Reduction of the recovery period of marsh ecosystem through the use of new mining technologies

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Abstract. The article touches upon the issue of restoring wetland ecosystems after the industrial extraction of peat. The analysis of the processes occurring in the swamp reclamation, and the ways of development of peat deposits technologies that reduce ecosystem restoration period after production.

1. Introduction

According to the International Peat Society (IPS, 1995) of peat resources in the world amount to more than 400 million hectares, of which only a little more than 305 million hectares is under construction.

Peat fuel for agriculture has long been mined in 23 countries. The largest peat reserves are concentrated in two countries: Russia - 150 million hectares and Canada - 111 million hectares. Over the years, the development of the peat industry in different countries have developed several areas of use of peat and peat products [1,19], the continuous exploitation of peat deposits has not been in vain for wetland ecosystems, and the extent of the negative impact is determined primarily by way of the development of peat deposits.

In the world there are several ways of peat mining, the main ones: milling method of production, they produce up to 95% peat, hydraulic method, excavating method [2,3,4,5,6,7]. Let us consider them in terms of impact on the ecosystem of the bolt.

Milling method for the extraction of peat layers surface [6]. In this case, the peat in the form of small crumbs going to the surface prepared for the exploitation of peat deposits. With this method, there is a maximum drainage of the peat deposits by removing most of the water drainage network is adversely increases the period of recovery after ecosystem production [17,20].

The hydraulic method of peat production, invented by Russian engineer R. Klasson, based on the use of high-pressure water jet (1.0-1.5 MPa) for the erosion of the peat deposit and turn it into a fluid hydro mass, then transported in pipelines over long distances [6,8, 22]. Technological process of sod peat by the method of hydraulic extraction consists of three stages: hydro mass production (erosion of deposits and excavation); transport and flood hydro mass on drying fields; drying and harvesting sod peat [21, 23]. Currently not applicable due to the low profitability of production, in the process of mining has contaminated nearby water bodies suspended solids after extraction of peat in this way remains a large number of pits filled with water in Figure 1.
Figure 1. Space image, abandoned fields developed by hydraulic method (shown in black water flooded career)

A third way to a career is a method of extraction technology includes four basic operations: excavation of peat from the quarry across the depth of the deposit, drying peat sometimes turning it, carrying out operations, cleaning of finished products in the stacks [15]. In this process, the period of recovery bog ecosystem is the smallest, so the development of new production technology, we adhere to this method of development [9].

2. Description of the suggested technology
In the course of the scientific research carried out field experimental research as the object of the preliminary (evaluation) studies were selected peat deposits Sakkala, Priozersk district of Leningrad region, where the currently works on peat extraction were stopped.

It was found that the development of deposits excavation method involves running peatlands that have a positive impact on the local carbon footprint.

According to a comprehensive field research, peatlands with high groundwater levels are characterized by the emission of methane exceeds the amount of the absorbed carbon dioxide.

As it is known, the greenhouse potential of methane exceeds the capacity of carbon dioxide is 23 times.

Therefore, excavation of peat in the fields with low emissions of methane leads to almost total reduction of greenhouse gas emissions.

Peat deposits after peat excavation to the full depth can be quickly and easily restored as a functioning wetland. Excavation natural peat permit a progressive recovery in production areas so that only a relatively small area of peatland affected at certain times. This minimizes dust problems and by carefully monitoring the hydrological and water management will reduce the negative effects on the local water system [18].

Monitoring of air quality has confirmed that in their natural bedding peat deposits are sinks of CO₂ at high methane emissions. After peat extraction and recovery, new wetlands are carbon consumers due to more actively recovering surface vegetation. The process of extraction or recovery leads to a reduction of greenhouse gas emissions.
As it is shown in Figure 2, before peat excavation - CH$_4$ emission more than 10 times greater than absorbed CO$_2$. After extraction - CO$_2$ absorbed 10 times greater than the emission of CH$_4$.

Excavator method allows virtually year-round production of various products based on peat (9-10 months of production and processing, 1 month - preventive maintenance and repairs, 1 month - a break for vacation). This reduces the overall cost and increases production efficiency.

3. Results & Discussion
The advantages of the new production of peat fuel are the following:
- Reduction of environmental impacts (dust emissions, noise and water impacts, reduction of greenhouse gas emissions);
- Expansion of the production season;
- Optimal use of weather conditions;
- Production efficiency is 20 times higher than the current production;
- Increasing the number of exploitable peat resources;
- Rapid recovery of production space absorbing carbon.

Our group of authors proposed the introduction in Russia, based on GIS technology and satellite positioning data, aimed at complete removal of peat from the field, which will reduce the human impact on the ecosystem of the bogs and lead to the speedy restoration of peatland [10,11].

Rewetting drained peatlands leads to an increase in groundwater levels, which reduces the rate of peat mineralization. However, rewetting does not always immediately lead to a reduction in greenhouse gas emission [16]. Rewetting fens often leads to increased release of methane (CH$_4$), whereas when the discharge of carbon dioxide (CO$_2$) can be high. Water level fluctuations can cause a significant increase in the release of nitrous oxide (N$_2$O).

Due to limited experience rewetting, long-term changes in the information available. Available data show that the natural function of the peat bog as an absorber of CO$_2$, recovered quickly enough. At the same time, this process can be accompanied by sufficiently high separation of methane [12].

We can distinguish three periods after rewetting with different characteristics:
1. High allocation of CH$_4$ is accompanied by a high absorption (accumulation) of CO$_2$. This primary phase has an extremely negative impact on the climate.
2. Isolation CH$_4$ sharply reduced, while maximally absorbed CO$_2$. This period has several positive climate effects.

3. Poor selection of CH$_4$ and CO$_2$ absorption is weak, similar to the situation on the pristine bogs. This phase has a neutral impact on the climate.

Although drained bog (zero phase), the global warming potential is determined in addition to CO$_2$, and the presence of N$_2$O, CH$_4$ and CO$_2$ effects dominates in all types of bogs after rewetting. In phase 1 is still no clear distinction between the types of wetlands, but they are noticeably smoothed in the second phase.

Rewetting of degraded peatlands has significant benefits in any scenario. Even on the most pessimistic scenario three, rewetting will avoid greenhouse gas emissions in an amount equivalent to more than 30 million tons for hundred years [13].

4. Conclusion

Despite the fact that the qualitative changes in the dynamics of greenhouse gases from rewetting obvious need for further research in the field of long-term quantitative forecasts. This is due to the fact that peat swamp is relatively recent and long-term studies are not available. To determine the most effective methods of rewetting need comprehensive long-term study of greenhouse gas balance of peatlands.

Restrictions primary methane emissions can be achieved in the following way:
- Removing young decaying plant to water logging;
- Optimization of the water level (not deep-water logging);
- Artificial revegetation;
- Prevent the proliferation of vegetation, which decomposition results in the release of methane [14].

Whatever it is, despite all the difficulties, it is clear that the restoration of the bogs is the work carried out by trial and error, and we are only at the beginning.

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