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Sustainable Management of Peat Extraction Fields

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***Abstract*—Peatland self-recovery after peat extraction is restricted and without any purposeful actions, recovery of the territories is disproportionately long. The abandoned peat fields are not only worthless from the point of view of biodiversity but are also large SEG issuers.**

By developing an inventory of extracted peat fields, it has been concluded that there are about 18,000 ha that are not re-cultivated and for now have lost their natural functions. The peat formation in these areas and ecosystems functions are disturbed or destroyed.

There are a number of potential ways of re-cultivation of degraded peatlands that can provide different types of benefits – either to carry out economic activities or to re-naturalise territories. Each of the potential types of re-cultivation is able to deliver different types of benefits. Landowners should select the most appropriate and acceptable option for re-cultivation based on socio-economic, environmental and climate change mitigation criteria.

Based on the research and the results obtained, a model for the sustainable use of peat extraction fields has been developed, that provides support for the planning of further use of degraded peatlands. The developed model provides information about financial, economic and environmental benefits of implementing a particular form of re-cultivation. Developed model ensures the optimal information balance between GHG emission reductions, ecosystem service assessments and socio-economic aspects of land use.

Based on the findings and using the developed model, it is possible to implement deliberative management decisions regarding degraded peatlands, evaluate potential re-cultivation costs, plan the expected financial return, assess the benefits of climate mitigation and take into account natural values.

Keywords*— *Sustainable management, recultivation, abandoned peat fields.

I. Introduction

Peatlands provide a wide range of ecosystem services. Most important role of peatlands is to ensure climate regulation and water circulation functions [1]. At the same time peatland ecosystems are globally valuable in terms of biodiversity, as well as economic importance of the areas varies with respect to the potential options of economic activities to be carried out within [2], [3].

In Latvia peat has been extracted since the end of the 17th century [4]. In 2015, 1.3 million tons of peat were extracted, 95% of which was exported to West Europe to ensure the supply for the needs of gardeners [5]. Peat is one of the major Latvian export products [6]. In 2016, peat exports accounted for 1.4% of Latvia's total exports. Based on information of Latvian Peat Association, the amount of peat extraction in Latvia accounts for almost one third of the amount of peat used in professional gardening in the European Union countries. Peat substrate produced in Latvia has been exported to more than 100 countries, including China, Japan and Australia [5].

On the one hand, peat resources obtained from mires, provide significant economic benefits [7], but at the same time, by changing the hydrological regime and removing natural vegetation during peat extraction, the area is no longer able to deliver the ecosystem services provided by natural bog areas [8].

In Latvia, the Regulations No 570 of the Cabinet of Ministers on the procedures of mineral resources obtainment determine the procedures for the extraction of the peat resources, as well as the procedures for re-cultivation of the territory after the extraction of peat [9].

As the degraded peatlands can be source of GHG emissions, as well as the CO2 sequestration function is limited, the management of these areas is essential for reduction of GHG emissions in long term [10].

Sustainable management of extracted peatlands has to focus on synergies between environmental and climate actions, by integrating the climate, environmental and biodiversity objectives into the responsible and sustainable management and re-use of degraded peatlands [11].

Sustainable land use management should contribute to the transition towards a low emission and climate-resilient economy, society and integration of climate objectives into the public and private sector. The multiple risks posed by climate change, according to the GEO 2012 and IPCC (2013) [12] include the conclusion that wetlands and peatlands are seriously disrupted ecosystems causing significant GHG emissions in most major drainage basins. Moreover, forests – a major carbon storage system, are being over-harvested, threatening both the global climate and local well-being and leading to loss of biodiversity [13]. Testing and implementing of innovative approaches to climate change mitigation will be one essential aspect for making the shift towards sustainable land use management.

II. Methods

Sustainable management of degraded peatlands has to be based on thoughtful use of territories and long-term decisions. Activities related to the land-use management can be divided into two categories: (1) to gain economic benefit and (2) to restore natural functions of mires or to transform territories into other natural areas.

The first group includes such re-cultivation actions

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as (1) berry cultivation, (2) tree planting with the aim to get wood for energy purposes, (3) agriculture and (4) grassland cultivation.

The second group includes the creation of natural areas – (1) bog re-naturalisation, (2) afforestation (3) creation of water bodies.

Each of the above-mentioned peatland re-cultivation scenarios provide different types of benefits – financial profit from economic activity, diversified ecosystem services, GHG emission reduction.

By comparing and evaluating the re-cultivation options, it is possible to make sustainable and well-considered decisions from the above-mentioned perspectives and to support the process of planning for the further use of degraded peatlands.

The information gathered within the framework of LIFE programme project "LIFE REstore – Sustainable and responsible management and re-use of degraded peatlands in Latvia" (hereinafter referred to as LIFE REstore), has been summarised in one single model that reflects the financial, economic and environmental benefits of implementation of a particular re-cultivation scenario.

The model calculation algorithm ensures a linear correlation between the size of the areas to be re-cultivated and the financial and economic indicators of the re-cultivation of these areas.

The precision of model output data is determined by the correctness of the assumptions made by the model user and the data entered, such as the field geological exploration, costs of re-cultivation, planned yield, etc. used in the calculations. The economic values of ecosystem services and data of carbon dioxide reduction of re-cultivation scenarios that has been included in model has been based on research data obtained within the LIFE REstore project. Data reflecting the required investments and potential revenues are based on information of the Latvian Rural Advisory and Training Centre.

Inventory of the area affected by peat extraction that has been carried out within the LIFE REstore project shows that there are about 18,000 ha of degraded peatlands in the territory of Latvia that has to be re-cultivated [14].

However, the preconditions for implementing each type of re-cultivation are different. By implementing one of the territory management plans, it is necessary to evaluate the criteria characterising the territory. These criteria determine both which one of the re-cultivating scenarios can be implemented and what amount of investment is necessary to implement the particular re-cultivation scenario.

By using inventory data collected within the LIFE REstore project and the developed optimisation model, the possible re-cultivation scenarios for the degraded territories were modelled and evaluated based on the potential of the environment, climate mitigation and socio-economic benefits.

The most important methodological limitation is related with the precision of geological and necessary investment data. When analysing and reviewing the summarised information described below, it is important to take into account that the data reflects general information and serves only as a tangible comparison of the scenarios.

III. Results and discussion

By using the developed model and by modelling possible re-cultivation scenarios for the degraded peatlands in Latvia, it has been concluded that in most cases it is possible to re-naturalise the territories (Figure 1). It can be explained by the fact that this type of re-cultivation has the least restrictive criterion. This re-cultivation scenario has only two limiting criteria – the remaining peat layer must be at least 0.3 meters of thickness and the area cannot be flooded for more than 90 days a year. As a result, re-naturalisation could be implemented in approximately 96% of 18 000 ha of the degraded peatlands.

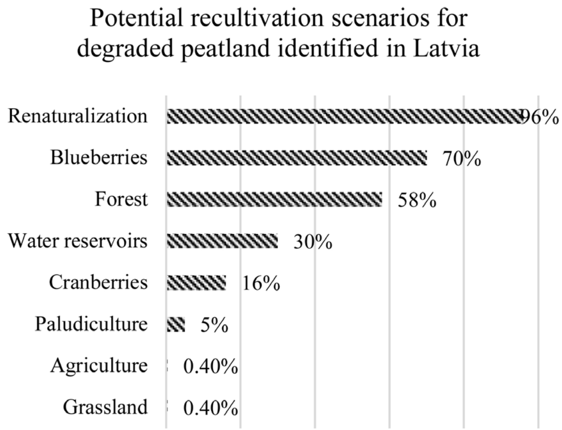

Fig.1. Potential re-cultivation scenarios for degraded peatland identified in Latvia

At the same time, model data confirm the assumption that peat extraction sites are less suitable for agricultural activities and for the cultivation of permanent grasslands. The abovementioned re-cultivation scenarios are possible only at 0.4% (each of the types of re-cultivation) of all degraded peatland territories.

It is interesting to note that although the cultivation of blueberries and cranberries can be classified as one type of re-cultivation – berry growing, the implementation possibilities for these berries in peatlands are very different. As can be seen in Fig.1, blueberry cultivation is possible in 70% of degraded peatlands, while cranberry cultivation is an option only available in 17% of degraded peatland areas. Also, more than half of the degraded peatlands can be afforested.

Socio-economic benefits

Investments are needed for the site re-cultivation and for each scenario the amount of investment is different. The average investment required to implement the particular re-cultivation scenarios is visualised at Fig. 2. In the calculation, it is assumed that the area to be re-cultivated is 10 ha and that all the preparation activities of the area mentioned in the model (such as the construction of the drainage system, removal of vegetation, etc.) are necessary.

As can be seen in Fig. 2, blueberry and cranberry cultivation require significantly higher investments than other scenarios. Mostly this is due to the purchase of planting material, planting and installation of the irrigation system.

For such re-cultivation scenarios as arable land development, paludiculture cultivation, re-naturalisation, permanent grassland creation and establishment of water reservoirs, investment costs are significantly lower than for berry plantations.

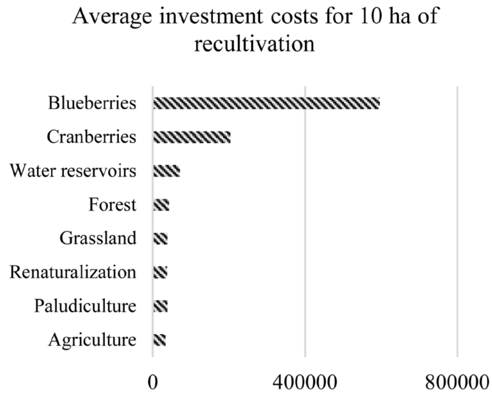

Fig.2. Average investment costs for 10 ha of re-cultivation

Fig. 3 shows the potential production revenue modelled on a 10-ha area over a 10-year period. As can be seen from the Fig. 3, the highest potential revenue is expected from blueberry cultivation and cranberry cultivation. It is natural that revenues are not expected from the establishment of water reservoirs and re-naturalisation, as these re-cultivation scenarios do not profit in the nearest 10 neither 50 years. In the long term, as a result of re-naturalisation, it can be expected that formation of peat will be started in the re-naturalised mire, but calculation of such revenue is not foreseen within the developed model.

Afforestation of degraded peatland is not profitable in the nearest 10 years. This can be explained by the fact that for the calculation of afforestation scenarios the birch was chosen, which in 10-year period does not provide the necessary amount of wood.

By comparing potential production revenue and investment in re-cultivation, it can be concluded that blueberry cultivation is the only form of re-cultivation that pays off over a 10-year period.

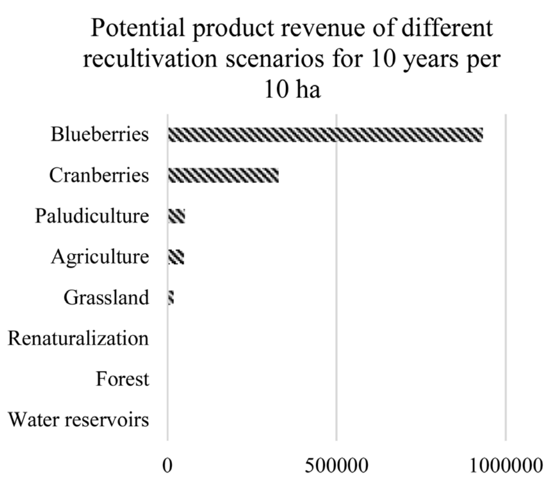

Fig. 3. Potential product revenue of different re-cultivation scenarios for 10 years per 10 ha

However, it has to be taken into account that the re-cultivation of degraded peatlands is necessary not only to bring economic benefits but also to benefit the whole society.

Climate mitigation benefits

Benefits for society through degraded peatland re-cultivation by landowners are the reduction of carbon and the conservation/restoration of biological values, which are modelled from the point of view of ecosystem services provided.

Fig. 4 illustrates the reduction of CO_2 emissions from different re-cultivation scenarios. As shown in Fig. 4, the most valuable form of re-cultivation providing the greatest public benefit in terms of CO_2 reduction, is afforestation. At the same time, two less efficient options for degraded peat re-cultivation are the establishment of permanent grasslands and the creation of arable land that does not provide reduction of CO_2 emissions. Other re-cultivation scenarios provide very similar effects of CO_2 reduction.

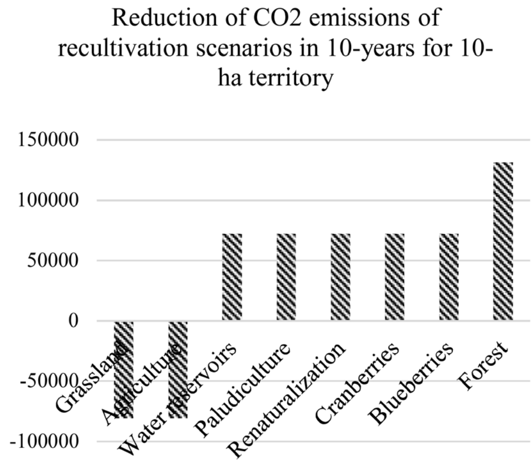

Fig.4. Reduction of CO_2 emissions of re-cultivation scenarios in 10-years for 10-ha territory

Environmental benefits

Fig. 4 shows the monetary values of ecosystem services for degraded peatland re-cultivation scenarios for 10-year period and for 10 ha area.

It can be concluded that natural areas are able to provide significantly higher ecosystem services, while agricultural areas provide ecosystem services at significantly lower volumes.

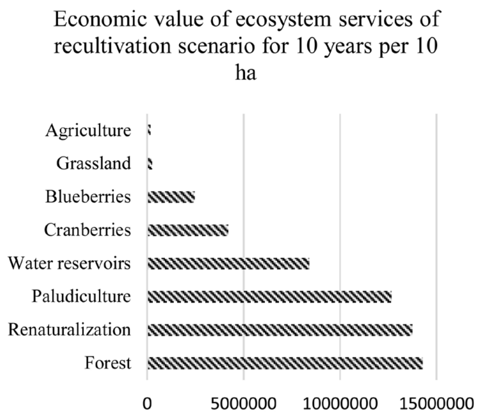

Fig.5. Economic value of ecosystem services of re-cultivation scenario for 10 years per 10 ha

Afforestation, re-naturalisation and paludiculture cultivation provide significantly higher value of ecosystem services than other scenarios. Analysing re-cultivation scenarios that are related with economic activity, it can be seen that cranberry cultivation provides higher ecosystem services than other scenarios.

IV. Conclusions

Evaluating re-cultivation scenarios from all three aspects - environmental, climate and socio-economic benefits, it can be concluded that although blueberry cultivation requires the highest financial investment at the beginning of economic activity, the financial return from this type of re-cultivation is the highest in 10-year period.

Assessing the re-cultivation scenarios from the climate change mitigation perspective, it can be concluded that in the 10-year period, the highest benefit is from forest areas (regardless of whether trees are planted for the purpose of creation of natural area or for the purpose to grow trees for energy use).

Assessing potential re-cultivation scenarios from an ecosystem service point of view, it has been concluded that natural areas have the greatest value. The greatest economic value of ecosystem services is gained from forest areas.

By evaluating the results described above, it can be concluded that the decisions of the re-cultivation of degraded peatlands should be thoughtful, sustainable and based on the common development of Latvia.

It is important to take into account that after peat extraction and land use transformation within the area, it is excluded that peat resources will recover and the statement that peat is a renewable resource is only true when the area is restored to a natural bog.

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