FUNCTIONAL LAND MANAGEMENT MODEL – TOOL FOR SUSTAINABLE AND CLIMATE FRIENDLY MANAGEMENT OF NUTRIENT RICH ORGANIC SOILS

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Abstract. Climate change is one of the greatest environmental, social and economic challenges of our days and warming of the climate system is unequivocal. Greenhouse gases (GHG) emissions caused by human activities are the most significant driver of the observed climate changes since the mid- 20th century. Managed nutrient rich organic soils are one of the largest key sources of GHG emissions in Boreal and Temperate cool and Moist (TCM) climate regions in Europe. In these regions managed organic soils usually are drained forests and fens or mires that when efficiently drained can increase GHG emissions. The total area of managed organic soils in EU is 34.5 mill. ha (7% of the EU area). Organic soils can have high GHG emission as well as carbon storage potential depending on chosen management strategies. Based on the research and results obtained within the framework of the LIFE program project "Demonstration of climate change mitigation potential of nutrient rich organic soils in Baltic States and Finland" (LIFE OrgBalt), the authors have developed a functional land management model – a tool for sustainable and climate friendly management of nutrient rich organic soils. The model is designed to allow the user to assess the performance of organic soils depending on the planned land use type (scenario), based on the land use performance criteria: financial return, economic return, financial deficit and the optimal amount of public funding, reduction of GHG emissions and ecosystem services assessment. Based on the findings and using the developed model, it is possible to implement deliberative management decisions of managed nutrient rich organic soils, to evaluate potential management costs, plan the expected financial return, assess the benefits of climate mitigation and take into account nature values.

Keywords: climate change mitigation (CCM), nutrient rich organic soils, sustainable management measures, financial, socio-economical assessment, greenhouse gas (GHG) emissions.

Introduction

Soil carbon sequestration and the conservation of existing soil carbon stocks is an important mitigation pathway to achieve the less than 2 °C global target of the Paris Climate Agreement, given its multiple benefits including improved food production [1]. With the European Climate Law, the EU made climate neutrality by 2050 a legally binding goal, set an interim target of a net 55% emission reduction by 2030 and is now working to set a new target to be reached by 2040. The agriculture, forestry and land-use sectors are responsible for 22% of global greenhouse gas emissions, and deforestation is a major driver [3]. Organic soils are one of the largest sources of GHG emissions in Europe. According to the European Environment Agency, the total area of organic soils reported by Member States in Europe is over 33 million hectares (approx. 7.7% of the total area of the EU). The spread of organic soil in Europe is geographically uneven, with a more significant proportion found in Northern, Eastern, and Central Europe. Organic soils occur mainly in northern Europe, where the colder and more wet climate favours the build-up of carbon in soil. In 2019 EU Member States reported net emissions of 108 Mt CO_2 from organic soil [3]. In countries, like Latvia, Lithuania, Ireland, the United Kingdom, and Finland, GHG emissions from managed organic soil make up more than a fifth of the total national emissions [4].

There are different management practices for organic soils which determine the decomposition of the previously accumulated carbon, resulting in the release of increased levels of carbon dioxide and nitrous oxide. Historically, peatlands have often been drained for peat extraction and later subjected to various land management scenarios, including conversion to cropland and grassland with organic soil. Currently, one of the typical organic soil management methods is agriculture management (arable land) [5]. In general, the relevance and topicality of the article are based on consideration that implementation of CCM measures lacks traditional investments and performs high risk for landowners/managers. It is important to provide a scientifically validated and empirically grounded decision-making tool that furnishes stakeholders with comprehensive information on benefits and trade-offs [6].

There are numerous research studies in relation to the impact of different CCM measures. To address the need for climate change mitigation measures in organic soils, it is essential to consider both the potential of sustainable practices in enhancing soil carbon sequestration and reducing greenhouse gas emissions, as well as the potential impact on farm and forestry productivity. Furthermore,

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sustainable soil management practices, such as conservation tillage, crop residue retention, and agroforestry, can enhance soil carbon storage and contribute to CCM.

The most of the Northern, Eastern, and Central Europe EU member states Common Agriculture Policy 2021-2027 plans highlight the necessity for more precise research and data and more targeted support to minimize GHG emissions from organic soils. The more targeted and research based CCM support management practices in organic soils, thus supporting the more stable movement toward the achievement of national and international CCM targets, especially considering climate neutrality goals are emphasized also by Licite I et al. [7].

The management of agricultural landscapes for both CCM and adaptation require considering trade-offs and synergies with ecosystem services [8; 9]. Conservation practices, such as reduced tillage and returning crop residue to the field, can contribute to carbon sequestration and help mitigate climate change, but may also impact agricultural productivity [10]. Additionally, the trade-offs of ecosystem services under climate change conditions can lead to complex interactions, highlighting the need for innovative approaches to address challenges associated with climate change [11; 12]. Therefore, it is crucial to seek optimal solutions that enable the implementation of functions significant for societal socio-economic well-being while simultaneously reducing or not increasing GHG emissions.

Based on the research and results obtained within the framework of the LIFE program project "Demonstration of climate change mitigation potential of nutrient rich organic soils in Baltic States and Finland" (LIFE OrgBalt), the authors have developed functional land management model – a tool for sustainable and climate friendly management of nutrient rich organic soils. The aim of the model is to suggest innovative measures for low emission management practices by demonstrating how these important territories can be managed also in economically, socially and climate friendly balanced way. The article aims to present and discuss the opportunities the model provides for identifying and assessing the potential socio-economic impact of CCM measures on forest and agricultural lands. This is intended to facilitate more sustainable decision-making at both the farm and policymaker levels.

Materials and methods

The functional land management model methodology approbated within the project LIFE OrgBalt demonstrated CCM measures [13]. The model incorporates the current project's measurement data on GHG reduction obtained through the implementation of specific CCM measures.

The analysis of the functional land management model has been done by dividing the applied CCM measures implemented within the LIFE OrgBalt project in four main groups, one falling under the forest sector and three under the agricultural sector (please, see Table 1).

Table 1

CCM measures analysed within the model

Forest sector CCM measures
Application of wood ash in coniferous tree stands (LVC307) *Continuous forest cover in spruce stand (LVC308)* *Forest regeneration with black alder and birch in non-drained organic soil (LVC309)* *Riparian buffer zone in forest land planted with black alder (LVC311)* *Forest regeneration with pine in non-drained organic soil (LVC312)* *Strip harvesting in pine stand (LVC313)*
Agricultural sector CCM measures
Measures involving change of crop type
Conversion of cropland to grassland (LVC301) *Introduction of legumes in crop rotation (LVC304)*
Measures involving complete or partial afforestation
Conventional afforestation (Spruce) (LVC302) *Introduction of forest paludiculture (Deciduous trees) (LVC303)* *Agroforestry – fast growing trees and grass (LVC306)* *Fast growing species in riparian buffer zones (LVC310)*
Measure involving controlled water table level
Controlled drainage of grassland (LVC305)

The model provides financial, economic, and socio-economic indicators for different types of land management (agricultural land and forest land) based on two levels of input data. First level data are necessary to understand which CCM measure can be implemented on a given territory, for instance, for agricultural land: type of agricultural land, soil type, land use assessment, management system, drainage system, restrictions on economic activity. For the first level data there are several restrictive criteria, since the CCM measures included in the model can be implemented only on lands with certain given characteristics. Once the first level input data are entered all possible implementable CCM measures are shown for users in a separate window. For each implementable CCM measure second level data must be entered so to obtain financial and socio-economic indicators. There are no restrictive criteria for the second level data (Please, see the second level data example in Fig.1).

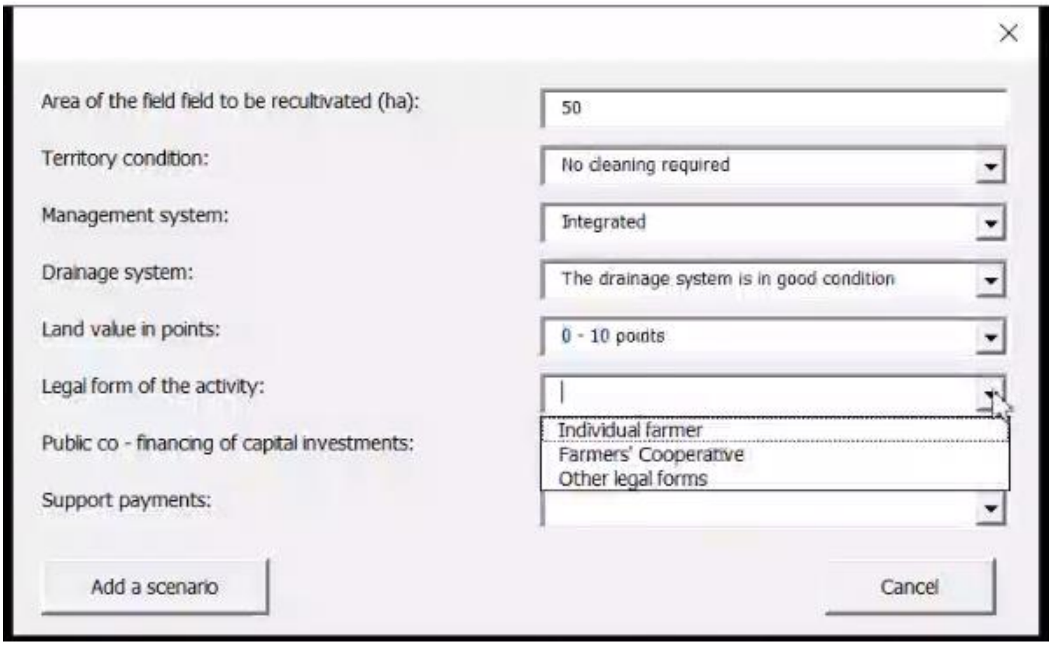

Fig. 1. **Second level data input panel**

The model calculates the benefits of land use scenarios for the following six different periods: 5 years, 10 years, 25 years, 50 years, 100 years, 200 years, considering the lifecycle of CCM measures. The main model output data gives the following financial and economic indicators for each potentially implemented CCM.

1. **Financial indicators**: (1) **Average investment costs (EUR)** – the average amount of money spent for the investment – the model calculates the average amount of money what needs to be invested to implement the chosen CCM measure on a x ha land. The amount varies and is influenced by the average costs of territory cleaning, the type of management chosen, the status of the drainage system, the type of planting culture, the presence or the absence of public funding; (2) **Average notional profitability on net profit** – the profitability on net profit is calculated by dividing the cash flow by total revenue and divided by the number of years of the analysed time period (5, 10, 25, 100, 200 years); (3) **Average notional return on equity (ROE)** – a measure of financial performance calculated by dividing net income by shareholders' equity. The average notional ROE is calculated by dividing the cash flow by the investment costs and divided by the number of years of the analysed time period; (**4) (EUR) Financial net present value (FNPV)** (real discount rate: 4%) – the net present financial value of the measure's investment. A negative net present value (NPV) forecasts loss, while a positive NPV forecasts profitability. The measure qualifies for attracting public funding if FNPV is less than 0 EUR: **(5) Financial internal rate of return (%) (FIRR)** – the financial profitability of measure investments. If FIRR is higher than the discount rate used in the calculation (4%), then the measure has sufficient revenue to cover the investment and operating costs, and possibly EU co-financing is not needed or is needed in a smaller amount.
2. **Economic indicators: (1) Reduction of GHG emissions** (tonnes per year) – the total reduction of GHG emissions in tons obtained as a result of the CCM measure implementation; **(2) GHG**

emission reduction value (EUR) – the economic value attributed to obtained GHG emission reduction. The yearly economic benefits for the reduction of GHG emissions (EUR) is calculated by multiplying the predicted GHG emission reduction value ($t \cdot ha^{-1}$), by the price attributed to that reduction ($EUR \cdot t^{-1}$ CO2 ekv.) and by the size of the land area (ha). **(3) Value of ecosystem services (EUR)** – estimation of the value of ecosystem services, based on previous researches; (4) **Economic net present value** (**ENPV) total value (EUR)** (real discount rate 5%) – the net present economic value of the measure **(5) Economic internal rate of return total value (EIRR) (%) –** economic profitability of measure investments. If ERR is greater than the social discount rate, then the measure is socio-economically beneficial for society. (4) and (5) can be calculated both with or without ecosystem services value.

3. **Funding gap: (1) Eligible costs (EUR)** – amount of costs that can be considered for a funding request; **(2) Financing deficit rate (%)** – the financial deficit is the part of the investment costs that is not covered by the measure net income. The financing deficit is the amount of public financing for the measure to be profitable for its implementer (FNPV = 0 EUR). The financial deficit determines the maximum amount of public funding to be attracted for the measure implementation. (**3) Decision amount (EUR)** (Relative amount funding gap rate).
4. **Cost effectiveness: (1)** investment payback period (years); GHG reduction costs (EUR per ton) – the total reduction of GHG emission costs obtained as a result of the measure implementation in EUR. For the emission reduction price, the value 50 EUR per ton CO2 ekv.is used [14].

Results and discussion

The article examines various model options and their outcomes by analyzing CCM measures (shown in Table 1) in agricultural and forestry land using the model output data. The provided data encompasses a range of model output indicators, including investment costs, return on investment, GHG emissions reduction, financial metrics, and environmental impact.

The analysis compares the “costs of inaction” with the expected outcomes of implementing the proposed CCM measures. Certain indicators are selected by the authors as they most accurately represent the available choices for landowners and decision-makers. While financial return is considered, it is important to note that this return is limited due to the extended investment payback period. FNPV, ENPV, and the Financing gap rate are estimated, considering discount rates, resulting in relatively low values, especially for long-term measures (100 and 200 years).

The analysis of agricultural CCM measures is conducted over a five-year period on a one-hectare agricultural land plot and the results are summarized in Table 2.

Table 2

Model data for agricultural CCM measures

Model output indicators	**CCM measures in agriculture land**		
	Agricultural measures (5 year period)		
	LVC305	LVC304	LVC301
Average investment costs, EUR	2502.81	5878.25	2022.00
Return on investment, years	3.00	4.73	2.48
Reduction of GHG emissions, $t \cdot year^{-1}$	3.25	-0.64	0.55
FNPV, EUR *(real discount rate: 4%)*	4694.23	4532.72	4045.03
FRR, %	53.25	0.03	0.30
ENPV, EUR *(real discount rate 5%)*	33660.61	9010.00	23043.59
Financing gap rate, %	-2.18	0.02	-2.54
Decision amount, EUR	0.00	113.80	0.00

From the data presented in the table, it can be inferred that the measure LVC301 has the shortest return on the investment period at 2.48 years, followed by LVC305 at 3 years and LVC304 at 4.73 years. A shorter return period signifies quicker recoupment of the initial investment. Measure LVC305 shows the highest reduction in GHG emissions at 3.25 tonnes per year, while LVC301 reduces emissions by 0.55 tonnes per year. Interestingly, LVC304 has a negative reduction of -0.64 tonnes per year, indicating an increase in emissions. FNPV at a real discount rate of 4% is positive for all measures, indicating a positive financial outcome for farmers, moreover, FRR is exceptionally high for LVC305 (53.25%), indicating a substantial financial return compared to the investment. ENPV at a real discount rate of 5% is also positive for all measures, but specially for LVC305 and LVC301, indicating a positive economic impact based on GHG emission reduction and ecosystem service values. The financing gap rate is negative for LVC305 and LVC301, usually for measures with zero or negative FNPV a funding gap rate exceeds 0% of eligible investment costs and the decision amount (the amount of eligible public subsidy) exceeds 0 EUR and could reach the planned investment amount of measure. However, it is positive for LVC304, suggesting a small shortfall in financing and results in 113,80 EUR of decision amount per hectare.

Afforestation measures are analyzed separately, implemented on one-hectare agricultural land, but over a different time period of 100 years (please, see Table 3).

Table 3

Model data for afforestation CCM measures

Model output indicators	CCM measures in agriculture land Afforestation measures (100-year period)			
	LVC302	LVC303	LVC306	LVC310
Average investment costs, EUR	3427.14	1677.14	5112.27	4112.27
Return on investment, years	61.11	0.00	21.43	21.43
Reduction of GHG emissions, $t \cdot year^{-1}$	22.94	21.06	31.26	31.26
FNPV, EUR *(real discount rate: 4%)*	-896.50	-2577.08	9658.99	9658.99
FRR, %	0.03%	0.00%	0.08%	0.08%
ENPV, EUR *(real discount rate 5%)*	95761.27	86142.16	134023.80	134023.80
Financing gap rate, %	0.28	1.21	-2.35	-2.68
Decision amount, EUR	970.08	2029.34	0.00	0.00

LVC302 have the longest payback periods, with a return on investment of 61.11 years which is related that the measure provides afforestation with spruce. All afforestation measures show a significant reduction in GHG emissions, ranging from 21.06 tonnes per year for LVC303 to 31.26 tonnes per year for LVC306 and LVC310. FNPV is negative for LVC302 and LVC303, indicating a negative financial outcome. However, it is positive for LVC306 and LVC310. ENPV is positive for all afforestation measures, indicating a positive economic impact. There is not necessary public funding for LVC306 and LVC310, despite that they are economically beneficial related to significant reduction in GHG emissions. LVC302 and LVC303 need a public funding support (respectively 970, 08 EUR and 2029,34 EUR).

The analysis of the model output indicators for CCM measures in forest land over a 200-year period, as presented in the table, reveals several key insights (see Table 4).

Table 4

Model data for CCM measures in forest land

Model output indicators	CCM measures in forest land (200-year period)					
	LVC307	LVC308	LVC309	LVC311	LVC312	LVC313
Average investment costs, EUR	2102.14	3604.60	1352.14	2460.15	1875.15	2102.14
Return on investment, years	2.03	47.33	0.00	0.00	149.69	50.38
Reduction of GHG emissions, $t \cdot year^{-1}$	1.19	1.28	-1.02	0.73	1.05	0.12
FNPV, EUR *(real discount rate: 4%)*	15835.75	-355.91	4960.16	-2526.43	-1957.10	-1078.17
FRR, %	0.04	0.00	0.00	0.00	0.00	0.00
ENPV, EUR *(real discount rate 5%)*	80192.23	77750.33	22540.51	64955.07	64262.19	78378.81
Financing gap rate, %	-11.00	0.41	-17.85	1.03	0.74	0.29
Decision amount, EUR	0.00	1475.28	0.00	2533.95	1388.64	616.63

LVC308, LVC312, and LVC313 also show relatively shorter payback periods compared to LVC311 and LVC309, which have no return on investment within the 200-year period analyzed.

LVC308, LVC309, LVC311, LVC312, and LVC313 show positive reductions in GHG emissions, indicating their effectiveness in mitigating climate change. However, LVC309 has a slight negative reduction (-1.02 tonnes per year.) FNPV is positive for LVC307, LVC309, and LVC313, indicating a positive financial outcome for foresters. However, it is negative for LVC308, LVC311, and LVC312, but at the same with relatively high economical return. Also, in this case ENPV is positive for all measures. Decision amounts vary among the measures, with LVC308, LVC311, LVC312, and LVC313 requiring additional public funding (subsidies), while LVC307 and LVC309 require no additional support.

O'Sullivan et all also have explicitly quantified an example of the trade-offs between two soil functions: primary productivity and C cycling and storage in response of intervention of drainage systems in agriculture lands in Ireland. The results show that at the current CO_2 price, the agronomic benefits are larger than the monetised environmental costs. This results in an incentive for farmers to drain [15]. In our case, the model reveals that over a five-year period, in agricultural organic soils, the most financially and economically beneficial CCM measure is LVC305, which involves Controlled drainage of grassland, followed by LVC301, Conversion of cropland to grassland. For afforestation measures over a 100-year period, the CCM measures with the best financial and economic returns are Agroforestry with fast-growing trees and grass (LVC306) and planting fast-growing species in riparian buffer zones (LVC310). Conversely, Conventional afforestation with spruce (LVC302) is not as financially beneficial due to its long payback period. In forest lands, the most financially and economically beneficial measure is the Application of wood ash in coniferous tree stands (LVC307). Other measures, such as Strip harvesting in pine stands (LVC313), Forest regeneration with pine in non-drained organic soil (LVC312), Riparian buffer zone in forest land planted with black alder (LVC311), and Continuous Forest cover in spruce stands (LVC308), show a relatively large economic value but indicate a negative financial outcome for foresters. Therefore, public funding support should be considered for these measures.

In common, results demonstrate the financial viability and potential environmental impact of the proposed CCM measures. Additionally, they provide valuable insights for decision-making and investment strategies.

Conclusions

1. Achieving a balance between productivity and climate mitigation in organic soil management necessitates a comprehensive understanding of the trade-offs involved. Sustainable practices that enhance soil carbon sequestration, maintain soil fertility, and optimize agricultural productivity are essential for addressing the challenges posed by climate change while ensuring the long-term sustainability of the agriculture and forestry sector. By quantifying these trade-offs, researchers and policymakers can develop sustainable land management practices that optimize both productivity and carbon storage while maintaining the ecosystem health and resilience.
2. The model shows that all afforestation measures are related to significantly bigger cumulative reductions of GHG emissions than other sets of measures because of much more significant changes in land use. Investment costs and financial return differ significantly due to the growth rate of selected species and lengths of rotation periods respectively. The measures related to planting fast growing tree plantations are the most profitable within the group of afforestation measures taken into consideration, while the least profitable is the set of measures related with planting of black alder and excluding the maintenance of drainage systems.
3. Financial return of the agriculture CCM measures is larger and the payback period is shorter than that of the forestry measures, it must be considered that these sets of measures provide annual income but, on the other hand, compared to forestry measures, risks related to weather conditions (droughts, frosts, snowless winters, flooding, hail, etc.) may be comparatively higher for the harvest.
4. There are several measures in forest lands, mainly continuous forest practices have a relatively large economical value based on GHG emission reduction and ecosystem services but indicating a negative financial outcome for foresters which means that for these measures there can be considered public funding support.
5. Based on the findings and using the developed model, it is possible to implement deliberative management decisions of sustainable management of organic soils, evaluate potential CCM

measure implementation costs, plan the expected financial return, assess the benefits of climate mitigation. The analysis of these model output indicators provides a comprehensive understanding of the financial, environmental, and investment aspects of the project, enabling stakeholders to make informed decisions regarding its implementation and potential impact so to meet the current and future EU environmental requirements.
6. The estimation of GHG emissions provided within the model, allows in fact to evaluate the potential inclusion of these measures in policy documents and national plans, such as the Nature Restoration Plan which will be adopted by states following the enforcement of the EU Nature Restoration Law. In addition, policy makers will be able to evaluate the necessary support payments and public co-financing measures, including GHG credit selling opportunities, to make these measures implementable and profitable for landowners.
7. Almost every CCM measure in organic soils has a different nature, environmental and climate impacts (irrigation, drainage, afforestation, etc), therefore, further research of clear benefits and adverse effects is necessary. There are various studies investigating these relationships, shedding light on potential trade-offs and synergies, emphasizing the importance of managing forests and agriculture land for multiple ecosystem services while considering trade-offs.
8. In the future, the model could be enhanced by incorporating additional suitable CCM measures, thereby broadening the range of evaluation options for both farmers/foresters and policy planners.

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Author contributions

Conceptualization, E.K.; methodology, E.K and A.L.; data provision and analysis A.L. I.K. awriting – original draft preparation, E.K.; writing – review and editing, A.L. and I.K. visualization, I.K. All authors have read and agreed to the published version of the manuscript.

References

[1] Zomer R. J., Bossio D. A., Sommer R., L. V. Verchot. Global Sequestration Potential of Increased Organic Carbon in Cropland Soils. Scientific Reports, 15554, 2017., DOI: 10.1038/s41598-017-15794-8
[2] Forests are key to cutting emissions and tackling the climate crisis, WWF, Foprests and climate. [online] [11.02.2024] Available at: https://wwf.panda.org/discover/our_focus/forests_practice/forest_climate/
[3] European Environmental Agency. Climate change mitigation: reducing emissions [online] [11.02.2024] Available at: https://www.eea.europa.eu/en/topics/in-depth/climate-change-mitigation-reducing-emissions#:~:text=With%20the%20European%20Climate%20Law,line%20with%20the%202030%20goal.
[4] Tanneberger F., Tegetmeyer C., Busse. S., Barthelmes A., Shumka S., Kirca S., Mykytiuk O., Lindsay R., Joosten H. The peatland map of Europe. Mires and Peat, 19 (22), DOI: 10.19189/MaP.2016.OMB.264., 2017., pp. 1-17.
[5] Barthelmes A., Couwenberg J., Risager M., Tegetmeyer C., Joosten H. Peatlands and Climate in a Ramsar context, 2015.
[6] Searchinger T.D., Wirsenius S., Beringer T. *et al.* Assessing the efficiency of changes in land use for mitigating climate change. *Nature* 564, DOI: 10.1038/s41586-018-0757-z2018., pp. 249-253.
[7] Licite I., Popluga D., Rivza P., Lazdiņš A., Meļņiks, R., Nutrient-Rich Organic Soil Management Patterns in Light of Climate Change Policy, Civil Engineering Journal, ISSN: 10.28991/CEJ-2022-08-10-017. Vol. 8, No. 10, October, 2022, pp. 2209-2304.
[8] Locatelli B., Pavageau C., Pramova E., Gregorio M. Integrating climate change mitigation and adaptation in agriculture and forestry: opportunities and trade-offs. Wiley Interdisciplinary Reviews Climate Change, 6(6), DOI: 10.1002/wcc.357, 2015., pp. 585-598.

[9] Wang L., Ma S., Qiao Y., Zhang J. Simulating the impact of future climate change and ecological restoration on trade-offs and synergies of ecosystem services in two ecological shelters and three belts in china. International Journal of Environmental Research and Public Health, 17(21), DOI: 10.3390/ijerph17217849, 2020., p. 7849.
[10] Lal R., Delgado J., Groffman P., Millar N., Dell C., Rotz A. Management to mitigate and adapt to climate change. Journal of Soil and Water Conservation, 66(4), DOI: 10.2489/jswc.66.4.276, 2011., pp. 276-285.
[11] Sun G., Zhang N., He J., Wu N. Impacts of land-use and climate change on ecosystem service in eastern tibetan plateau, china. Sustainability, 10(2), 467. DOI: 10.3390/su10020467, 2018.
[12] Kleinman P., Osmond D., Christianson L., Flaten D., Ippolito J., Jarvie H., … Sharpley A. Addressing conservation practice limitations and trade-offs for reducing phosphorus loss from agricultural fields. Agricultural Environmental Letters, 7(2). DOI: 10.1002/ael2.20084, 2022.
[13] LIFE OrgBalt newsletter, [online] [11.02.2024] Available at: https://www.orgbalt.eu/?page_id=1719&lang=lv, October 2023.,
[14] Commission staff working document impact assessment Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social committee and Committee of the Regions. Stepping up Europe's 2030 climate ambition Investing in a climate-neutral future for the benefit of our people. SWD/2020/176 final, [online] [11.02.2024] Available at: https://eur-lex.europa.eu/legal-content/EN/tXT/?uri=CELEX:52020SC0176
[15] O'Sullivan, L., Creamer, R. E., Fealy, R., Lanigan, G., Simo, I., Fenton, O., ... Schulte, R. P. Functional Land Management for managing soil functions: A case-study of the trade-off between primary productivity and carbon storage in response to the intervention of drainage systems in Ireland. *Land use policy*, *47*, 2015., pp. 42-54.