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# RESEARCH AND RENOVATION OF PEAT BOGS IN THE CENTER OF RUSSIA AND THE BELARUSIAN POLESIE

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**Abstract**

Under conditions of aridization in humid zone of Russia and Belarus there is a practical need to restore part of previously drained marsh landscapes for the ecological sustainability of the territory and the restoration of biotopes, improving fire safety and reducing greenhouse gas emissions. Rational nature management in peat bogs should be based on a scientific approach, with an assessment of the dynamics of modern natural processes in peat bog systems, both in their natural state and under anthropogenic impact. It is necessary to consider the totality of all wetland complexes used for various purposes and unused. In order to carry out works on reclamation arrangement of bogs and their use in agricultural production, it is necessary to develop rational methods for assessing the safety of peat soil and its durability. The article presents theoretical aspects of protection and rational use of peat bogs based on their ecological restoration. The issue of restoration of depleted peat bogs and scientifically substantiated prospects for studying peat bogs in national economic and ecological aspects in modern conditions are also considered. The rational use of peat bogs should be based on the type of water supply of the bogs, determining the nature of the peat deposit, types and methods of nature conservation and reclamation measures. The water regime is determined by the conditions of surface and groundwater runoff of watershed landscapes. In this regard, the direction of their use in industrial, agricultural and nature conservation areas is determined.

**Keywords:** peat bogs, reclamation, rational use, nature protection measures, renovation.

## ИССЛЕДОВАНИЯ И РЕНОВАЦИЯ ТОРФЯНЫХ БОЛОТ ЦЕНТРА РОССИИ И БЕЛОРУССКОГО ПОЛЕСЬЯ

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**Реферат**

В условиях аридизации гумидной зоны России и Беларуси возникает практическая необходимость восстановления части ранее осушенных болотных ландшафтов для обеспечения экологической устойчивости территории и восстановления биотопов, повышения пожарной безопасности и снижения выбросов парниковых газов. Рациональное природопользование на таких территориях должно базироваться на научном подходе, который связан с оценкой динамики современных природных процессов в торфяных болотных системах как в естественном состоянии, так и в условиях антропогенного воздействия. Необходимо рассматривать совокупность всех водно-болотных комплексов, используемых в различных целях, а также неиспользуемых. Для проведения работ по мелиоративному обустройству болот и возможному дальнейшему использованию их для различных целей, в том числе в сельскохозяйственном производстве, необходима разработка рациональных методов оценки сохранности торфяной почвы и ее долговечности. В статье изложены теоретические аспекты охраны и рационального использования торфяных болот на основе их экологической реабилитации. Рассмотрены вопросы восстановления выработанных торфяных болот и научно обоснованные перспективы изучения и использования торфяных болот в различных секторах экономики, с учетом экологических аспектов, в современных условиях, а также с учетом возможной трансформации территории в условиях изменяющегося климата. Рациональное использование торфяных болот должно учитывать тип водного питания болот, определяющем характер торфяной залежи, виды и методы проводимых природоохранных и мелиоративных мероприятий. Водный режим определяется условиями поверхностного и грунтового стока водораздельных ландшафтов, в связи с чем определяется направление их использования в промышленных, сельскохозяйственных и природоохранных целях.

**Ключевые слова:** торфяные болота, мелиорация, рациональное использование, природоохранные мероприятия, восстановление.

### Introduction

Peat bogs are natural formations that play an important role in the Earth's biosphere, preserving large reserves of fresh water and thereby determining the hydrological regime of the territory.

In Belarus, the goals and directions of swamp rehabilitation are regulated by such fundamental documents as the Strategy for the Conservation and Rational (Sustainable) Use of Peatlands [1] and the Scheme for the Distribution of Peatlands by Target Designation for the Period up to 2030 [2]. According to these documents, by 2030 it is planned to restore approximately 75,000 hectares of disturbed peatlands – depleted areas of peat deposits, degraded lands with peat soils, and swamps that have not been effectively drained by forest reclamation.

In the last 10 years with the support of international organizations such as the UN Development Programme (UNDP), Belarus has been restored to a water regime of 60,000 hectares of disturbed and inefficiently drained swamps [3]. There are a number of approaches for the effective rehabilitation of such territories [4–8]. For example, Belarus is testing methods for controlled winter burning of dry vegetation as well as sowing of swamp plants. The ecological rehabilitation of disturbed upper marshes is being successfully implemented through the construction of hydraulic engineering structures (jumpers, dams, locks) in order to control the groundwater level of drained peatlands.

To determine the most effective watering scheme (project) rationally use mathematical (numerical) modeling of the flood processes of drained wetlands during spring floods, which are the main sources of watershed water supply (70–90 % of total discharge) [9, 10].

### Purpose and methodology of the research

The purpose of the work is to provide scientific foundations for the protection and rational use of natural resources of bogs. The methodological basis is a systems approach, analysis, and synthesis of current regulatory documents [11–13], the authors' practices [14–18], and scientific



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research [19–20]. Today the main Belarussion ruls for rehabilitation of disturbed peatlands are seted out in TKP 17.12-02-2008 "Procedure and Rules for Conducting Work on the Environmental Rehabilitation of Depleted Peat Deposits and Other Disturbed Bogs and the Prevention of Disturbances to the Hydrological Regime of Natural Ecosystems During Reclamation Work" [13]. In accordance with the requirements of this regulatory document, a scientific justification for the environmental rehabilitation of the site and an environmental impact assessment are initially conducted, and only then are the necessary design and survey work carried out. This workflow does not allow for a full assessment of the feasibility, appropriateness, and results of the measures. On examples of some projects developed for sites in Russia, the possibility and necessity of using an integrated approach to planning the rehabilitation of depleted peat deposits is demonstrated, based on surveys and modeling of the existing and potential changes to the site's hydrological regime [14, 18].

**Materials and methods**

What is the difference between ecological restoration and traditional recultivation or so-called "flooding" measures as fire prevention measures or recultivation.

The main goal of ecological restoration is to restore the original ecosystem, which will be maintained by natural processes. Methods of ecological restoration are not only the restoration of the ecosystem structure, but also the main processes in ecosystems and ecosystem functions. The result of the work at the initial stage is not the final ecosystem, but the conditions for its formation later. Optimal ecological (abiotic and biotic) parameters must be set, they can then lead to the target ecosystem due to natural processes. In modern practice of nature management in many countries, this direction is often called – "working with nature" or "green engineering".

Methodology of ecological restoration of drained peat bogs is in the Table 1.

A natural ecosystem can be the object of recultivation in the Russian Federation and in the Republic of Belarus, for example, for greenhouse gas emissions. In this case, recultivation can be aimed at implementing climate-efficient solutions. Traditionally, this is planting forests on dry lands. In the case of drained bogs, afforestation leads to an increase in greenhouse gas emissions. The only possible approach in the case of peat bogs is the cultivation of crops on waterlogged lands or dual regulation systems of the hydrological regime. For example, a voluntary carbon market, or an ecosystem services market, or part of a business's social environmental or corporate responsibility program.

Like most projects, ecological restoration projects involve the steps shown in the figure, which are also part of the adaptive management cycle, since the results of the monitoring-based assessment may lead to further project adjustments. The adaptive management cycle has not been fully integrated into domestic nature management practices yet. The main stages of ecological and reclamation restoration of swamps recultivation project ends with an acceptance certificate, and at best, specific recommendations are given for maintaining the site for several years. Adaptive management does not exclude changes to the original project based on the results of monitoring data analysis.

The main stages of ecological restoration of swamps are shown in Figure 1.

Ecological restoration is based on comprehensive information about the current situation in three areas at each stage: information about the state of ecosystems – ecological and biotic parameters; information about the socio-economic situation; information about the legal basis for the implementation of the project.

The Table 2 provides an approximate list of information for each of the three blocks that is required at each stage.

**Table 1** – Methodology of ecological restoration of drained peat bogs

| | Ecological restoration | Recultivation, including climate-efficient technologies | Fire prevention measures |
|---|---|---|---|
| Purpose | Restoration of the natural ecosystem | Creation of an artificial ecosystem with specified economic and ecological characteristics[2] | Creation of conditions for reducing fire risk and/or fire suppression infrastructure |
| Indicators | Complex indicators/parameters of ecological processes or functions of a natural bogs ecosystem | Structural and functional characteristics of agricultural land, forest area or water body | Frequency of fires |
| Maintaining the state of the ecosystem | Mainly due to natural processes | Management during usage | Continuous target management |
| Costs of maintaining sites | No regular costs, limited costs possible when succession scenario changes, or for monitoring if the site is part of a special program that includes regular reporting[3] | The costs are mostly covered by the price of the produced products | High annual costs |
| Principles of technical solutions | The use of natural materials, technical solutions are based on modeling and forecasting of processes to achieve target indicators of abiotic and biotic characteristics | Traditional methods of recultivation to create conditions for the growth of forest or agricultural crops, including fish farming, functioning of a water body | Construction work on the creation of dual control systems, fire reservoirs and roads, creation of an artificial ecosystem |

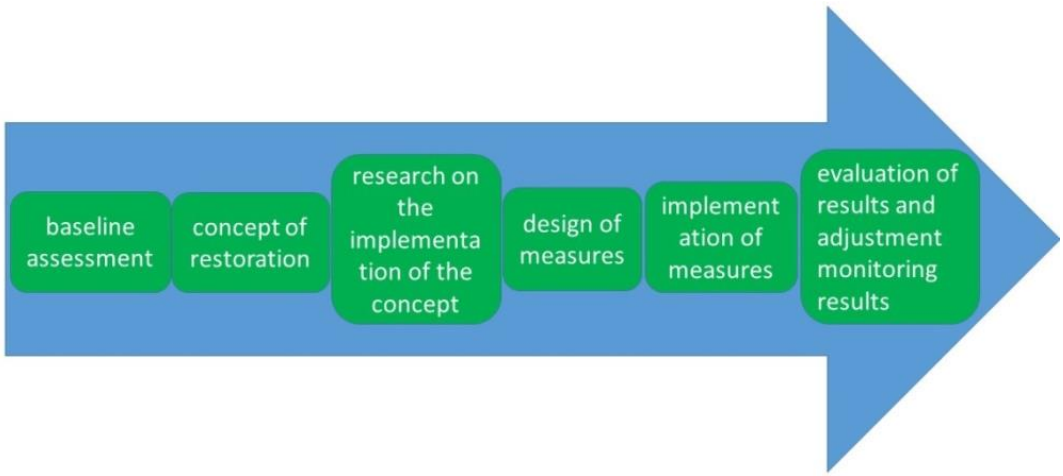


**Figure 1** – The main stages of ecological restoration of swamps

**Table 2** – Information for the stages of wetland restoration

| Stages of work/result | Tasks and content of stages | | |
|---|---|---|---|
| | Ecological block | Social and economic block | Legal block |
| Baseline Study / Baseline Study Report | Data on the state of abiotic and biotic ecosystem characteristics of the disturbed and background area. Definition of target parameters of the ecosystem<br>Additionally – data on the types of disturbances and their impact on the main characteristics | Estimation of ecosystem service losses in the disturbed area compared to the background one. Therole of the site in the economy and social life. The attitude of different groups to restoration | Information about the lands of the site. Land category, owner, user, nature of the relationship between the user and the owner, existing encumbrances and easements, rules for the use of natural resources based on the land category, encumbrances, easements, conditions of the owner and user |
| Concept (Project Concept) or preproject solutions | Forecasting and modeling processes to achieve ecosystem targets Identifying structural parameters that will facilitate these processes | Forecasting the attitude of the population to various scenarios, the potential of the territory for the socio-economic situation | Checking proposed solutions for compliance with regulations and legislation |
| Engineering survey / Survey report | Identification of conditions for technical implementation of predesign solutions | Study of the possibility of involving the population in the performance of work as volunteer assistance, prevention of counteraction, development of measures to support the conduct of research | Assistance in concluding contracts |
| Design (Development of engineering design)/project (Desing) | Alignment of models and technical solutions. Step-by-step planning and budgeting of works. Writing a project based on the concept and research, including a description of the monitoring scheme | Informing the public about design solutions, public hearings together with events to support design solutions | Checking proposed solutions for compliance with regulations and legislation. Assistance in concluding contracts |
| Project implementation / Work execution protocol and acceptance certificate | Supervision of implementation. Record-keeping | Involving the population in the implementation of the project – planting trees, etc. | Supervision of compliance with standards. Legal basis for further management of the territory<br>Preparation of acceptance and/or transfer acts |
| Monitoring the state of ecosystems | Defining parameters for monitoring, implementing a monitoring scheme | Involvement of the population in monitoring, publication of monitoring data | Legal status of information, degree of openness, authorship, legal possibility of wide distribution |
| Evaluation of project results | Evaluation of the progress of processes and the degree of achievement of target indicators, identification of deviations from processes | Evaluation of the population's attitude to the implemented project | Evaluation of the legality of the measures and grounds for further work |
| Recommendations for project adjustments | If necessary, set new intermediate target parameters | Taking into account the opinions of different population groups | Checking proposed solutions for compliance with regulations and legislation |

**Theoretical research results**

The work on the development of swamps has begun in the 50s of the last century with the aim of using waterlogged lands in agriculture. The following areas have been defined: drainage network parameters have been developed; peat soil drainage modes have been studied; a system of farming on drained peat soil has been developed; peat sedimentation and depletion processes have been studied; the effect of bogs drainage on the adjacent territory has been studied.

The reclamation condition of drained peat lands has significantly worsened due to the lack of proper maintenance of the drainage network and its repair. Work on the reconstruction of drainage systems has also been completely stopped, which has led to the abandonment of previously used peat soil in agricultural production.

The rational use of peat bogs should be based on the type of water supply of the bogs, determining the nature of the peat deposit, types and methods of nature conservation and reclamation measures. The water regime is determined by the conditions of surface and groundwater runoff of watershed landscapes. In this regard, the direction of their use in industrial, agricultural and nature conservation areas is determined. It is necessary to develop: recommendations for the formation and implementation of agroecological monitoring of reclaimed agricultural landscapes; new technical and technological solutions aimed at rational measures to preserve the fertility of residual peat soil; measures for the environmental protection of peat bogs from the intensive production load of their use; hydrological and agro-meliorative measures for the recultivation of exhausted and depleted peat lands or the return of the bog ecosystem to its original state (their restoration).

Restoration of exhausted and depleted bogs of the Meshcherskaya lowland and Belarusian Polesie. Restoration of bogs is carried out in stages. There are the following stages of restoration: **initial situation** (bog after use of peat extraction or in agriculture); **over-watering** (restoration of the hydrological regime – 10 years); **renaturalization** (restoration of natural vegetation – 10–100 years) and **regeneration** (the process of peat accumulation over 100 years).

The process of waterlogging is considered as the primary stage of bogs restoration, which is characterized by an increase in the water level almost at the surface for 3–5 years until it stabilizes.

The second stage (renaturalization) consists of the restoration of the natural bog vegetation cover and is defined as a technically controlled measure, after which the regeneration of the peat bog begins. In general, bog regeneration is understood as a set of natural processes and artificial technical measures that affect the renewal of bog formation and peat accumulation processes.

It should be noted that the regenerated bog develops thanks to special measures much faster than natural development.

The stage of over-wetting is the most critical moment in the restoration of the bog, since the increase in the water level to the surface of the developed peat will increase the level of groundwater in the adjacent territories. In this regard, it is necessary to study the impact of bog flooding on the ecology of the adjacent territories.





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**Conclusion**

It is necessary to conduct a patent search for technologies and technological solutions that can be used in modern conditions, a comprehensive reconnaissance survey of all bogs, their quantity, area, efficiency of use, types of bogs, water-physical and agrochemical properties of peat and mineral adjacent soil, and also to evaluate the work of reclamation systems.

Nature restoration work to return to the environment must be carried out according to specially developed projects, taking into account the recommendations and methodology outlined in this article. This will make it possible to resume peat accumulation and habitat for the animal and plant world of wetlands. This is shown by the existing experience in the center of Russia and the Belarusian Polesie.

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