Justification of transport and logistics routes for the movement of natural resources in order to minimize the impact on the environment

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Abstract. Resolving environmental issues is one of the most important challenges facing the world community. The modern development of industry, on the contrary, tends to maximize the negative impact on nature. The growth of productive forces in Russia is increasingly aimed at the removal of natural resources, which is associated with a negative impact on nature. At the same time, a negative impact is exerted through the abandonment of vast territories contaminated with waste and the results of production activities, as well as the transportation of seized resources to processing sites. The work shows that in order to minimize the impact on the environment, waste should be maximally involved in the production process, and transportation should be carried out by the most optimal routes. As a result of the study, an algorithm for solving the problem of using various natural resources in order to minimize the impact on the environment has been developed, and the stages of working with natural raw materials in order to minimize the impact on the environment and their potential effectiveness are presented.

1. Introduction

Environmental protection is one of the priorities of state policy in Russia. At the same time, at the moment the Russian economy has a predominantly resource-producing basis. Oil, gas, coal, metal ores, timber and other resources are actively used both domestically and exported to various countries. In this regard, it is important to minimize the impact on nature during the seizure and use of the natural resources of our country.

Extraction and/or procurement of natural resources will remain an integral part of Russian reality for a fairly long time. At the same time, in addition to the harm caused by such withdrawal, nature is significantly affected by the further use of resources to obtain various products, as well as by leaving various wastes in the mining areas: waste rock, contaminated soils, logging waste, etc. At the same time, part of the remaining waste can be used to obtain products, which will reduce the anthropogenic load. It
is also necessary to apply the most reasonable solutions when transporting natural resources, causing minimal harm to the environment.

Among the studies that solve certain problems in the use of secondary natural resources to minimize the impact on the environment in the context of the use of logistics and information technology tools in the field of transportation, the forest industry should be noted. There is a sufficient number of specialists and works here, which are of the most important both theoretical and applied significance.

So, in work [1], the authors consider the problem of solving the set problem using the graph-analytical method. Computing graphs with a large number of vertices and arcs connecting them is quite laborious and time-consuming. To solve this problem, the article presented the development of a computer application that performs basic calculations and calculates the optimal technological sequence of operations. The algorithm and the principle of the application were presented, as well as its description. The program makes it possible to automate the process of finding the optimal sequence of technological operations of the production process of a logging enterprise, the results of which allow comparing and analyzing various options of the technological process for making decisions. An important place in the study is given to the involvement of felling waste in production and its rationale and logical justification.

A lot of studies are devoted to the general aspects of reducing environmental impact, as well as particular problems faced by individual enterprises and public institutions [2]. The solution of the stated problematics both in the places of extraction of natural resources and their processing is an extremely urgent task. However, in this study, in addition to those noted, it is put forward as a key goal - the substantiation of transport and logistics routes for the movement of natural resources in order to minimize the impact on the environment. It should be noted that in this case, minimizing the impact on nature is assessed from two positions: reducing the impact due to the involvement of unused secondary resources in production, as well as due to optimal transport and logistics solutions that cause the least possible damage to the natural environment.

2. Solution of problems and discussion of the results

One of the possible areas of using various options for the development of transport and logistics routes is the forest industry, which is relevant for the Krasnoyarsk Territory. There are quite acute problems here in increasing the remoteness of logging sites from processing centers [3]. At the same time, in the process of logging, a huge amount of waste is traditionally left unused for industrial or other consumption. This is often unacceptable from an economic and environmental standpoint. At the same time, a number of enterprises in the region (as well as in other parts of our country) have a need for raw materials of wood origin. The waste left at the present time at logging sites could be used for the production of many types of valuable products. Also, the problem of environmental pollution with many tons of logging waste would be solved.

However, this requires the development of two key elements of the mechanism for including such secondary resources in production:

1. Technological solutions (technologies) for the inclusion of heterogeneous logging waste in production.
2. Transport, logistics and technological solutions for the transportation of these waste from the forest area to the processing sites.

The first of these decisions should justify the immediate possibility of using various logging waste in the production of industrial products. The difficulty lies in the fact that certain types of logging waste are extremely difficult to use when obtaining products [4]. They may contain an unacceptable amount of bark, needles, heterogeneous inclusions, have an excessive number of defects, improper size and quality composition, etc. As a result, the substantiation and development of the features of the inclusion of such wastes is relevant and necessary.
Transport and logistics solutions are the second side of the issue. Receiving products at an enterprise in modern conditions is impossible without the availability of profit from its sale. Thus, the cost of production should be lower than the selling price. However, in the conditions of obtaining goods from logging and other waste, delivered over many tens and hundreds of kilometers, transportation costs excessively increase the cost of production.

As a result, without reducing the cost of delivering raw materials (including secondary ones), the release of such products becomes unprofitable, and, therefore, impossible. Thus, finding transport and logistics solutions for the delivery of various natural resources to processing facilities is the most important task from both the economic and environmental sides [5]. In the course of the study, an algorithm was developed for solving the problem of using various natural resources in order to minimize the impact on the environment (figure 1).

![Algorithm for solving the problem of using various natural resources in order to minimize the impact on the environment.](image)

Figure 1. Algorithm for solving the problem of using various natural resources in order to minimize the impact on the environment.

It attaches key importance to the two elements noted above: selection of technology for the use of secondary wood resources and optimal transport and logistics solutions.

Justification of transport and logistics routes for the movement of natural resources in order to minimize the impact on the environment also requires detailing certain impacts along the entire chain of movement of resources, in order to improve the environmental situation, and assess the results. The paper proposes a diagram that clearly demonstrates the stages of working with natural raw materials
(including secondary ones) in order to minimize the impact on the environment and their potential effectiveness (figure 2).

The presented diagram shows that natural resources pass from the moment of receipt (withdrawal) to the moment of consumption, a rather long production process. At each stage, a number of possible management influences can be identified. The goal of each of them is to reduce the impact on the environment. It should be noted that the scheme identifies two stages of transportation - initial raw materials and finished products. However, the need to move certain goods (natural resources) arises practically at each of the stages presented. The movement of natural resources and products from them can be insignificant (from one workshop to another or from a transport unit to a warehouse), however, any movement should be assessed in relation to the entire volume of resources.

In this case, even the smallest movement in space can be extremely expensive and, in particular, harmful to the environment. Thus, the optimization of transport and logistics routes is required at each of the stages presented.

Direct substantiation is traditionally carried out by economic, mathematical and logistic methods [6]. It should be noted that modern science complements the traditional tools with geoinformation tools, as well as a variety of software products that optimize the set of calculations required to solve various problems [1].

It should also be clarified that certification is an important aspect in the development of environmental protection measures when moving natural resources. The adoption by domestic enterprises of international standards, including in the field of environmental protection, helps to minimize the impact on nature. The most obvious are the ISO series. However, industry-specific standards and certifications are more effective in protecting the environment. So, in the forestry industry, the FSC and PEFC certification should be noted [7]. They are largely aimed at environmental protection and optimize various processes at enterprises, taking into account the interests of nature, the population, the state, and not purely business [8].

At the same time, during certification according to these international systems, a separate (important) place is given to the transportation of wood resources and transport chains.

3. Conclusion
Optimization of transport and logistics routes for the movement of natural resources is an extremely urgent task in the context of reducing the impact of production activities on the environment [9]. Efficient logistics allows not only achieving high economic results, but also, to a certain extent, improving the environmental situation. This fact is due to the possible involvement of various wastes (secondary resources) in the production with due justification of technical and logistic solutions.

It should be noted that the limitation of the involvement of secondary natural resources in production in the form of economic feasibility presented in the work can be somewhat adjusted [10]. Departure from the priority of economic results in the production of products can be observed with certain subsidies (compensation payments) to enterprises dealing with environmental issues. This process is organized differently in different countries. In Russia, significant government assistance is observed only in certain sectors and is not so significant on an all-Russian scale.

At the same time, it is extremely important for a business that exports its products to comply with a set of environmental requirements, and in accordance with foreign recommendations. It is also important from the standpoint of forming a favorable image of companies and a number of additional bonuses.

As a result of the study, information was generalized on the need to justify transport and logistics routes for the movement of natural resources in order to minimize the impact on the environment, an algorithm for solving the problem of using various natural resources in order to minimize the impact on the environment was developed, and the stages of working with natural raw materials in in order to minimize the impact on the environment and their potential effectiveness.
Figure 2. Stages of working with natural raw materials in order to minimize the impact on the environment and their potential effectiveness.

The team of authors plans to use the results obtained to develop practical recommendations for the involvement of various production wastes at individual enterprises in order to minimize the impact on the environment.

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