Problem of temporary logging roads' inventory as real estate items

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Abstract. The article focuses on the question of temporary logging roads' studying as real estate items. The relevance of research is proved by need of effective use of land and forest resources while road infrastructure seating. Strategic aim of research is advanced technology development of compartment description of temporary logging roads. The main research objectives are: economic importance definition of temporary logging roads, uncovering geographical and climatic conditions providing possibility of road’s functioning, reviewing methodological approach of their accounting and systematization. Today there is no system concept of problem solving as relating to transport infrastructure on forest lands. Land law doesn’t properly regulate construction and maintenance of transport infrastructure, and lessee's rights who are engaged in construction and operation of temporary logging roads under terms of forest lands’ lease are not defined. Besides, seasonal temporary logging roads are not included into the list of regional or local roads and they are not presented in area planning schemes. Therefore, problem solution demands further scientific and methodical development.

1. Introduction

One of the factors of timber complex development is road availability and their capacity on forest lands. On the other hand, the most important direction of logging industry development is full and ecologically safe acquisition and use of forest areas [1]. Therefore the effective management of forest resources cannot be increased without competent planning of road network and rational use of the forest land.

The isolated regions of Far North are hard-to-reach areas with poorly developed infrastructure. In difficult geological, hydrological and climatic conditions of northern regions the basis of transport infrastructure are temporary logging roads [2]. The extent of these roads of such territories is comparable to highways as development, arrangement and operation of forest resources demand delivery of large-size loads and the equipment. Basic research tasks are:
- to define specifics of temporary logging roads as real estate items;
- to expose need of temporary logging roads’ registration taking into account distribution of their structure in time;
- to rank the factors defining physical and mechanical soil properties on extent of influence on temporary logging roads’ location;
- to develop the technology of spatial basis’ construction allowing to solve problem of temporary logging roads’ registration in view of their changing location.
Goal of research involves advanced technology of inventory work’s development for temporary logging roads’ registration. This technology gives opportunity of first-ever defining possible changes of temporary logging roads’ boundaries by results of field measurements of physical and mechanical soil properties.

Temporary logging roads impose need for constant control and monitoring. Consequently inventory of such roads is necessary to make immediate strategic decisions concerning their construction and operation [3]. For maintenance of timber industry in different countries bordering on the Arctic: Canada, Finland, Estonia, Iceland, Norway, Russia, Sweden and the USA temporary logging roads which operation is possible only in winter conditions according to subzero weather are intended [4].

On the one hand, temporary logging roads represent the way of certain direction which location changes every season. On the other hand, they have features of real estate as they are inseparably linked with the ground surface, and their movement without disproportionate damage to appointment is impossible. In both cases temporary logging roads are complex objects and they are liable for inventory. Today the question of territory planning while designing of such objects in difficult geological and climatic conditions is one of the most difficult in the field of civil engineering, geodesy and land management.

Construction of temporary logging roads is efficient for regions where creation of roads with the hard road topping is impossible. Their runway consists of snow, ice and frozen soil and is destroyed considering difficult engineering and geological territory conditions within the period of one operational cycle [5]. Therefore, this cycle of temporary logging roads is not specific to other real estate objects (Figure 1).

![Figure 1. Stages of temporary logging roads’ service life.](image)

According to the Figure 1, functioning of temporary logging roads is provided with annual restoration and includes preliminary aerial photography in the routing direction, finding areas with high ice soil. The process of engineering surveying consists of topographical, frozen-ground, engineering and geological works in the reduced volume the and also hydrometeorological forecasting which are necessary for location updating of the road [6].
Taking into account the designated specifics and the objects’ economic importance reliable and full data on their location and the main characteristics are necessary. However today the questions concerning inventory of temporary logging roads remain the most difficult in the field of land and forest law.

2. Material and methods
Basic data for carrying out an experimental part of a research are provided by survey schemes, legal documents, data of geodesic surveying (Figure 2), general materials of land management.

![Figure 2](image.png)

**Figure 2.** Fragment of project documentation for temporary logging road.

The practical research was conducted concerning the temporary logging road which is located in Leningrad Region. Its basis consists of projects of Russian and foreign scientists in the field of inventory, land use planning, legal and economic regulation of land relations and management of land resources. There are statistical, computational and constructive and cartographic methods which are used in research. At statement and the solution of temporary logging roads’ location problems of the system approach which is based on use of geoinformation technologies is used. Studying, the analysis and assessment of set of the natural and production and situational conditions providing placement of objects of transport on forest land are carried out on the basis of geographical approach [7].

On the basis of these coordinate catalogs of road’s seasonal baselines the image of location of the object of research according to the operational season is received.
According to the drawing it is possible to note a divergence of axes (43-68 meters) that is connected with specifics of an object of a research. The location of the road of seasonal action is under the influence of physical and mechanical properties of soil which numerical coefficients are defined as a result of carrying out year-round stationary observations of the temperature and moist modes, deformations of draft of a roadbed on specially organized posts and pilot sites [8]. The following stage of a field research consists in carrying out engineering researches in the form of a complex of geodetic, geological and hydrometeorological works.

The seasonal roads’ location is under the influence of physic-mechanical properties of soil which numerical indicators are defined as the result of carrying out year-round stationary observations of the temperature and humidity conditions, depression in the subgrade surface on specially organized posts and test area [9]. The field investigation phase consists of carrying out engineering research in the form of complex geodetic, geological and hydrometeorological works. These investigations are included into the list of management functions of the land and property relations of Federal Highway Agency of Ministry of Transport of the Russian Federation.

As a result of field works coordinate catalogs of road’s axes according to operational seasons of 2011-2018 and the field records of soil with information about humidity, stability, frost depth, soil bearing capacity, depth of snow cover and others are received (Table 1).

**Table 1.** Data of field records of physical and mechanical soil properties.

| Soil Properties                  | Distance of seasonal baselines’ deviation, (m) |
|----------------------------------|-----------------------------------------------|
|                                  | 10-20 m | 20-30 m | 30-70 m |
| Moisture content of soil (%)     | 0.05    | 0.22    | 0.35    |
| Soil stability code              | 0.15    | 0.12    | 0.13    |
| Depth of frost penetration (cm)  | 6.11    | 13.0    | 5.26    |
| Driving resistance code          | 0.88    | 0.76    | 0.74    |
| Ground freezing point (°C)       | 7.4     | 3.8     | 2.1     |
| Dry density of soil (t/m³)       | 2.74    | 1.45    | 2.08    |
As a result of the analysis and systematization of indicators of the studied physic-mechanical characteristics of soil it is possible to draw a conclusion that for each reference point of a seasonal axis there corresponds a certain size of an indicator: frost penetration depth; humidity; bearing capacity of soil.

The cameral stage is carried out using the method of spatial analysis, as the result materials of geotechnical investigations taking into account experience of roads’ design and construction during last operational seasons are interpreted. Subsequently geotechnical mapping is made. For the purpose of quantitative substantiation of made decisions on management of territories’ development, the mathematical modeling is carried out that allow to predict results of the object’s functioning under various conditions.

Research phases are some kind of framework for advanced technology of inventory works’ carrying out which algorithm demands awareness of the studied object’s distribution in space and time and also of indicators which are characterized physical and mechanical properties of soil in the territory of its location.

For forecasting of location of such roads by the most effective use of the given characteristics as basic data for creation of functions of dependence of systems together with the geoinformation (GIS) technologies allowing to generalize cartographic and semantic information of land management is [10]. As a result of work of a cameral stage with use of a method of the spatial analysis materials of engineering researches taking into account experience of design and construction of roads during last operational seasons are interpreted. Thus, the model of a buffer zone which defines the possible provision of an object of seasonal existence on the area is created (Figure 4).

Figure 4. Layout of seasonal baselines with boundaries of the buffer zone.

The fragment of the buffer zone projected for the purpose of the optimum land organization intended for placement of temporary logging roads is the right of way prototype. Coordinates of their boundaries are determined with analysis of the corresponding attributive characteristics received as the result of geotechnical investigations. Accepting that distribution of corrective actions’ time instant happens according to Poisson's law, his probability will be equal to of stability of boundaries:

\[
\lambda = \frac{\mu}{t}
\]

where, \( e \) - the basis of a natural logarithm; \( t \) – time period between correction of borders of a strip of branch, years; \( \mu \) - life cycle of the road, for roads of seasonal action this indicator is equal to 1 year.
Respectively, to support stability of borders of a strip of withdrawal of the explored roads with the probability 0.9 - 0.95, it is necessary to carry out their specification every 0.05 year that is economically inexpedient.

So to avoid repeated preparation of cadastral documentation for specification of the land plots in borders of a strip of branch transformation of a strip of branch to buffer zones for which the particular legal regime for the purpose of rational, effective and full use of land and forest resources is set is carried out.

3. Results and discussion

Investigation phases are a framework for advanced technology of carrying out inventory of temporary logging roads which algorithm of performance demands knowledge of distribution of the studied object in space and time and also about a number of the indicators characterizing physic-mechanical properties of soil in the territory of its placement. This technology can be used with industry programs’ development and also forest use projects’ development at the federal, regional and local levels both for forest users, and for public authorities of executive power.

Besides, as a result of research creation of the buffer zone designating borders of possible object’s passing according to operational season is offered. The main concept of the buffer zone consists in display of dependence of coordinates of rotary points of the seasonal forestry and landscape road on the chosen basic data characterizing a territory environment. The established zone is necessary for accounting of temporary logging roads and also to avoid boundary intersections, legal disagreements and other local questions caused by features of use and development forest territories.

Thus, actual technology of temporary logging roads’ inventory has number of limitations. It don’t consider natural factors defining location of objects of research that doesn’t allow to avoid numerous imposings of study objects on adjacent lands of other categories.

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