are satisfactory, and the ecological condition of the arable land is tense in some places.

The East Sayan district of the landscapes of the folded-block and blocky mountains occupies the central and eastern parts of the Eastern Sayan – the high-mountain massifs of the Great Sayan, Tunka and Kitoi Chars, etc. The central height is 3284 m. The terrain is dominated by massive mountains, less alpine-type mountains with mountain-glacial terrain. Fragments of narrow ridge mountains are found, in the north-north-eastern part of the province there are foothills uvalisty.

The soil cover is represented by mountain primitive and high-mountain sod-char soils, tundra and taiga podburs, alfegumus podzols, and sod-podzolic soils.

The river network is quite extensive and belongs to the Yenisei basin. The largest rivers: Tagul, Biryusa, Uda, Oka, etc.
In the structure of land, forests occupy about 70% of the area of the district. Cedar, cedar-fir, cedar-spruce forests predominate. Smaller areas are occupied by secondary larch-pine, birch, aspen, and mixed forests. Above 1500-2000 m, rocky, moss-lichen tundras and areas of kobrezi meadows are common.

Other lands occupy more than 22%, swamps – 3.2%, under water is 1.3% of the area, shrubs – more than 1%, deer pastures – 1.1%.

Agricultural land is represented only by NFL (pastures and hayfields), which occupy 2.0% and 0.8%, respectively. In the foothills and low mountains there are 80% of NFL, in the mountains-100% of deer pastures.

The most common are bluegrass-grasses with different grasses and grasses with weed-grass pastures. Here there are also more productive with meadow fescue, hedgehog and other grass stands of good fodder value.

The district also has lowland dry land (10%), floodplain (5%) and swamp (5%) forage land. The most common are short-stemmed-veiny, bluegrass and wheatgrass-grass, meadow-grass and bluegrass-creeper, fox-tailed and large-grass-sedge grass stands.

Small areas of deer pastures (141.7 thousand hectares in the Nizhneudinsky district of the Irkutsk region) are located in the north-eastern part of the district, along mountains with upland terraces, where moss-and shrub - lichen-spotted tundras are developed on mountain-tundra gravelly and stony soils.

The ecological condition of the district's landscapes is good. Including, NFL – good, forests – good, only on the north-eastern edge of the district – tense.

Khamar-Daban district of the landscapes of the folded-block and blocky mountains is confined to the Khamar-Daban ridge, with a maximum altitude of 2371 m – Khan-Ula. The medium-mountain terrain with steep-sloping, narrow-ridge, sharp-ridge, massive mountains prevails.

The soil cover is dominated by mountain primitive and high-altitude sod-char soils, alfegumus podzols, taiga podburs.

The river network is represented by small mountain rivers. In the northern part of the district they flow into Lake Baikal, in the southern part they are tributaries of larger rivers.

More than 60% of the territory of the district is occupied by forests, mainly fir-cedar, cedar, cedar-larch, in the south – pine-larch. In the highlands, shrub-moss-lichen tundra, thickets of cedar elfin, and bare rocks are common.

Other lands occupy more than 17.6%, swamps-1.6%, 13.4% of the area is under water, shrubs-0.7%.

Agricultural land is represented by pastures (2.5%) and hayfields (1.1%). The structure of the NFL is dominated by mountain pastures (70%) and dry meadows (21%). Floodplain (6%) and swamp (3%) lands are less common.

For pastures the flat-slope meadows of the forest belt are mainly used. The hedgehog team, meadow fescue, short-legged grass, mixed grass meadows and their pasture modifications predominate. Haymaking is carried out mainly on flat areas. Mainly dry land with good quality grass, floodplain, also good and above average quality, in dry years – swamp, giving poor quality hay.

Along the coast of Lake Baikal, hollow - and steep-slope meadow-steppe pastures with tipchak-, bluegrass -, wheatgrass-grass stands of different degrees of downing are common.

Tunkinsky district of ancient alluvial, lake alluvial and lake landscapes is confined to the Tunka basin. It is a system of intermountain depressions with a length of about 200 km and a width of up to 50 km. Altitude from 500 m in the west to 1400 in the east. It is drained by the Irkut River and its tributaries.

The terrain of the Tunkinsky basin is dominated by plains: sloping, gently undulating (foothill plumes, cones of removal); flat, heavily swampy (low terraces); the Irkut valley with a wide floodplain. In the north, the basin is bordered by sharply crested, steeply sloping mountains, in the south by ridge-outlier and foothills.
The soil cover is diverse. Sod-taiga saturated, gray forest non-podzolic soils predominate. Floodplain soils are confined to the Irkut Valley. In some places, there are meadow-swamp, sod-carbonate soils.

The forest cover of the territory is 40 %. In the north – it is cedar-fir, in the south – pine low-mountain forests.

The flat territory of the basin is occupied by agricultural land, swamps, vineyards, park pine-larch, and floodplain forests.

In the structure of land about 9% is occupied by other land, swamps – 6.7%, under water – about 1%.

Agricultural land occupies 43.4% of the area of the district. Of these, arable land – 12.4%, NFL – 30.4%. The area of pastures (24.3%) is 4 times larger than the area of hayfields (6.1%).

In the structure of the NFL mountain and foothill pastures of the forest belt occupy 70%, dry meadows – 21%, floodplain meadows – 6%, swampy meadows – 3%.

The most common downed bluegrass-grass-mixed grass and grass-weed grass pastures of the forest belt. Less common are grass stands dominated by hedgehogs, meadow fescue, mixed grasses weakly downed. On the plains dry-grass short-stemmed-veiny, hedgehog, meadow fescue-bluegrass stands of hay, mixed and pasture use predominate.

High-level floodplains are mostly grazed. Wet, damp and wet floodplain meadows are mowed down, but even here there is a mixed use. Marsh grass stands, both floodplain and watershed, are used in dry years.

The ecological state of the district's landscapes is tense. In particular, arable land – tense, NFL – tense, forests – tense.

Poor use and lack of care has led to the fact that most of the areas of hayfields and pastures are in poor condition. Almost all forage lands need rational use, surface and radical improvement: drainage, clearing of shrubs, fertilization, and seeding of forage grasses.

The established patterns are the necessary information basis for the development and implementation of innovative technologies for sustainable agricultural development, rational nature management and environmental protection in the East Sayan Mountain Province of Eastern Siberia and the Far East.

4. Conclusions

According to the data of the agro-landscape and ecological zoning of Eastern Siberia and the Far East, conducted by us using different sources of information, the spatial distribution of biological and ecological patterns in the studied territory of the East Sayan Mountain Province was established.

The East Sayan Mountain Province is located in the East Sayan mountain system within the Southern Taiga Zone. The area of the province is 17022.5 thousand hectares. It is characterized by mountain-glacial terrain. Mountains occupy 76% of the province's territory, plains – 24%.

The climate is sharply continental, with long harsh winters and cool summers. At altitudes of 900–1300 m, the average temperatures in January range from -17 to -25° C, in July from 12 to 14° C. Precipitation falls 400–700 mm per year.

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The ecological state of the province's landscapes is good and satisfactory. In particular, NFL – good and satisfactory, forests – good and satisfactory, mountain deer pastures – good. Only the ecological state of the arable land is tense.

The characteristics of 4 mountain regions of the province (Prienisey, East Sayan, Khamar-Daban, Tunkinsky) are given.

The established patterns are the necessary information basis for the development and implementation of innovative technologies for sustainable agricultural development, rational nature management and environmental protection in the East Sayan Mountain Province of Eastern Siberia and the Far East.

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