Target indicators for the development of the forest complex in the context of the Altai Republic municipalities

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ABSTRACT

Forest resources play an important role in shaping the natural-territorial complex sustainability. The degradation processes taking place on the territory of the forest resources fund make it necessary to assess the condition, use of forests and develop a set of measures to improve the rational use of the forest resources. The article discusses the reasons for the loss of forest stand in the forestry of the Altai Republic. The main reasons for the degradation of forest resources are identified, among which the most significant are forest fires and the spread of insect pests. Insufficient volumes of sanitary-improving measures also contribute to the increase in the area of weakened stands. It has been shown that since 2007 there has been a steady increase in the area of plantations with impaired and lost stability in the Republic of Altai. And in 2015, the maximum area of forests with impaired stability due to existing of pest harborage area was noted. The target indicators of the development of the forest complex for each forestry are given. The system of balanced indicators is evaluated as a tool for assessing and managing the forest complex.

Keywords: Altai, Causes of loss of forest stand, Forest fires, Forest diseases

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1. Introduction

Forest resources play an important role in shaping the natural-territorial complex sustainability. The degradation processes taking place on the territory of the forest resources fund make it necessary to assess the condition, use of forests and develop a set of measures to improve the rational use of the forest resources [1-7]. The lack of understanding of the relationship between the forest sector, on the one hand, and strategic management, on the other hand, leads to the fact that it is often not possible to realize the development potential of the forest strategy [8-14].

According to the authors of the concept of a system of balanced indicators D. Norton and R. Kaplan, there is no single correct way to manage performance. The choice of development indicators should depend on specific conditions [15-21]. The targets for the development of the forest complex for municipalities as a whole coincide with the targets for the entire republic. However, those indicators that can illustrate the most significant achievements for a particular area should be given priority. The conditions for the development of the forest complex of municipalities are significantly different. It depends on many factors and, first of all, on the climatic conditions [22].
2. Materials and methods

Territorial units of forest management are 10 forestry’s, the largest of which is Turochak. It includes three branches: Turochak, Teletsk and Baigol (Figure 1).

![Forest Management Diagram]

Figure 1. Forestry structure of the Altai Republic (forestry’s are located top to bottom in terms of the estimated cutting area)

Forestry’s are engaged in state control, organize the formation of forest plots, collect data for the state forest register, conduct industry-specific statistical reporting and ensure the implementation of forestry regulations [23-29]. The territory of the Altai Republic is predominantly mountainous, which is precisely what caused the great pattern structure of nature and climatic conditions. Accordingly, the conditions for forest growth vary greatly depending on the geographical location. They try to take into account this specificity at the level of legal regulation and in accordance with the order of the Federal Forestry Agency dated 09.03.2011 No. 61 “On approval of the list of forest growing zones of the Russian Federation and the list of forest regions of the Russian Federation” [30-32] forests of the Altai Republic are assigned to the South Siberian Mountain zone and occupy two forest areas: Altai-Sayan Mountain taiga and Altai-Sayan Mountain forest-steppe.

Within the Altai-Sayan mountain-forest-steppe region, there are the Kosh-Agach forestry, the southern part of the Ulagan and Ust-Koks forestry. This most elevated southern part of the republic includes a system of high ridges interspersed by plateaus and intermountain basins. The vertical zoning is as follows: desert steppes (1500-2000 m above sea level), forest belt (1200-2400-2600 m), tundra-nival (2400-4000 m). The dominant formation is larch (Siberian larch – Larix sibirica), rising from the steppes to the upper border of the forest. Siberian spruce (Picea obovata) is constantly present in the lower forest belt, Siberian cedar pine (Pinus sibirica) is in the upper. The rest of the territory of the republic is occupied by the Altai-Sayan Mountain taiga forest region. Deciduous forests, black and coniferous taiga are located here. The belt vegetation scheme is as follows: birch-pine belt of the forest-steppe, belt of dark coniferous forests, taiga-larch and subalpine and alpine tundra [33-38]. Altitudes range from 350 to 2000 meters above sea level.

From north to south and from the tops of the mountains to the foothills in the living ground cover, the participation of mosses and shrubs decreases and the role of herbaceous plants increases. The closeness and height of the tree layer increases, the growth rate of trees in height and in diameter increases, and as a result the productivity of forest stands increases. With advancement from the peaks to the foothills of the mountains, the bonitet class, completeness, growth and timber reserve per 1 hectare increase. A more diverse composition of forests and higher average taxation indicators of the Altai-Sayan Mountain taiga forest region are due to a more favorable climate and better soils [39].

3. Results and discussion

The key to successful forest management is a correct understanding of the growth processes of the stand and its death [40-47]. As a basic principle of choosing priority indicators for municipalities, it is necessary to focus on the causes of the death of forest stands [48-55]. As already noted, forest conditions differ significantly and, accordingly, the causes of death of forest vegetation are also very different. There are enough studies in
Russian and foreign literature on methods for identifying the causes of forest stand loss, from local ones such as windfalls and ravines to the effects of climate change [56-62]. Based on an analysis of the situation from 2012 to 2016, it was revealed that the greatest loss of forests due to fires was observed in three areas: Ulagan, Kosh-Agach and Onguday (Figure 2-4).

Figure 2. The area of forest plantations of the Ulagan forestry (hect) that died as a result of various reasons from 2012 to 2016

Figure 3. The area of forest plantations of the Onguday forestry (hect) that died as a result of various reasons from 2012 to 2016

Figure 4. The area of forest plantations of the Kosh-Agach forestry (hect) that died as a result of various reasons from 2012 to 2016
Thus, the priority indicators for these areas should be: the number of forest fires, the amount of damage from forest fires, the area of forest lands killed by fires and the costs of protecting forests from fires per 1 hectare of forest fund. The indicators characterizing the work on forest reproduction are equally important in all regions of the republic [63-70]. For the Onguday district, monitoring of the forest disease situation is also necessary. This reason for the death of the forest was recorded here each of the five analyzed years. As an indicator, we can use the area of forests that died as a result of forest diseases, and the proportion of forests covered by the forest pathological monitoring system. Ulagan forestry also recorded forest diseases, but only in 2016 and on a small area [71-76]. For Ust-Koksa and Shebalino forestries, two main causes of the destruction of forest stands were identified: fires and forest diseases [77-84] (Figure 5-6).

In the Ust-Koksa forestry, the forest stand was most affected in 2012. Moreover, both from fires and from diseases. Shebalino forestry lost most of the area in 2012 as a result of fires, and in 2015 from forest diseases. In both forestries, along with indicators to track the effectiveness of fire prevention, significant attention should be paid to indicators to track the effectiveness of measures to combat forest diseases [85-92].

![Figure 5. The area of forest plantations of the Ust-Koksa forestry (hect) that died as a result of various reasons from 2012 to 2016.](image)

![Figure 6. The area of forest plantations of the Shebalino forestry (hect) that died as a result of various reasons from 2012 to 2016.](image)

The situation in the Chemal and Ust-Kan forestry’s (Figure 7-8) is similar to the Ust-Koksa and Shebalino, however, forest diseases come first in the list of causes of death and priorities must be set accordingly [93-97]. In Chemal forestry, the greatest damage was done in 2012 and 2013. In Ust-Kan, the largest areas of forest stand were affected by fires in 2012, but the damage from diseases was observed for almost five years on almost the same scale every year [98-103].
Figure 7. The area of forest plantations of the Chemal forestry (hect) that died as a result of various reasons from 2012 to 2016.

Figure 8. The area of forest plantations of the Ust-Kan forestry (hect) that died as a result of various reasons from 2012 to 2016.

All forestry’s in the northern part of the republic demonstrate a difficult situation with the causes of death of forest stands (Figure 9-11). So, for example, in the Turochak forestry, the cause of death that comes first – damage by insects, in second place – forest diseases. In this case, the death from forest fires is negligible. In the Maima forestry, the influence of fires is also negligible, and forest diseases and insect damage take on significance [104].

The most difficult picture is observed in the Choy forestry, where all the causes of death are noted, including anthropogenic factors that were not recorded for other forestry’s. Here the reason lies in the complexity of accounting and fixing this factor. Air pollution, soil acidification, changes in the composition of nutrients – all this contributes to a decrease in the viability of trees [14]. But in this forestry for five years, forest fires were not recorded.

Figure 9. The area of forest plantations of the Turochak forestry (hect) that died as a result of various reasons from 2012 to 2016.
Figure 10. The area of forest plantations of the Maima forestry (hect) that died as a result of various reasons from 2012 to 2016

Figure 11. The area of forest plantations of the Choy forestry (hect) that died as a result of various reasons from 2012 to 2016

For all these forestry’s, it is possible to reduce target indicators for protecting forests from fires, and instead introduce an indicator such as the ratio of the area of sanitary and recreational measures to the area of dead and damaged forests (%) [104-110].

4. Conclusions

It should be noted that since 2007 in the territory of the Republic of Altai there has been a steady increase in the area of plantations with impaired and lost stability. In 2015, the maximum area of forests with impaired stability was noted due to the spread of insect pests, the area of which was 137 thousand hectares, including insect pests – 134.3 thousand hectares, forest diseases – 2.7 thousand hectares. In addition, the formation of the total area of weakened stands is affected by the chronically insufficient volumes of sanitary and recreational activities carried out in the republic.

The following forest protection measures are very relevant: conducting forest pathological monitoring, fire hazard monitoring, assessing the effectiveness of forest protection measures; sanitary and health measures (sanitary felling, cleaning the forest from clutter) and a number of measures for reforestation. In the future, it will be timely to study the dependence of the identified causes of forest reduction on the observed climate changes. Since in a number of forestry’s (Choy, Turochak) one of the reasons for the degradation of the forest stand is adverse weather and soil climate conditions. In foreign publications significant attention is paid to this matter.
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