Agro-ecological assessment of the soil cover of the forest zone in Omsk region

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Abstract. The study is based on the agro-ecological assessment of the main soils of the forest zone in Omsk region. Agro-ecological regions and categories of natural and economic assessment of soils are distinguished: from very low (less than 25) to low (up to 75) score. The agro-ecological assessment of the most common soils of the forest zone enabled ranking the soils in descending order by scores and by the natural resource potential: dark gray forest – soddy-podzolic – podzol – floodplain – meadow-boggy – boggy soils. The main arable soils of the forest zone are sod-podzolic and gray forest soils. The agro-ecological assessment score of sod-podzolic soils vary from 19 to 54 depending on the natural economic zone, and gray forest soil scores vary from 40 to 73.

1. Introduction
In the modern world, greening of production processes is an urgent task for all industries. At present, ‘green’ technologies, ‘green’ economy, eco-production are widely discussed. Modern agriculture employs new, environmentally friendly technologies, adaptive farming systems, biotechnology, etc. The basic element of agricultural production is the soil cover. Rational use of the soil cover, increased soil fertility and soil protection are the most important tasks. One of the mechanisms for achieving these tasks is the transition to modern, adaptive landscape farming systems [1–6].

The basis for the construction of adaptive landscape farming systems should be a comprehensive assessment of the soil cover of the territory with the allocation of agro-ecological groups of lands. At the same time, modification of the farming system should take place within each agricultural landscape with due regard to its features (heat and moisture supply, geomorphology, soil cover, degradation susceptibility, etc.) [7–9].

To accomplish all the tasks, it is necessary to conduct a comprehensive agro-ecological assessment of each elementary soil area, taking into account the natural and economic conditions for the growth of agricultural crops within the elementary areas of the agricultural landscape, and a comprehensive assessment of the soil cover in the study area [10].

2. Methods and Equipment
The study was carried out in 2015–2017 at the Department of Ecology, Nature Management and Biology, Omsk State Agrarian University, using the equipment of the Center for Collective Use ‘Agrarian and Technological Research’. The object of the study was the soil cover of the forest zone in Omsk region. Agro-ecological assessment of soils was carried out according to a comprehensive
methodology for calculating agro-ecological points developed by Ya.R. Reingard and O.V. Nezhevlyak [10].

A comprehensive agro-ecological assessment of the soil cover is based on a landscape analysis of the forest zone with regard to 40 natural and economic indicators. The assessment is presented as a total integral indicator of a certain elementary area of the agricultural landscape expressed in points, which depends on the natural and economic conditions of the zone and the soil economic fertility.

3. Results
The study aims to perform an agro-ecological assessment of the main arable soils of the forest zone in Omsk region.

Agro-ecological assessment of the most common soils of the forest zone in points enabled ranking the soils in descending order by scores, and, accordingly, by the natural resource potential: dark gray forest – soddy-podzolic – podzolic – floodplain – meadow-boggy – boggy soils (Table 1).

In the forest zone of Omsk region, four agro-ecological regions (I–IV) can be distinguished, according to the prevailing agro-ecological group of lands, which elementary areas are assessed within one group. Due to the local natural features of the landscapes of the forest zone (mesorelief, parent rocks, local basis of erosion, etc.), agro-ecological regions can be divided into subregions. At the same time, the category of natural and economic assessment of forest zone lands ranges from very low (less than 25) to reduced (up to 75) score:

- region I – Imgytsko-Vasyugan south-taiga watershed area of very low score (less than 25);
- region II – Right-bank south-taiga ridge-wavy region of low score (25–50);
- region III – Ishimo-Priirtyshsky watershed area of lowered score (25–75);
- region IV – Ayevo-Irtysh-Uysky district of lowered score (50–75).

Table 1. Agro-ecological assessment of the main soil types of the forest zone in Omsk region

| Soil type                                      | Bonitet score | Agro-ecological score of soils in various natural and economic* zones |
|-----------------------------------------------|---------------|---------------------------------------------------------------------|
|                                               |               | I* | II | III | IV  |
| Podzol                                        | 37            | 14 | 19 | 30  | 37  |
| Podzolic-gley                                 | 19            | 7  | 10 | 15  | 18  |
| Sod-podzolic                                  | 55            | 19 | 29 | 45  | 54  |
| Sod-strongly podzolic                         | 52            | 18 | 27 | 43  | 50  |
| Dark gray and gray forest podzolized          | 71            | -  | -  | 59  | 70  |
| Dark gray forest                              | 73            | -  | -  | 60  | 73  |
| Gray forest                                   | 51            | -  | -  | 42  | 50  |
| Light gray forest                             | 45            | -  | -  | 37  | 44  |
| Gray and light gray forest solodized gleyed   | 41            | -  | -  | 34  | 40  |
| Peat boggy and peat, low                      | 9             | 3  | 4  | 7   | 8   |
| Peat boggy and peat, high                     | 6             | 2  | 3  | 5   | 6   |
| Meadow-boggy                                 | 22            | -  | -  | 18  | 21  |
| Floodplain alluvial-boggy                     | 12            | -  | -  | 10  | 12  |
| Floodplain alluvial-podzolic                  | 23            | -  | -  | 19  | 22  |

3.1 Sod-podzolic soils
Sod-podzolic soils formed in the forest natural-climatic zone have an average bonitet score of 55. These soils are found in the four agro-ecological regions. The agro-ecological assessment score for these soils ranges from 19 to 54:
1 – Imgytsko-Vasyugan southern taiga watershed region of very low agro-ecological score. The region is heavily waterlogged due to poor drainage of the territory. The soil cover is represented mainly by boggy, podzolic and gley-podzolic soils. Less than 5 % of the territory of the region is developed for agricultural production by. More than 50 % of the territory is under forests, and this is the maximum indicator for the region. In the first region, low-score elementary areas of the agricultural landscape are formed, of which 1.1 % are areas of sod-podzolic soils. In agro-ecological region 1, soddy-podzolic soils are included in agro-ecological group 2 with a score of 19, soddy-podzolic soils – with a score 14, and soddy-podzolic – with a score 17.

2 – Right-bank south-taiga ridge-wavy region of low agro-ecological score. The region is significantly drained. The soil cover is mainly represented by podzolic, soddy-podzolic soils, and bogs. A total of 30–50 % of the territory of the agro-ecological region is developed for agricultural production, and the erosion rate is on average 11.6 % of the agricultural land area, weak water erosion is widespread. On average, 45–55 % of the territory of the region is covered by forests. In accordance with geomorphological zoning, the territory is located on the southwestern slope of the Vasyugan plateau. In agro-ecological region 2, soddy-podzolic soils are included in agro-ecological group 3 with a score of 29, soddy-podzolic soils – with a score of 24, soddy-podzolic – with a score of 27 (Fig. 1).

Due to the large areas of the first five groups of lands (93.4 % of the region’s territory) with a low agro-ecological score (up to 50) that are suitable for limited introduction into hay and pasture lands, agro-ecological region 2 is a low-score area.

3 – Ishimo-Priirtyshskiy watershed region of lowered agro-ecological score. The region is poorly drained, therefore it is swampy. A total of 30–40 % of the territory of the region is developed for agricultural production, the erosion rate is 7.1 % of agricultural land area, and weak water erosion is also widespread in the region. On average, 25–50 % of the region is under forests.

In agro-ecological region 3, soddy-podzolic soils are included in agro-ecological group 5 with a score of 45, soddy-strongly podzolic soils – with a score of 43, and soddy-podzolic soils are included in agro-ecological group 4 with a score of 38.

4 – Ayovo-Irtyshsko-Uysky region of lowered agro-ecological score. The region is heavily swampy, which is due to a weak drainage of the territory. In geomorphological terms, the region is flat-rare-ridge. In agro-ecological region 4, soddy-podzolic soils have a maximum agro-ecological score of 54 and are included in agro-ecological group 6 (soddy-podzolic soils with a score 50).
3.2 Gray forest soils

Gray forest soils formed along the southern border of the forest zone, on average, have a bonitet score equal to 59. Agro-ecological score of gray forest soils in the forest zone ranges from 34 (gray and light gray forest solodized gleyed) to 73 (dark gray forest). In general, agro-ecological score of gray forest soils in Omsk region varies from 34 to 102 in various agro-ecological regions of the forest and forest-steppe zone, covering regions 3 to 7.

In agro-ecological region 3 (Ishimo-Priirtyshsky watershed area of low agro-ecological score), gray forest soils are included in agro-ecological group with a score of 42, light gray forest soils – in group 4 (37 points), dark gray and gray forest podzolized – in agro-ecological group 6 with a score of 59 (Figure 2).

![Agro-ecological assessment of gray forest soils in the forest zone](image)

Figure 2. Agro-ecological assessment of gray forest soils in the forest zone

Ayovo-Irtysh-Uysky region of lowered agro-ecological score (region 4). The soil cover of the region is mainly represented by gray forest, gray gley forest, meadow, and bog soils. A total of 50–60 % of the territory of the region is developed for agricultural production. The region exhibits weak water and wind erosion, and the erosion rate is 6.1 %. On average, 20–40 % of the land is plowed, while 25–50 % of the territory is occupied by forests. In agro-ecological region 4, gray forest soils are included in agro-ecological group 5 with a score of 50 (gray forest gleyed with a score 40).

The assessment results show the need to introduce adaptive-landscape farming systems on arable land of the region, which will increase the potential of each area of the agricultural landscape, and enable the use of modern land reclamation measures and performance of anti-erosion work on individual projects.

4. Conclusion

The results of the study show that the forest zone in Omsk region can be divided 4 agro-ecological regions. The natural and economic assessment of soils in this zone ranges from very low (less than 25) to low (up to 75) score. At the same time, the main arable soils of the forest zone are sod-podzolic and gray forest soils. The agro-ecological score of sod-podzolic soils varies from 19 to 54 depending on the natural and economic zone, and the score of gray forest soils range from 34 to 73.
Each agro-ecological region exhibits its unique spectrum of abiotic and biotic factors that form the soil cover, and its natural resource potential. Therefore, the approach to the formation of modern farming systems in each region should be different and adapted to local conditions of each elementary area of the agricultural landscape.

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