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## HYDROLOGIC ASPECTS OF DRAINED PEATLAND RENATURALIZATION

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The peatland drainage is one of the main man-made factors of the landscape water circulation and peatland ecosystems degradation. To return former sustainable ecological state of peatland it is necessary to carry out the renaturalization. The essence of renaturalization is renewal of water regime with following renewal of the peatland ecosystem like it was before drainage. Change of water runoff regime is effective mechanism of the peatland renaturalization – so called active protection. To renaturalize the Zalyvky peatland in the Roztochia Natural Reserve it is necessary to keep high groundwater level that will cause renewal of peat forming, stop succession processes, growing up by untypical for peatland plant species, reduce the risk of peat burning. Based on the results of natural conditions and recent ecological state of the Zalyvky peatland analysis the general scheme of renaturalization and hydrologic regime renewal has been worked out. With this aim, the series of measures are realized. They allow increasing the groundwater levels due to coming of water from the river streams and channels, making the runoff slower and renewing small water bodies. Small water bodies like ponds play not only water regulating role but also key ecological role for many bird species, ecological education, and tourist-recreation attractive. It is expected that keeping of higher ground water levels will be assisted by the beavers population with their natural dams.

*Key words:* renaturalization, drainage melioration, peatland, water runoff regulating.

The Roztochia region has been man-made changed in XX-th century. Especially it concerns to the peatlands of high ecological value. For example: a) during 1960–1980 most of the peatlands have been drained and transformed to monoculture grasslands for pasture; b) dense drainage channels network caused rapid decrease of groundwater levels and surface water runoff changes; c) natural lakes and floods have been disappeared; d) hydrological, hydrochemical, hydrobiological parameters of the ecosystems have been changed; e) land use structure of the region has been transformed; f) the area of the peatlands, peatbogs and water bodies has been decreased.

The main factor of water resources and peatlands forming is precipitation within the catchment. And a man has not effective impact upon this factor. At the same time, a man can regulate another component of water balance of the territory – water runoff. The peatlands drainage is one of the main man-made factors of water circle changes within the landscape. So the water runoff regime change is an effective instrument of the peatlands renewal. It is so called active protection of the peatlands. And the main instrument of the runoff change is water regulation.

To restore the former sustainable ecological state of the peatlands it is necessary to carry out the renaturalization process. The process of renaturalization combines the surface and ground water levels renewal, return of the peatbog ecosystems, which exists before the drainage melioration, restoring forage reserve for the water-fowl, decrease of the human impact, nesting,

propagation and migration conditions improving for water-fowl and other animal species, recurrence and reintroduction of the autochthon plant and animal species.

Necessity of the research and renaturalization of drained areas is caused by high level of manmade pressure. Another cause is low level or even lack of drained and secondary swamped lands using as well as the areas covered by untypical plant species. Effective renaturalization of low-productive and ecologically disturbed lands needs special study.

The subject of matter is peatbog Zalyvky located in the natural reserve Roztochia (Yavoriv district, Lviv region). The peatbog is situated on the left bank floodplain of the Vereshchytsia River, to the north of the Yaniv Pond and it is detached from the Vereshchytsia by-pass channel by a ground dike.

Natural ecological state of the Zalyvky peatbog has been disturbed due to drainage melioration impact. Research of the biologists and ecologists allow to conclude that here it is needed and possible to renew the natural vegetation and to carry out reintroduction of the autochthonal species of plants and animals. Start of renaturalization process in the Zalyvky peatbog is substantiated by: not using in agriculture, no satisfied technical state of the drainage network, often peat inflaming during dry summer periods, secondary swamping and succession processes with atypical secondary vegetation, low soil fertility, high peat mineralization and little thickness of peat layer.

The objective is limitation and reduction of negative ecological impact of the drainage channels by hydrological regime regulation. The main goal is slowdown of water runoff, increase of soil water saturation and reswamping. The main tasks were: 1) inspection of drainage system elements technical state and drained areas; 2) working out of the renaturalization scheme for the Zalyvky peatbog; 3) hydrologic and hydrogeological investigations and substantiation of the renaturalization scheme; 4) working out of the measures complex for water level renewal considering the hydrological and hydrogeological regime of the adjoining areas; 5) assessment of the planed measures upon environment.

The work is realized within the International research project "Implementation of nature protective measures for local community adaptation to climate changes in Roztochia (Yavoriv district, Lviv region, Ukraine)" realized by NGO "Public Institute of Nature Protection" in cooperation with the "Roztochia" Natural Reserve and the National Environmental Centre of Ukraine within the frame of the International program "Climate Forum East II" funded by the European Union, the Austrian Development Cooperation and the Austrian Red Cross and WWF coordinated.

State of knowledge. Studying problems of renaturalization and land use on the drained areas testifies about noticeable decrease of bioproducing ability of the soils during last decades. As the main cause of these processes the ineffective using of the drained areas, their podzolization, carbonization, superdrying, peat inflaming, deflation, secondary swamping, succession, depletion of plant species diversity and monoculture domination are called. Most of these areas are used for pasturing [1, 2, 4–6].

Taking into account direct relation between these parameters and level of agricultural use of the drained areas, technical state of the drainage system and agricultural techniques the experts and scientists consider to carry out the renaturalization on the lands where during last years the ecological situation was permanently unsatisfactory [5, 6].

Thereby studying of the present technical and ecological-meliorative state of drainage systems and drained areas with selecting of priority for renaturalization territories is actual

and urgent scientific and practical task. Its solution is impossible without substantiation of the scientific concept of investigations and the methods development of their realization.

On the strategic level it is necessary to develop the program of drained areas inventory, determining of their using effectiveness, ecological-meliorative monitoring and the general scheme of the lands renaturalization [3, 5, 6].

**Geographic conditions.** It is two main reasons for water runoff regulation: its natural irregularity in space and time and manmade disturbance (unbalancing). The seasonal precipitation distribution is presented in the Table.

Average and maximal precipitation sum and average amount of days with precipitation by the months for Yavoriv town (according to the State Committee on Hydrometeorology)

| Month                     | 1  | 2  | 3  | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  |
|---------------------------|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Average precipitation, mm | 35 | 38 | 36 | 45  | 75  | 89  | 92  | 74  | 55  | 42  | 41  | 46  |
| Maximal precipitation, mm | 88 | 98 | 71 | 122 | 148 | 254 | 237 | 172 | 152 | 178 | 113 | 105 |
| Days with precipitation   | 15 | 15 | 14 | 12  | 15  | 15  | 14  | 12  | 12  | 12  | 15  | 17  |

Such distribution of precipitation determines the main features of studied area hydrological regime: a) mixed river alimentation; b) high spring flood and low-water in summer-autumn drought period; c) uneven seasonal runoff distribution with domination in summer-autumn period; d) during low-water years the portion of winter runoff increases (underground alimentation), and during high-water years the portion of spring runoff reaches 40–60 %, winter period – 10–20 %; e) often floods in summer, episodic floods in winter; f) amount of floods reaches 1–5 per year, mean duration is 8–15 days, maximal – 35, water level height is equal 1,2–1,4 m; g) spring floods excess summer floods; ж) unit discharges reach 20 dm<sup>3</sup>/s/km<sup>2</sup> in river headwaters.

According to observations on the gauging stations network the long-term average, mean maximal and mean minimal water runoff parameters for the periods 1965–1987, 1980–2013 and 1963–2013. The analysis shows that average runoff has increased in the upper part of the Vereshchytsia River, and has decreased in the catchments of Svyntia, Rata and Solokia Rivers. Partly it can be explained by drainage systems decay since low-water runoff has increased everywhere.

**Methods of peatland research for renaturalization.** Important precondition for successful realization of peatlands and bogs renaturalization projects is zoning of the meliorated lands by technical, hydrologic-meliorative, ecological states to ascertain practicability of follow exploitation, reconstruction, renovation drainage systems or renewal of natural biogeocoenoses as well as landscape and biological diversity enhancing.

Degradation degree of the drainage systems and practicability of their renovation depends on the time past since their constructing or last reconstruction. So the first criterion of the drainage system degradation degree is amount of idle hydrotechnical constructions and drain collectors without runoff versus to the total amount of these constructions. Execution of this research task gives to us one of the key criteria for assessment of peatland renaturalization possibility.

But it is necessary to note that high rate of the technical degradation does not cause flooding or high groundwater level every time. In other words the drainage system degradation degree evaluated by the technical parameters can inadequately reflect hydrologic-meliorative state of the drained land and inversely. We can differentiate the assessment of drainage system

technical degradation degree based on the idle construction elements and the evaluation of the drained landscape degradation degree based on swamping rate and the time of runoff (so called degree of hydrogeologic-meliorative degradation). In this case the share of swamped and flooded lands is considered as a dominant (priority) feature of degradation. This feature should have straight impact upon water pollution and relatively higher in comparison to drained area amount of carried away pollutants. Thereby the second important research task is evaluation of recent hydrogeologic-meliorative state. Following works include corresponded monitoring system organizing with hydrogeological bore-holes and gauging stations network. Planning and realization of the hydrogeologic-meliorative monitoring can be considered as the third and key task of renaturalization works.

Under drainage impact the row of natural features and elements are noticeable changed: first, hydrographic network, second, regime and balance of natural surface and ground waters, third, seasonal water runoff distribution, chemical composition of ground waters, soil structure, vegetation type etc.

The overall degree of the drainage system obsolescence can be defined with the help of water balance accounting. The tendency of decreasing ground water inflow to the stream network is characteristic for a territory where drainage system obsolescence and disabling are observed. Due to water level increase in the channels and rivers and prolongation of ground waters alimentation the intensive silting, overgrowing and sedimentation in the river beds and channel. These processes delay the water cycle, and make for decreasing of low-water period and ground water outflow, and overall recession of area drainage.

Such analysis based on a water balance accounting and modelling can be considered like central element of the peatlands renaturalization project implementation, as long as it allows to obtain synthesized information and implications concerning the applicability and possibility of the natural hydrological regime and biogeocoenosis renewal.

So the overall value of drained peatlands degradation is carried out by three main criteria: first, ground water level regime and intensity of its increasing, second, duration of surface water run away, unit discharge, third portion of the areas with secondary swamping or irregular runoff distribution.

First criterion is evaluated by direct measurement of ground water level on observation boreholes network. Second one can be ascertained by the following parameters assessment: dates and duration of high water levels in open channel network; content of organic matter and oxygen in water. Third criterion consists of the following features: receipts and expenditure ratio in water balance (method of balance); hydrophytes plants distribution as indirect feature; peatland areas increasing in a catchment basin land structure (remote sensing methods).

These criteria and parameters determination also have to be included into research tasks within the peatlands renaturalization project.

Next phase of such research is assessment of ecological and biological values of the lands, biological and landscape diversity rate, degree of degradation and manmade changes in biogeocoenoses, assessment of the practicability and availability of concrete landscape renaturalization and renewal of it biocoenose.

**Main results and discussion.** For the nature reserve peatbog Zalyvky renaturalization it is necessary to support permanently high water level. High water levels will lead to peat forming renewal, stop succession processes, reduce risk of dry peat and forest flaming.

Based on the results of geographic conditions analysis and recent state of the Zalyvky peatbog the general scheme of it renaturalization and hydrological regime renewal has been elaborated. Relief and hydrographical features of the project area has been analyzed with

the help of geodesic and cartographic methods. The core of worked out scheme is following. In the upper part of Zalyvky peatbog, which is bended by the Stavchanka riverbed and the drainage channels two water inlet pipes are installed. Through these inlet pipes with diameter 400 mm water from the drainage channel and partly from river bed comes into peatbog area. The water is distributed on the peatbog surface by the network of new or cleared all drains. A part of water passes through these drains far into peatbog and other part infiltrates and saturates the peat layer.

Ground water level is scaled up to 0,4 m in average during next few years due to water incoming from the neighboring drainage channels and streams and slowdown water runoff from the peatbog, renewal of local flooding and small water bodies. Water runoff slowdown is reached by construction of small dams across the channels on the peatbog area. Small water bodies play not only important water-detention role but also become ecological nidi for many bird species, are the object for environmental education and tourist-recreation attractions. As it is expected in nearest future high water level and flooding will be supported by natural dams built by beavers. The population of this typical for the region specie increases recently in the Roztochia Natural Reserve.

#### Conclusions

1. Drained lands zoning by technical, hydrological-meliorative and ecological states with the aim to ascertain applicability of further exploitation, reconstruction of drainage systems, renewal of natural biogeocoenoses, and protection of soils, peatlands and water resources is important precondition for successful renaturalization project realization.
2. Overall value of drained peatlands degradation degree can be worked out by three main criteria: ground water level and intensity of its increasing, duration of surface water run away and unit discharge, subsurface runoff, and portion of the areas with secondary swamping or irregularity of water runoff distribution.
3. Realization of the project will assist to stabilize the ecological situation, to raise bioproductivity of the drained lands, and to reduce fire risk. Renaturalized peatlands will play role of "safety corridor" and "natural areas" within the agrolandscapes that will promote migration of animals and birds of passage. Thereto successful renaturalization of the peatbogs gives outlooks to lay out the education-cognitive routs with appropriate infrastructure, scientific research program extension and local environmental monitoring system widening.
4. Renaturalized peatlands can be used in economic activities for energetic willow, osier, herbs cultivation, berry, fir, quick-growing wood plantations etc.

#### REFERENCES

1. Konishchuk, V. (Ed.). (2014). *Ecology of wetlands and peatbogs*. Kyiv: Scientific-manufacturing company "Interservice", 300 pp. (in Ukrainian).
2. Kovalchuk, I. (Ed.). (2009). *Environmental monitoring of the region: expert judgement of state and functioning*. Lviv: Scientific-publishing centre "Opillia-L", 608 pp. (in Ukrainian).
3. Marushevskiy, H., & Zharuk, I. (Eds.). (2006). *Wetlands of Ukraine*. Kyiv: Black Sea Program Wetlands International, 312 pp. (in Ukrainian).
4. Maslov, B., & Minaev, I. (1985). *Melioration and nature protection*. Moscow, Rosselkhozizdat, 271 pp. (in Russian).
5. Shvorak, A. (2010). Renaturalization of ineffective for agriculture lands. In: *Bulletin of the Lesia Ukrainka Volyn National University. Series Physical Geography*, 15, 32–35 (in Ukrainian).

6. Tsarenko, P. (Ed.). (1999). *Ways of the peatbogs reclamation and protection of Ukraine*. Kyiv: Techprint, 72 pp. (in Ukrainian).

#### СПИСОК ВИКОРИСТАНОЇ ЛІТЕРАТУРИ

1. Екологія водно-болотних угідь і торфовищ: зб. наук. праць / за ред. В. Коніщука. К. : Інтерсервіс, 2014. 300 с.
2. Екологічний моніторинг регіону: експертна оцінка стану функціонування / за ред. І. Ковальчука. Львів : ГО "Опілля-Л", 2009. 608 с.
3. Водно-болотні угіддя України / ред. Г. Марушевський, І. Жарук. К. : Чорноморська програма Ветландс Інтернешнл, 2006. 312 с.
4. Маслов Б., Минаев И. Мелиорация и охрана природы. М. : Россельхозиздат, 1985. 271 с.
5. Шворак А. М. Ренатуралізація земель, не ефективних для господарського використання // Науковий вісник ВНУ ім. Лесі Українки. Луцьк, 2010. № 15. С. 32–35.
6. Шляхи покращання збереження торфових та інших боліт України: Матеріали навчання в Україні, 28–29 квіт. 1999 р., м. Київ / ред. П. Царенко. К. : Техпринт, 1999. 72 с.

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#### ГІДРОЛОГІЧНІ АСПЕКТИ РЕНАТУРАЛІЗАЦІЇ ОСУШЕНИХ ТОРФОВИХ БОЛІТ

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Осушення торфовищ, заболочених угідь – один з головних антропогенних чинників змін обігу води у ландшафтах і деградації болотних екосистем. Для повернення колишнього збалансованого екологічного стану болотам необхідно застосовувати ренатуралізацію, суть якої полягає у відновленні водного режиму з подальшим відновленням водно-болотної екосистеми, яка існувала до осушення. Зміни режиму стоку води є ефективним механізмом ренатуралізації боліт – це так звана активна охорона. Для ренатуралізації заповідного торфового болота Заливки в природному заповіднику Розточчя необхідне постійне підтримування високих рівнів ґрунтових вод, яке зумовить відновлення торфоутворення, припинить процеси сукцесії, заростання відкритих торфових боліт і цінних природно заболочених луків нетиповою рослинністю, знизить ризик займання торфовищ. На підставі досліджень природних особливостей та аналізу сучасного стану болотного угіддя Заливки визначено загальну схему його ренатуралізації, і відновлення гідрологічного режиму зокрема. З цією метою вживають низку заходів для поступового підвищення рівня ґрунтових вод унаслідок надходження води з місцевими водотоками, струмками і каналами та сповільнення й обмеження стоку з території болота, відновлення малих водойм, які виконують не лише водозатримувальну функцію, а й відіграють визначну екологічну роль для багатьох видів птахів, для екологічної освіти, є туристично-відпочинковими принадами. У майбутньому очікується підтримання ефекту обводнення природними загатками бобрів, популяція яких відновлюється в заповіднику.

*Ключові слова:* ренатуралізація, осушувальна меліорація, торфові болота, регулювання водного режиму.