Assessment of infrastructure of forest land

V Kovyazin*, A Romanchikov, A Kitcenko

Department of Engineering Geodesy, Saint-Petersburg Mining University, 2, 21 line of Vasilyevsky Island., St. Petersburg 199106, Russian Federation

*Corresponding email: vfkedr@mail.ru

Abstract. The article discusses the main directions of forest policy in the field of creating forest fund infrastructure, provides foreign experience in accounting for infrastructure and comparative indicators. An analysis of the transport infrastructure of the forest fund was carried out, as well as a methodology for assessing the infrastructure. Based on the data obtained, conclusions are drawn and ways to solve the existing problems in the forest sector are proposed.

1. Introduction

To date, the methodology for cadastral valuation of forest land is imperfect and has several disadvantages. The legal concept of the territory of the forest background does not coincide with the land allotment. Assessment of forest land is associated with the transfer of land to lease, to establish the exact rental rate, in some cases, to assess the pricing policy of the rental rights of the land of the forest fund, which directly include forests. The cost of forest land depends on many factors, one of which is the degree of development of forest infrastructure [1].

One of the significant drawbacks is that the state cadastral valuation of forest lands does not take into account the infrastructure of forest territories. Forest infrastructure involves the construction of forest roads, timber depots and similar facilities. In general, in the constituent entities of the Russian Federation, the degree of development of forest infrastructure, which includes: forest roads, fire reservoirs, bridges, hydraulic structures for draining the territory, etc., is very low today, despite the fact that it is necessary to ensure rational use, protection, protection, reproduction of lands of the forest fund.

Therefore, the issues of the correct accounting of forest infrastructure objects in the cadastral valuation of forest lands and, in general, the improvement of the cadastral valuation of forest lands are especially relevant. To take into account the infrastructure of the forest fund in the cadastral valuation of forest lands, it is necessary to first assess the infrastructure itself [2].

2. Methods and Materials

The formation and development of forest infrastructure is the basis of the socio-economic development of the regions. However, today the problems that exist in forestry are related to the forest fund infrastructure. Recent decades have seen a decline in production in the forestry industry. For example, in developed countries, much attention is paid to the development of infrastructure on forest lands (figure 1).

The high availability of forest roads in countries that are large loggers is due to the fact that the availability of forest resources helps to make thinning operations on time, which in turn increases the
productivity of forests. T S Lobovikov conducted studies on the restoration of forest areas after intensive logging and fires, which showed that in Europe the forest area increased by 54% (spruce forests replaced by small-leaved forests), and the rental Soviet model of the economic mechanism in forestry adopted in Russia did not even provide compensation cut down coniferous forests [3]. According to A P Petrov, the current situation arose due to the neglect of the experience of other foreign countries in forest management [4].

![Figure 1. Forest roads in some countries of the world.](image)

The main problems are insufficient financing (more than 60% of industrial funds are worn out) of the road transport network. A large area of forests of the Russian Federation is located in remote parts of the region, which increases the costs of production enterprises and the concentration of timber processing enterprises in specific areas. We can conclude that the insufficient development of the forest fund infrastructure affects the forestry economy.

One of the features of the forest sector of the economy is that it is dominated by large loggers (tenants), and small and medium-sized businesses are being forced out of this sector due to the fact that it is difficult for such enterprises to get additional investments for creating forest roads, forest conservation and protection. Including the creation of forest and timber processing infrastructure.

A poorly developed road network is the cause of incomplete forest development, depletion of forest resources in some regions and the inviolability of forest resources in other parts of the country. In many ways, the reason for the low developed road network is the natural features and landscape of the country’s regions. However, in order to increase the accessibility of forests, the Strategy for the Development of the Forest Complex of the Russian Federation for the period until 2020 was adopted, which was aimed at ensuring the achievement of indicators to increase the density of the forest road network and the quality of their creation. On average, the need for the creation of new forest roads in the regions varies from 2.2 thousand km to 9.3 thousand km. When evaluating the transport network, it is necessary to consider not only the length and density of the network of motor roads, but also their quality. Due to the climatic characteristics of many regions, forest roads in some constituent entities of the Russian Federation become unusable after a season [5].

The profitability of the construction of the forest road is estimated by the optimal density of the road network, which is achieved by minimizing the cost of construction and operation of the road, as well as reducing the distance of transportation. Data on the required annual growth of forest roads are presented in figure 2.
Figure 2. Forecasted need for an increase in the length of forest roads.

However, for an objective assessment of the need to create forest roads, it is necessary to study and analyze in detail other economic indicators, such as volume of cuttings, reforestation, in order to fulfill which the road network is mainly being created [5].

In addition, an important component is the economic income received from the forest sector. This aspect is significant as it provides priority funding for the development of forestry. The costs of financing the forest sector significantly exceed revenues from the use of forest land, forming a huge hole in the country's budget. Based on the analysis, it can be concluded that the current forest management system is inefficient and represents a loss-making industry for the Russian economic sector at the present stage [6]. To change the situation, a reorganization in the system of approaches to the assessment of forest resources, the distribution of responsibilities of tenants of forest plots and the state, as well as in the development of methods of control and responsibility for the distribution of material resources and the quality of the created infrastructure of the forest fund is required. Particularly affected by the lack of transportation routes and poor quality roads are the multi-forest areas where the main target raw materials are concentrated today.

A separate issue is given to the classification of infrastructure according to various criteria. The most common is the classification of infrastructure based on action. According to this classification, the infrastructure can be: industrial, social, transport, engineering, information, military, market, innovative, tourism, etc. [7]. Forest infrastructure is most often understood as forest roads, timber depots, and other structures and structures necessary for the effective functioning of forestry as a branch of production. According to Article 14 of the Forest Code of the Russian Federation [8], the forest processing infrastructure includes facilities for processing harvested wood and other extracted forest resources, bioenergy facilities. In addition to forest infrastructure and forest processing facilities, it is allowed to create objects in the forest fund that are not related to the creation of forest infrastructure.

To improve the methodology for cadastral valuation of forest lands, in this article, the authors propose to take into account the infrastructure of the forest fund, and also provides a methodology for assessing infrastructure [9].

The cadastral valuation model includes many infrastructure factors (the presence of forest infrastructure and land infrastructure to increase forest productivity, recreational use and the mineral resource complex and the purpose of forest use), which affect the cadastral value of forest land. After selecting the factors affecting the infrastructure of the lands of the forest fund, it is necessary to take these factors into account in the methodology for assessing forest lands, taking into account the degree of development of their infrastructure. The next stage of the assessment involves the establishment of a coefficient of infrastructure development. To establish the coefficient of infrastructure development, it is indispensable to link the previously defined indicators.
O V Kharionovskaya to assess the level of infrastructure development by regions, in the course of the study, she suggested using the following indicators: length of roads per 1 thousand hectares, forest fund area per forestry worker; number of non-governmental forestry enterprises. In the work of O V Kharionovskaya also proposed a ranking system for assessing infrastructure indicators. In our work, as a result of the correlation and regression analysis, the following indicators affect the cadastral value of forest lands to the greatest extent: the length of roads per 1 thousand hectares, the number of timber enterprises, and the annual costs of creating the forest fund infrastructure [9].

To calculate the coefficient of infrastructure development, the following methodology is proposed. Firstly, the territorial unit of the cadastral assessment should not be the subject of the Russian Federation or the forest tax region, but at least the region of the RF subject, the forest tax region, in the best case, if the initial data are sufficient, the territory of the forestry.

For each indicator, a rank is determined \( r_r, r_c, r_{fe} \) respectively, calculated as a fraction of its maximum value, which characterizes the position of the region in the distribution of the indicator’s values in the general series (formula 1). In this case, the application of the normalized coefficient in the best way reflects the relationship between the values:

\[
 r_i = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} \tag{1}
\]

where, \( r_i \) – rank of infrastructure indicator \( r_r, r_c, r_{fe} \); \( x_i \) – the value of the infrastructure indicator for the district; \( x_{\max} \) – the maximum value of the indicator in a row.

Based on the values of the ranks for each of the three indicators for each region of the region, the coefficient of infrastructure development is determined using the arithmetic mean (2):

\[
 k_i = \frac{r_r + r_c + r_{fe}}{i} \tag{2}
\]

where, \( k_i \) – the coefficient of development of the district infrastructure; \( r_r \) – rank along the length of the roads; \( r_c \) – rank of the costs of creating the forest fund infrastructure; \( r_{fe} \) – rank by the number of timber enterprises in the region; \( i \) - the number of investigated parameters.

Further, the classification of district forestries by the level of infrastructure development is carried out. Forestry groups with high, medium and low levels of forest fund infrastructure are identified. The division into intervals is carried out according to (3):

\[
 i = \frac{x_{\max} - x_{\min}}{n} \tag{3}
\]

where, \( x_{\max} \) – the largest value of the grouping characteristic in the aggregate; \( x_{\min} \) – the smallest value, \( n \) - the number of groups.

Next, the classification of district forestries by the level of infrastructure development will be carried out. Forestry groups with high, medium and low level of forest fund infrastructure have been identified. The division of the obtained values into intervals is carried out according to (3).

Based on the values of the ranks according to the indicators of the forest area, the coefficient of infrastructure development is determined as the arithmetic mean value [9].

3. Results and Discussion

The Leningrad Region was chosen as the subject for assessing the infrastructure of the forest fund. The industry of the region is represented by a wide range of mining, processing and manufacturing enterprises [10].

The products of chemical processing of wood and oil are a constant component of Russian exports, as well as scarce timber: softwood sawlogs, raw materials for the pulp and paper industry and other
products. In the Leningrad Region, there are wooden house-building enterprises, pulp and paper mills, woodworking and sawmills, furniture and plywood-slab factories, and biofuel production facilities. One of the most important conditions for the intensification of forestry and forest management is infrastructure. Forest roads provide access to forest resources and allow year-round supply of wood to enterprises.

The economic effect of the increase in transport routes is achieved at different stages of forestry activities. Leningrad Region is the largest transport and logistics hub of the North-West Federal District. The share of the transport and communications industry in the structure of the gross regional product is 15.9% [10].

The infrastructure on the lands of the forest fund affects the rate of technological growth. Transport infrastructure is of great importance for the forest fund. It includes automobile and railway roads, parking of vehicles, tunnels, bridges, trestles, crane and access roads (railway or automobile) [11]. The length of forest roads in the forestries of the region are shown in table 1.

Table 1. The length of forest roads in forestries of the Leningrad region.

| Name of the local forestry   | The length of forest roads, km / thousand ha | District Name      |
|-----------------------------|----------------------------------------------|-------------------|
| Vsevolozhskoye              | 22.1                                         | Vsevolozhskiy     |
| Severo-Zapadnoye            | 15.1                                         | Vyborgskiy        |
| Gatchinskoye                | 6.5                                          | Gatchinskiy       |
| Lodeynopol'skoye            | 6.3                                          | Lodeynopol'skiy  |
| Podporozhskoye              | 6.2                                          | Podporozhskiy    |
| Slantsevskoye               | 6.1                                          | Slantsevskiy      |
| Kirovskoye                  | 6.0                                          | Kirovskiy         |
| Volosovskoye                | 5.9                                          | Volosovskiy       |
| Kirishskoye                 | 5.8                                          | Kirishskiy        |
| Luzhskoye                   | 5.6                                          | Luzhskiy          |
| Lomonosovskoye              | 5.5                                          | Lomonosovskiy    |
| Bokstogorskoye              | 5.5                                          | Bokstigorskiy    |
| Kingiseppskoye              | 5.4                                          | Kingiseppski      |

The territory of the Leningrad Region, in accordance with the transport accessibility of forest resources, can be divided into 4 regions: north-western (Karelian Isthmus), central, western and eastern. Differences in growing conditions between the Karelian Isthmus and the rest of the Leningrad Region led to noticeable differences in the species composition of these regions: 81% of the forested lands of the Karelian Isthmus are occupied by conifers. But the stock of ripe and overripe stands of this category is only 29%.

The formation of the forest fund structure of the Karelian Isthmus is undoubtedly influenced by the relatively lower productivity of forests and intensive harvesting, due to the developed road network and the proximity of Finland [11].

The Karelian Isthmus is the only region in the Leningrad Region that has a forest fund with a road network 10.4 km / thousand ha, which is approaching the optimal (10-12 km / thousand ha). This indicator varies widely in the Leningrad Region (table 2).

Table 2. Provision with a road network of the Leningrad regions.

| Region of the Leningrad region | Administrative region of the Leningrad region                                      | The coefficient of coverage of the road network, km / thousand ha |
|--------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------|
| Northwest (Karelian Isthmus)   | Priozersky                                                                         | 10.4                                                             |
| Central                        | Vsevolozhskiy, Kirovskiy, Tosnenskiy                                              | 9                                                                |
| West                           | Slantsevskiy, Kingiseppeskiy, Luzhskiy, Volosovskiy                                 | 7                                                                |
| Oriental                       | Kirishskiy, Lodeynopol'skiy, Tikhvinskiy, Volkhovskiy, Bokstogorskoy, Podporozhskiy | 2-3                                                              |
The average value of the coefficient of provision with forest roads for the forest fund of the region is 5.9 km / thousand ha, which is slightly more than 50% of the standard indicator, which is 11.2 km / thousand ha. In the eastern regions of the region, the most common roads are the so-called “winter roads”, which cannot be used for thinning, main use, forest conservation and protection during the most intense summer period [12]. For the forest fund, the optimal length of the road network for the region is 9-11 km / thousand ha, which, with a uniform distribution of roads over the area, provides quarterly transport accessibility of forests. Such a density of the transport network is less than half of the forestries of the Leningrad Region. Currently, the transportation distance to loading points is from 25.0 km to 100.0 km or more. Therefore, the length of forest roads should be increased 2-2.5 times.

Figure 3 shows the volumes of wood harvesting by region and the number of timber enterprises in them.

Figure 3. Distribution of non-governmental forestry organizations in the Leningrad Region by the number and volume of logging.

To date, more than 500 timber enterprises have been registered in the Leningrad Oblast, and forests with an area of about 5 million hectares, with an annual volume of harvesting ripe wood of 7524.3 thousand m³, are leased for timber harvesting [12].

Table 3 presents the ranks for three infrastructure indicators for each district of Leningrad region. Due to the difficulty of collecting primary data, it was decided to do the gradation not in the regions of the Leningrad region, but in the administrative regions.

Table 3. Rank values for the main indicators of district infrastructure development.

| The name of the district | Rank | Length of roads, \( r_l \) | Cost of creating forest infrastructure, \( r_c \) | Number of timber enterprises, \( r_{te} \) | Coefficient of infrastructure development |
|-------------------------|------|--------------------------|---------------------------------|---------------------------------|---------------------------------|
| Vsevolozhskiy           | 1.0  | 0.1                      | 1                               | 0.93                            |
| Vyborgskiy              | 0.7  | 0.1                      | 0.5                             | 0.60                            |
| Priozerskiy             | 0.4  | 0.1                      | 0.4                             | 0.32                            |
| Tosnenskiy              | 0.4  | 0.1                      | 0.4                             | 0.46                            |
4. Conclusion
A study of the infrastructure of the forest fund of the Leningrad Region made it possible to determine the main directions of development of forestry. Not in all areas of the Leningrad region, the length of the roads reaches the average value for the region.

Therefore, there is a need to improve the transport infrastructure of the forest fund and finance work for the construction, repair and maintenance of forest roads. Based on the proposed methodology for accounting for infrastructure when assessing forest lands, a comparative and integrated assessment of the development of forestry infrastructure by regions of the subject of the Russian Federation and by forestries will be given. According to the assessment results, groups of districts with different levels of infrastructure development are distinguished. Also, based on the data used for cadastral valuation, it is possible to determine the main problems and possible directions for the development of forestry infrastructure within a specific territory [12].

The data obtained during the cadastral valuation of forest lands according to the methodology proposed in this paper can be used in GIS technologies to visually display the current situation in the forest fund. The need to improve the infrastructure of the forest fund in the constituent entities of the Russian Federation on the basis of the analysis is obvious, first of all, it is necessary to improve the transport system, not only in terms of length, but also in terms of quality. The formation of the forest fund infrastructure and forest processing infrastructure will allow for the stabilization and growth of the share of the forest sector in the Russian economy along with the large and major, today, oil refining and mining sectors.

References
[1] National Duma Committee for Natural Resources, Property and Land Use 2017 Round-table conference materials: “Exercise of Authority in the Field of Forestry by Government Bodies of Russian Regions: Issues, Aims, and Prospects” (Irkutsk: National Duma Committee for Natural Resources, Property and Land Use)
[2] Kovyazin V and Romanchikov A 2018 The problem of cadastral valuation of forest land, taking into account forest fund infrastructure Journal of Mining Institute 229 98-104
[3] Lobovikov T 1968 Forest as an economic phenomenon Journal of Issues of forestry economics of the USSR 126-140
[4] Petrov A P 1993 Economic assessment of forest resources in terms of their lease (licensing) Journal of Forestry 4 12-15
[5] Kovyazin V and Romanenko M 2019 Problem of temporary logging roads’ inventory as real estate items IOP Conference Series: Earth and Environmental Science 316 1-7
[6] Government of Russian Federation 2017 On Approval of Hunting Infrastructure Objects List (Decree N 1469 11 July 2017) [Moscow: Government of Russian Federation]
[7] Federation Council 2018 Condition and Prospects of Forestry Transport and Industrial Infrastructure (Moscow: Federation Council)
[8] National Duma of Russian Federation 2006 *Forestry Code of Russian Federation* (Moscow: National Duma of Russian Federation)

[9] Kharionovskaya I 2016 Features of the development of forestry infrastructure in the Komi Republic *News of Komi Scientific Center, Ural Branch of the Russian Academy of Sciences* 1 104-111

[10] Government of Russian Federation 2018 *On Approval of 2030 Forestry Development Strategy (Decree N 1989 20 September 2018 (ed 28 February 2019))* [Moscow: Government of Russian Federation]

[11] Lantsov A 2013 Infrastructure: concept, types and significance *Statistics and Economics* 3 49-54

[12] Demidova P and Gorelikov V 2013 Impact of Common Real Property Land Site Value Unit to Market Value of Non-commercial Horticulture Land in Leningrad Region *Journal of Mining Institute* 204 198-202