Improving of operating efficiency of fire brigades during the suppression of peat fires by introducing a unit for bioactivating drinking water into a water supply concept (an example of Tver region)

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Abstract. The article is devoted to an option to improve the concept designed for the water supply of fire departments during the suppression of peat fires (for example, Tver region) by adding to it a block of bio-energy activation of drinking water. The article deals with a review of the subject area were carried out in order to justify the relevance of the development and statistics on peat fires in the region for the last 5 years. The authors showed the methods of reagent-free water treatment and their comparative analysis. The article gives a detailed analysis of the theoretical basis for the further improvement of the water supply scheme.

1. The problem of developed peatlands
Emergency situations caused by earthquakes, floods, mudflows, hurricanes, and forest fires pose the greatest danger in the natural sphere. Peat gained notoriety due to underground fires [1], [2] [3], [4], known to mankind for thousands of years. Such fires can hardly be extinguished and pose a great danger [5].

Peat fires most often occur in places of peat extraction, usually occurring due to improper handling of fire, from lightning discharges or spontaneous combustion [6].

The main problem of the elimination of massive forest and peat fires often consists of several factors - the inaccessibility of the quenching areas [7], their remoteness from water sources, the irrationality or the inability to attract vehicles to deliver water. While the need for it to carry out fire activities can reach several thousand tons per day [8], [9].

The share of peat reserves located in the Tver region is 2 billion tons (with a moisture content of 40% [10], [11]), which is 43.5% of all the peat reserves in the Central Economic Region [12]. The territory of peat bogs occupies about 500 thousand hectares, which is 10% of the area of the region [13]. There are 3 main peat enterprises CJSC Tvertorf, OJSC Vasilyevskiy mokh , CJSC Seliger-Holding.
The greatest fire hazard is developed and abandoned peat deposits [14], [15], for example, OrshinskyMokh, where, according to the head of Greenpeace Russia forest program, in summer 2014, the largest peat fire was observed in Russia, deposits of more than two meters thick were burning.

Total there are in the Tver region about 16.7 thousand hectares of peatlands are developed (81 developed and 3 flooded peat deposits). These territories were freed up after intensive industrial use of natural resources [16], as a result of which the bottom layer of peat remains insignificant in thickness (the average thickness is 0.3-0.5 m).

2. Statistics on peat fires 2014-2017 years

Statistics on peat fires in the Tver region over the past 5 years is showed in table 1.

| Year | Number of fireplaces | Fire area, ha | First fireplace (date) | Last fireplace (date) |
|------|-----------------------|---------------|-------------------------|-----------------------|
| 2014 | 12                    | 3227.45       | 20 April                | 17 August             |
| 2015 | 43                    | 0.64          | 16 February             | 19 May                |
| 2016 | 9                     | 1.3           | 21 April                | 3 June                |
| 2017 | 2                     | 0.002         | 4 May                   | 6 June                |
| 2018 | 20                    | 20.115        | 5 May                   | 15 September          |
| Total| 86                    | 3249.507      |                         | –                     |

3. Projects to solve the problem of peat fires in the region

3.1 Prohibition on uncontrolled grass burning

Figure 1 clearly shows the difference in the number of thermal points found in the region. A comparison of mean annual values for 2002-2015 is showed (before the banning of grass burning), for 2016, for spring 2017. The graph is based on data from Greenpeace Russia.

![Figure 1. Comparison of the number of thermal points in the Tver region in different time periods.](image)

It has been established that the cause for the occurrence of peat fires to a certain extent is the uncontrolled burning of dry grass. In late spring of 2017, when the first wave of fires for many regions of Russia ended, Greenpeace Russia, analyzing the results of spring, found a positive trend in the problem of peat fires in the Tver region.

In 2013, the Government of Russia was ordered by the President to impose a ban on the uncontrolled burning of grass. The ban was finally adopted in 2015.
Thus, in the region, a record decrease was achieved in the number and area of fires in the spring period and against the background of mean multiyear values and against the background of a prosperous 2016 year. As a result of successful struggle with spring burning, the total number of fires has significantly decreased.

3.2 Restoration of peat bogs in Russia
As mentioned earlier, the greatest fire danger in the forest fund of the Tver region are peat deposits, developed and previously drained. They are located on lands of various categories (forestry, agricultural, stock, industry).

To solve this problem, Tver region since 2014 has been actively involved in the Russian-German project “Restoration of peat bogs in Russia”.

In 2014, Mokhovoye-II peat deposit (1.5 thousand hectares) was irrigated, in 2015, the Ozeretsko-Neplyuevskoye (900 hectares) in the Konakovsky district of Tver region and part of OrshinskyMokh deposit (1.2 thousand hectares) in Kalininsky district of Tver region.

In 2015, at the expense of the regional budget, work was carried out to water a part of the developed VasilyevskyMokh peat deposit (1,157 ha) in Kalininsky district. An analysis of the fires in 2014 showed that the largest fires were recorded at OrshinskyMokh peat deposit. The total area of this field is more than 67 thousand hectares, much of which (about 16 thousand hectares) was previously drained and developed. The watering of OrshinskyMokh deposit was started in 2015, the area of 1,200 ha was flooded. In the first half of 2016, work was continued; the 2nd section of the field was watered on an area of 1,050 hectares.

At the time of the release of data on the project, the website of the Federal Forestry Agency (August 2016) was negotiating with the coordinators of the Russian-German project on the implementation in 2016-2017 of a pilot project for irrigation of the 3rd section of the field.

4. Development of water supply concept
One of the main problems of eliminating massive forest and peat fires is often the inefficiency or the inability to attract vehicles to deliver water. In this case, water is meant both for extinguishing the fire center itself and for the food and household needs of rescue units operating in the emergency zone [17]. And, despite all the measures taken to solve this problem in the Tver region, it remains relevant due to the large number of peat deposits developed.

Thus, the relevance of developing the concept of water supply to rescue units in extinguishing peat fires was proved by the example of the Tver Region. and the circuit was designed (figure 2).

![Figure 2. Diagram of the water supply of fire brigades during extinguishing peat fires.](image)

5. Biologically active water. Subject domain overview
During the preparation of the materials and the review of the subject area, it was found out that poor-quality drinking water occupies a leading position in the pandemic of the metabolic caused morbidity
of the planet and it was decided to study the issue of non-reagent water treatment more deeply, because the mass use of water-preparation technologies leads to the fact that water becomes pure, but biologically inert or even unsafe [18], [19].

The definition of “biologically active water” takes into account the electrophysical properties of drinking water that affect cellular metabolism: biologically active water is electrically non-equilibrium water with metastable associates of anion-radical forms of oxygen as carriers of electrons, the breakdown of which provides the flow of electrons to the cellular receptors of a living organism and maintenance in cells and organ structures of electrical nonequilibrium, necessary for the stable functioning of macroscopic quantum oscillator phase associated water control cellular processes.

This basic concept serves as a methodological basis for the biological activation of water, the activation of the vital energy of living beings and man, the formation of an electrophysically favorable environment for humans, animals and plants, and the prevention and treatment of metabolic diseases [20].

Studies show that the use of drinking water, which has reducing electron-donor properties, has a compensatory effect on the negative impact of physical environmental factors on human health. In this regard, a number of technologies for the physical activation of drinking water have been developed, such as the conditioning of drinking water with mechanochemically activated calcium micelle, membrane electrochemical activation, water activation in hypomagnetic conditions, the use of various phase modulating microadditives in drinking water. However, many of these technologies have disadvantages, of which the most important is the low integrity of the reducing properties of drinking water, due to the relatively high relaxation rates of the metastable state of water.

In recent years, in the practice of water treatment, increasing attention is paid to the production of drinking water, the biological activity of which depends on the content of hydrogen isotopes. Hydrogen isotopes, whose concentration in the biosphere has increased significantly, make an important contribution to the problem of the biological activity of drinking water.

6. Conclusion
The article substantiates the relevance of improving the concept of water supply for fire departments when extinguishing peat fires by introducing into it a bioactivation unit for drinking water. In the process of writing, the main problem of the elimination of peat fires was formulated, statistics on peat fires in the Tver region for the last 5 years is given, methods of non-reagent water treatment are considered and their comparative analysis is conducted. The authors defined the basis for further improvement of the water supply scheme, which is determined by the subject of future research.

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