PECULIARITIES OF DESIGNING AND IMPLEMENTING PROTECTION MEASURES AIMED AT IMPROVING THE FIRE SAFETY LEVEL OF FORESTS NEAR URBAN SETTLEMENTS

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ABSTRACT

As the world practice shows, forest fire fighting is a long process, and it requires significant material and human resources. The existing methods of fire-fighting, especially under conditions of a high fire hazard, are insufficiently efficient and extremely difficult for implementation. Therefore, due to the hazard escalation of forest fires started near the settlements and threatening the well-being of their population, the preventive measures become especially crucial as they are aimed at preventing fires in the forests and decreasing the level of fire hazard.

The objective of the work is to offer new methods of improving the level of forest fire safety.

1. INTRODUCTION

As forests are the richest land ecosystems because of their structure and life forms and they contribute to the living of other natural formations, their preservation is one of the priority directions of the sustainable development of the planet, a necessary condition of the biosphere functioning. The increase in the non-normalized recreational load on forests has led to the growth of the number and scale of forest fires that are the second global factor of their destruction and suppression after deforestation [1].

Peculiarities of Designing and Implementing Protection Measures Aimed at Improving the Fire Safety Level of Forests Near Urban Settlements

The problem of forest fire prevention in many countries is unsolved until now. The improper regulation of recreational management of natural resources and the breach of fire safety rules often cause the breakout of forest fires.

Forest fires make a complex negative impact on ecosystems and societies living around the forests. The large scales and dynamic factor of fires, the remoteness from fire-fighting institutions, their improper provision and sometimes insufficient operational efficiency often lead to significant economic losses not only for forests but also for the nearest settlements [2]. Therefore, now fighting forest fires is an urgent problem.

Under the conditions of the anthropogenic impact on the environment, the negative environmental consequences of forest fires grew drastically also for the nearest urban settlements. The especially dangerous consequence of forest fires is the fast release and emission of CO_2 and chemically active emissions. In the areas of technogenic pollution that cover millions of hectares in Russia, during the forest fires heavy metals are transferred and territories are polluted with the toxic compounds for the second time [3].

An important point of forest protection from fires is the determination of a fire season and a fire-hazard period, revealing the regularities of forest fires' breakout taking into account the geographic peculiarities of particular territories, as it is known that the fire breakout is caused by: the high intensity of visits to the forest areas by the population; the proximity of the settlements, recreational institutions, roads and also the climatic conditions; long periods of drought; high temperature of air and soil surface; a long period of fire breakout risk in the forest. At the same time, most fires break out in the forests near metropolitan cities.

The analysis of the data on forest fires' quantity for many years allows determining the periods of fire maximum and fire peak. The fire maximum is a period of the fire hazard season during which the number of fires exceeds their average monthly number. The period of fire peak is a period of time of the biggest number of fires. The high threat of fire hazard remains during the whole fire maximum when there are many recreation institutions and weather anomalies. Most fires break out from 10 to 18, the least – at night. However, the difference decreases with the growth of the anthropogenic load. In the forests nearest to the metropolitan cities that are visited by the population also on week days, the frequency of fires does not depend upon the day of week. For more remote forestries, the typical peak of fires is on Saturday and Sunday. The distribution of forest fires depends upon the composition, condition, structure, dirtiness and also the wind rate [4].

Most fires that break out near metropolitan cities are creeping fires. Among the main reasons of their breakout, there are the careless handling of fire; unextinguished fire; a thrown match, cigarette butt. However, almost in half of the cases the reasons have not been determined. The fire peak is in lunch time. The fire peak is in August and July [5].

The distribution of forest fires depends upon the composition, condition, structure, dirtiness and also the wind rate. Fire-fighting is significantly complicated by the insufficiently studied mechanisms of fire development. The fire resistance of the forest plantings depends upon the biotic and abiotic factors of the performed preventive measures and forestry works [6].

The forest fire hazard is determined by the two main factors: weather conditions and the type of forest plantings [7, 8]. As a man cannot quickly impact the weather conditions, according to the level of fire hazard due to the weather conditions, it is necessary to perform the preventive measures. Such activity includes the work with the population, aimed at enforcing the fire safety rules in the forests. The set of measures is especially necessary the day before and on holidays and weekends. But not always the results are satisfactory. Therefore, the other direction of the preventive activity is the long-term forestry measures that

depend upon the type of forest plantings. Performing such measures, it is necessary to divide the forest area according to the fire hazard and according to the types of forest plantings into separate land lots and to perform the relevant work within their borders. At the same time, it is necessary to take into account the forest typological signs of fire hazard.

2. FOREST TYPOLOGICAL FACTORS OF FIRE HAZARD

The most common division is the division into classes of natural fire hazard offered by I.S. Melekhov that distinguishes 5 hazard classes depending, first of all, upon the types of forest plantings [9]. Such classes are determined for every part of forest and also the average class of natural hazard of a particular territory is calculated. To understand the nature of division into classes of the natural fire hazard, it is necessary to consider the impact of the natural factors on the forests that can have the external origin as well as the internal one, stipulated by the forest itself and its components.

Let us mention the factors that can influence the forest fire safety. The terrain layer of forest that includes the grass and green cover, small bushes and also the forest litter and tree waste shall be paid much attention. The fire breakout and the fire propagation or attenuation depends upon the composition and state of this layer. The formation of the forest terrain layer and its properties depend upon many factors, in particular, upon the type of forest plantings that form the forest litter and create the conditions for the growing of the green cover.

According to the fire hazard, softwoods are extremely dangerous, in particular, pine woods. It is known that pine needles can burn even during the rain and the process of its decomposition takes 2-3 years. The tree waste of leaf woods is the most dangerous at low relative humidity; however, it decomposes during a much shorter period – about a year. In mixed woods, there is more tree waste than in purely pine woods, but such tree waste decomposes faster than the purely pine tree waste. Due to the decomposition, the active phase of the tree waste forms the litter that is of great importance and is more sustainable to ignition. It is the forest litter that nourishes the terrain layer of the forest that in its turn forms the tree waste. The conditions are influenced by the climatic and anthropogenic factors that can have a direct (melioration, humidifying) or indirect character (construction, forest harvestings operations, extraction of mineral resources, etc.) [10, 11].

3. SILVICULTURAL MEASURES AS PREVENTIVE MEANS FOR FOREST FIRES

To improve the state of fire safety in the forests it is necessary to perform a complex of silvicultural measures that impact the above-ground and terrain forest layers. Such main measures include the forest crops, cutovers and cleaning. Taking into account the fire safety, the collection of dry tree waste is efficient in the places of public entertainment in the forests, grass mowing, etc.

Referring to the international experience, it should be mentioned that the existing silvicultural operations, for example, in Vietnam, directed to the prevention of forest fires, are one of the obligatory requirements for planning, designing of forest plantings and the forest practical use. Such measures include mainly:

- planting of mixed types of trees to limit the forest understorey (scrub) and green cover;
- Measures to decrease the number of forest fuel materials by means of their active burning before the beginning of the dangerous season [12].

Tree planting can influence the fire safety through the selection of the species of wood because the forest areas where different species grow belong to different classes of fire

hazard. When planting trees in particular territories, the average class of fire hazard can be changed by planting different species in particular areas. At the same time, in the places that are located close to the settlements and used for the recreation, near roads, etc., it is reasonable to plant soft woods. In this case, taking into account the fire safety, the territories that are difficult to access for the population will be the best place for such species. And in the places where the probability of people's visit and the threat of fire due to their activity are rather high, it is more reasonable to plant broadleaved trees.

The formation of mixed types of woods is a perspective and at the same time complicated measure of improving the fire safety level. As it was mentioned before, such woods can produce the safer forest litter than monocultural woods. However, during this measure different species are planted that, in their turn, influence mutually each other, and one specie suppresses the growth of the other. It requires the planning and planting according to the special layout for some species towards the others or planting of every specie in a different time. Also it should be mentioned that the calculation method of the fire hazard class of mixed forests according to the existing criteria is not sufficiently acute and clear.

Forest harvesting to cut and clean the forest is also an efficient fire-fighting measure; however, excessive cutting can lead to an increase in the illumination of the terrain layer and this causes an increase in the forest cover. The forest cover in the growing period decreases the fire hazard; however, in the dry condition it is very dangerous from the point of view of fire breakout.

The collection of tree waste helps to improve the level of fire safety. However, such measure is considered inappropriate due to the negative impact under the terms of the forest crops' growth. The absence of tree waste can lead to the nutrition depletion of the terrain forest layer, destruction of mushrooms and organisms. Besides, there are problems with tree waste utilization because, for example, it's burning leads to the pollution of the environment and is a threat of fire. To collect the tree waste, it is necessary to attract significant human resources. Therefore, it is reasonable to perform the measures only in small territories in the places of public entertainment in the forests.

The availability of the underground layer (peat), which is also fire hazardous, makes the process of impact on the fire safety much more difficult. The study of this layer requires a separate consideration. Separately, such traditional method as the creation of mineralized fire shelter belts among particular forest areas and on the border of the forest plantings should be mentioned.

Thus, the norms existing in Vietnam, directed to the prevention of the forest fires, include the creation of fire resistant shelter belts (including mineralized) that prevent fire distribution along the ground. According to Pham Ngoc Khanh's data, fire resistant shelter belts are created annually together with foresting on the forest areas along the bridges, roads, residential quarters, and agricultural lands. Also, natural barriers are additionally used for protection against forest fires: rivers and other water basins, walkways, artificial structures, such as railway and motor roads, high-voltage lines, etc. In these cases, the fire resistant shelter belts are created usually on both sides of the artificial structure with one or two fire resistant shelter belts, 6-10 m wide [13, 14].

However, fire resistant shelter belts can help only to stop the distribution of the forest fire and prevent its breakout from the agricultural burning that are performed in the territories close to the forests. Therefore, they do not impact the fire hazard factor of the forest area.

Besides the considered measures, it is possible to implement other measures promoting an increase in the fire safety level: construction of forest roads, improvement of forest water basins, development of mobilization plans for the case of fires, maintaining of fire-fighting

machines in the proper condition, patrolling of forests, training of forest workers, etc. But these measures are also useful in case of fire and directed to the improvement of reaction to the emergency situations and fires because they help to decrease the response time to the site of fire breakout and increase the efficiency of the personnel activity involved in the forest fire suppression.

In general, the fire safety of forests depends upon the season and particular weather conditions that are random factors. Therefore, silvicultural measures shall be anticipatory and take into account the season and weather forecast. However, these silvicultural measures are not enough. To provide the complete protection, it is necessary to perform a package of measures of a protective character (beats, patrolling in the dangerous period, agitation, etc.), attracting the subdivisions of the law enforcement establishment, police and the local authorities.

4. CONCLUSION

The intensification of the anthropogenic impact on the forests led to the growth of the number and scale of forest fires, an increase in the negative ecological and economic consequences of the damage from them. The fire breakout is caused by: the high intensity of visits to the forests by the population; the proximity of the settlements, recreational institutions, roads and also the climatic conditions. The distribution of forest fires depends upon the composition, condition, structure, dirtiness and also the wind rate. The biggest number of fires is observed in the forests near metropolitan cities. The forest protective measures shall take into account the specific conditions of the locality, relief, meteorological conditions and recreational loads.

When planning and performing the silvicultural measures, a complex of works shall be performed that will help to decrease the fire hazard level. One of the main factors that influence this level is the types of forest planting. Apart from traditional forestry methods of impact on the fire safety under conditions of their formation, the method of planning and planting different species of trees shall be used that forms the neighboring areas of different tree species or mixed areas of forest and this will decrease the general level of fire hazard.

REFERENCES

[1]   Goldammer, J.G. Vegetation Fires and Global Change: Challenges for Concerted International Action: A White Paper Directed to the United Nations and International Organizations. Freiburg: GFMC, 2013.

[2]   Bulgakova, M.A. Borba s lesnymi pozharami v sisteme obespecheniya ekonomicheskoi bezopasnosti gosudarstva [Forest Fire-Fighting in the Economic Security System of the State]. Vestnik Akademii ekonomicheskoi bezopasnosti MVD Rossii, 3, 2011, pp. 107-111.

[3]   Shestakova, A.V., & Mochaeva, T.V. Opredelenie ushcherba, prichinyaemogo lesnymi pozharami [Evaluation of Damage Caused by Forest Fires]. Inzhenernye kadry – budushchee innovatsionnoi ekonomiki Rossii, 6, 2016, pp. 166-168.

[4]   Malyukov, S.V., & Zhuravlev, I.N. Puti preduprezhdeniya pozharov [Fire Prevention Methods]. In: Aktualnye napravleniya nauchnykh issledovanii XXI veka: teoriya i praktika, 2(3-4(8-4)), 2014, pp. 98-102.

[5]   Sosnovchik, Yu.F. Zakonomernost razvitiya nizovykh lesnykh pozharov, metod profilaktiki i predotvrashcheniya nizovogo lesnogo pozhara [Regularity of Development of Creeping Forest Fires, Preventive Methods of Creeping Forest Fires]. In: Vavilovskie chteniya [Vavilov's Readings], Collection of articles of the International Scientific and Practical Conference, Saratov, Saratov State Agrarian University named after N.I. Vavilov, 2017, pp. 259-266.

[6]   Artsybashev, E.S. Planirovanie, organizatsiya i tekhnika borby s lesnymi pozharami [Planning, Organization and Method of Forest Fire Fighting]. Trudy Sankt-Peterburgskogo nauchno-issledovatelskogo instituta lesnogo khozyaistva, 3, 2014, pp. 56-62.

[7]   Nabatov, N.M. Lesovodstvo: ucheb. posobie [Forestry: Textbook], 2nd ed., revised and extended. Moscow: MSFU, 2002, 192 p.

[8]   12Zhengbing, H, Gnatyuk, S., Koval, O., Gnatyuk, V. and Bondarovets S.,"Anomaly Detection System in Secure Cloud Computing Environment". International Journal of Computer Network and Information Security (IJCNIS), 9(4), 2017, pp.10-21.

[9]   Melekhov, I.S. Lesnaya pirologiya: ucheb. posobie [Forest Pyrology: Textbook]. Moscow: MSFU, 2007, 296 p.

[10]   Nikonov, M.V. Gorimost novgorodskikh lesov i meropriyatiya po povysheniyu ikh ustoichivosti k lesnym pozharam [Fire Frequency of Novgorod Forests and Measures for Improving Their Resistance to Forest Fires]. Bezopasnost zhiznedeyatelnosti, 51, 2013, pp. 16-20.

[11]   Thai, L.H., Hai, T.S. and Thuy N.T. Image Classification using Support Vector Machine and Artificial Neural Network. International Journal of Information Technology and Computer Science (IJITCS), 4(5), 2012, pp.32-38.

[12]   Be Minh Chau Department of Forest Service – Legal Documents of Forest Fire Prevention. Hanoi: Agricultural Publishing House, 2000, 250 p.

[13]   Pham Ngoc Hung Forest Fires Management in Vietnam. Nghe An: INA, 2004, 231 p.

[14]   Bodyanskiy, Y.V., Tyshchenko, O.K. and Deineko A.O. An Evolving Neuro-Fuzzy System with Online Learning/Self-learning. International Journal of Modern Education and Computer Science (IJMECS), 7(2), 2014, pp. 1-7.