Analysis Risk Factors Forest Ecosystems the Krasnoyarsk Territory

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Abstract. A database on indicators of forest ecosystems for risk assessment has been formed. The method risk assessment forest ecosystems in the conditions of intensive anthropogenic impact by the multidimensional method are developed. An example of environmental risk assessment based on ground-based observations is shown, forest ecosystems status indicators, space sensing obtained by remote sensing methods. Rationing factors were performed using the coefficient of the variation series. Combining heterogeneous data is carried out on a single normalized scale, taking into account the characteristics of authenticity and taking degree participation in each factor. With help cluster analysis the ranking territories performed. In the course data analysis for 2018, 4 clusters were identified, for each which priority risk factors are analyzed. The greatest contribution is made by climatic factors and high population density.

1. Introduction
The role of the forest is of great importance because it occupies almost a third land mass globe. Forests are home to a wide variety of life forms. They support countless species and are source resources. Annually there is a significant reduction in forests. In large areas, integrity ecosystems have been disrupted, fresh water is being dried up and polluted, the biodiversity of natural ecosystems is decreasing and forest cover is decreasing. Role forest ecosystems in the Krasnoyarsk Territory is of great importance, this is due to the high rate forest cover throughout the region. Therefore, preservation of natural balance in the regional structure diversity forest areas - an important element of territorial monitoring and risk assessment.

2. Relevance
To date, there is no standard methodology for calculating environmental risk, suitable for combining heterogeneous data and identifying hazardous situations in forest ecosystems [1, 2]. A variety of risk assessment approaches is associated with set diverse factors, that need to be considered when assessing environmental risks, therefore, there is a need to create a methodology, suitable for all heterogeneous data. Risks are an important criterion environmental safety the territory, therefore, the choice of a correct and reliable method of their assessment is an important stage in any research [3].
The object of the study was the state of forest ecosystems in the Krasnoyarsk Territory for 2003-2018. As risk factors, indicators were chosen that characterize both the impact on forest ecosystems and their sustainability. Due to the expected climatic changes, the manifestation of a set of interrelated and interdependent threats to the sustainability of forest ecosystems, such as increasing the likelihood of fires, extreme weather events, and outbreaks of insect pests, is predicted [4].

So the weather affects the resistance of plantations to the effects of adverse factors, the formation of a one-year increase in plantations, and the yield of seed forest plants, as well as the development of populations of many species of insect pests and the aggressiveness of pathogens of forest diseases [5].

The impact of external factors, such as climate change, manifests itself in the form of changes in forest areas, forest cover territories.

Numerical values of the selected indicators were determined using official data, received on regional monitoring networks, evaluating state forest stands on territory by various methods, including remote sensing techniques [6-10]. Based on selected indicators, a database was formed for the task of assessing environmental risks, including the following indicators:

- Population density.
- Rainfall.
- Air temperature.
- The number of fires and the area of the damaged area.
- Forest land area.
- Number of pest outbreaks.

2.1. Work task

Combining heterogeneous data on a single normalized scale, taking into account the characteristics of reliability, degree of participation of each factor and their reduction to a single indicator characterizing the state, dynamics, and level of vulnerability of forest ecosystems in various regions of the Krasnoyarsk Territory.

3. Multidimensional methods

To obtain and analyze information, identify hidden patterns, search for the most important connections between variables among a large number of them about the state forest ecosystems, methods of multidimensional data analysis are used.

One method of multidimensional statistics that best shows the features of multidimensionality in the classification of objects - cluster analysis. The main task method is to divide the set of objects studied, characterized by a set of features, into homogeneous groups.

Previously, all considered indicators were normalized using the ratio [11]:

$$X_{ij} = \frac{|X_{ij} - X_{0j}|}{\max_{i=1,2,3,\ldots,n} \min_{j=1,2,3,\ldots,m} |X_{ij} - X_{0j}|},$$

where $X_{0j}$ is the worst value for each indicator; $\max_{i=1,2,3,\ldots,n} \min_{j=1,2,3,\ldots,m} |X_{ij} - X_{0j}|$ is the most different from $X_{0j}$ indicator value; $n$ is the number of observed territorial units; $m$ is the number of indicators used for calculations. Value each indicator after the procedure normalization varies in the range from 0 to 1. At this stage, all assumptions were used that each of these indicators affects the quality of forest ecosystems equally. Standardized values were summed for each region and period. The obtained complex index of state of forest ecosystems is a score, the values which vary in the range from 0 to 5.

Standardized values were divided into cluster analysis by the Ward method. In all clusters, for all available observations, average values of individual variables were calculated and the squares of Euclidean distances from individual observations each cluster to the average cluster value were calculated, these distances were summed. In one new cluster, those clusters are combined, the combination which results in the smallest increase in the total sum of distances [12].
This method allows to construct new classifications for poorly studied phenomena, when it is necessary to establish the presence links within the aggregate and try to bring into it the structure, as well as solve the problem classifying objects with regard to the signs, reflecting the essence, nature of objects, which leads, as a rule, to deepening knowledge combination classified objects [13-16]. To determine the number of clusters, a threshold distance was chosen, so that they are too distant, according to the characteristics chosen for the task, objects do not fall into one cluster. Selecting a measure distance and weights for classifying variables - very important stage cluster analysis, since composition and number of clusters formed depend on these procedures and the degree similarity objects within clusters. The dendrogram in the figure shows that results calculations, select 4 relatively homogeneous clusters for which the most important risk factors were analyzed, which act on the ecosystem together. The formation of a group, in this case, is always associated with an indication of its boundaries for each grouping attribute separately. At the same time, the state ecosystem may vary depending on the strength and simultaneous combination of various factors [17–20]. Evenki district did not fall into any of the clusters, due to significantly different values of the factors. The area is characterized by low population density and low anthropogenic impact on forest ecosystems.

Analysis contribution risk levels forest ecosystems each factor was carried out on the identified clusters (Fig. 2.). Clusters were analyzed to determine the highest risk factors for the degradation of forest ecosystems. That allows you to determine what aspect you need to focus on minimizing the negative effects that may lead to the degradation forest. Forest degradation, loss vitality, occurring under the influence anthropogenic or natural factors, manifests itself in a decrease in the vital status trees and drying stands, loss young growth, reduction species diversity forest ecological systems.
4. Conclusion
It is revealed that the biggest contribution is made by climatic factors and population density. Forest ecosystems, to a much greater extent than other ecosystems, are directly affected by climatic and meteorological factors, which are closely associated, in turn, with economic, social and technological conditions.

At the same time, the impact climate change on the vulnerability forest ecosystems due to the threat of mass reproduction pests and forest diseases is one of the few factors whose influence can be reduced by carrying out forest protection measures in a timely manner. The above-mentioned fact that the time lag in the peak forest death from the mass reproduction forest pests makes it possible to detect in advance the growth population pests and take measures to prevent the formation foci mass reproduction [21]. The need to develop integrated methods for assessing territorial risks is conditioned by the presence large number influencing factors, vastness territories and the complex ecological systems themselves, the state which in conditions intensive anthropogenic impact is constantly deteriorating.

Possible consequences for this process include:
• Violation of climate stability.
• The disappearance of many species of living organisms.
• Formation swamps, as trees prevent excessive soil moisture.
• Desertification.
• Soil degradation.

For the management territorial development is extremely important analysis and assessment factors, determine the sustainability of natural ecosystems. Further development proposed method includes expanding list factors considered, clarifying the contributions factors to risk levels and the interpretation risk indicators for territorial management tasks.

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