Lääne County recommendations: Incorporating grassland ecosystem services into environmental management and spatial planning in Lääne County

LIFE Viva Grass project (LIFE 13 ENV/LT/000189)
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1. INTRODUCTION

Grasslands play a key role within green networks. Specifically, less intensified grasslands such as permanent and semi-natural meadows are characterized by a high provision of *regulation and maintenance* Ecosystem Services (hereinafter "ES") related with *pollination*, the *maintenance of habitats* for key species or *global climate regulation* through carbon sequestration in vegetation and soils (**see table 2**). The provision of multiple ecosystem services ES, understood as multifunctinonality, highlights the role of semi-natural grasslands as relevant elements of the Green Network of Estonia.

The present report aims at:

- Summarizing the extent and conservation status of grasslands in Lääne County.
- Assessing the extent, conservation status and supply of ES **within** and **outside** of the current Green Network of Lääne County (hereinafter GN).
- Proposing scenarios for the inclusion and protection of grasslands in the GN by implementing the County level GN in the municipalities' general plans.
- Evaluation of grass-based energy sources

1.1 Overview of grasslands' extent and management status in Lääne county

Table 1 contains a summary of the extension of grasslands and the management status of semi-natural grasslands in Lääne County. The table also presents the amount of grasslands within and outside of the County GN. The classification of grassland types follows that of LIFE Viva Grass project (Villoslada et al, 2018) and the data has been compiled and aggregated from different sources:

- EELIS (Eesti Looduse Infosüsteem)
- PRIA (Põllumajanduse Registrite ja Informatsiooni Amet)
- PKY (Pärandkoosluste Kaitse Ühing)

Most of the baseline data used refers to the status of grasslands in 2016. However, some of the data regarding semi-natural grassland may refer to fieldworks done in 2001 and later.

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Table 1. Distribution of grasslands by type in Lääne County. The extent of grasslands inside and outside of the GN is shown separately.

Grassland type	Total area (ha)	Total area within GN (ha)	Out of GN (ha)
Cultivated	5603	2310	3293
Permanent	13112	6433	6679
Semi-natural	15015	14209	806
Management regime			
Grazing	2882	2864	18
Mowing	1845	1827	18
Grazing & mowing	85	85	0
Restored	392	390	2
Abandoned	5124	5070	54
No information	4687	3973	714
TOTAL	33730	22952	10778

The amount of abandoned grasslands is calculated as those grasslands in which agri-environmental payments have not been claimed since 2007. However, these numbers are an approximation and should therefore be taken with care. Approximately 34% of the total area of semi-natural grasslands is likely to be abandoned in Lääne County. Around 95% of semi-natural grasslands in Lääne County are included within the GN.

1.2 Ecosystem services (ES) provided by grasslands

In order to assess the **potential** provision of ecosystem services in Estonian grasslands, Viva Grass project has elaborated a specific grassland classification system based in three main factors comprising both biotic and abiotic components:

- *Land quality (boniteet):* The concept of land quality is an integrated evaluation of fertility of soils used in the Baltic States land evaluation systems and is composed of several factors, e.g. soil texture, soil type, topography and stoniness. Land quality is expressed in points per hectare with 100 points being maximum.
- *Slope:* Steeper slopes are associated with shallower soils with less water retention capacity due to gravity and with a higher risk for soil erosion, thus impacting ES supply potential.
- *The management regime of the grasslands:* Three types of management regime were considered in the analysis. **Cultivated grasslands** are seeded and ploughed, usually included in crop rotation and less than five years of age. **Permanent grasslands** are generally defined as land used to grow grasses naturally or through cultivation which is older than five years. **Semi-natural grasslands** are the result of decades or centuries of low intensity management and are currently not seeded or plughed. **Arable/cropland** is defined as intensively managed farmland used for crop production, plowed at least one time in the season and usually fertilized.

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All factors are combined through GIS algebra, resulting in a total of **30 grassland classes** plus **10 arable land** classes. **Table 2** shows the grassland classes found in Lääne County and the ES they provide. The evaluation of ES supply follows an Expert-based qualitative scoring methodology which is outlined in Villoslada et al. (2018). The 0 to 5 qualitative scores in table 2 represent an increase in the supply of ES as follows:

0 – No relevant supply of ES   5 – Very high supply of ES

Table 2. Grassland clases in Lääne County and the ES they provide

	Provisioning					Regulation & Maintenance							
Grassland classes	Cultivated crops	Reared animals and their outputs	Fodder	Biomass-based energy sources	Herbs for medicine	Bio-remediation by micro-organisms, plants and animals	Filtration/storage/accumulation by ecosystems	Control of (water) erosion rates	Pollination and seed dispersal	Maintaining habitats for plant and animal nursery and reproduction	Weathering processes/soil fertility	Chemical condition of freshwaters	Global climate regulation
1. Cultivated grassland on plain relief, low soil fertility	0	3	2	2	1	2	2	0	2	2	2	2	2
2. Cultivated grassland on plain relief , medium soil fertility	0	4	3	3	1	3	3	0	2	2	3	3	2
3. Cultivated grassland on plain relief in, high soil fertility	0	5	4	4	1	3	4	0	2	2	4	4	2
4. Cultivated grassland on plain relief, organic soils	0	4	3	3	1	4	4	0	2	2	0	3	3
11. Permanent grassland on plain relief in, low soil fertility	0	2	1	1	3	3	2	0	4	4	2	3	3
12. Permanent grassland on plain relief , medium soil fertilty	0	3	2	2	2	4	3	0	4	3	3	4	3
13. Permanent grassland on plain relief, high soil fertility	0	4	3	3	2	4	4	0	4	3	4	5	3
14. Permanent grassland on plain relief, organic soils	0	3	2	2	2	5	4	0	4	3	0	3	4
21. Semi-natural grassland on plain relief, low soil fertility	0	1	1	1	5	4	2	0	5	5	2	3	4
22. Semi-natural grassland on plain relief, medium soil fertilty	0	2	2	2	4	5	3	0	5	4	3	4	4
23. Semi-natural grassland on plain relief, high soil fertility	0	3	3	3	3	5	4	0	5	3	4	5	4
24. Semi-natural grassland on plain relief, organic soils	0	3	3	3	4	5	4	0	5	4	0	3	5

Table 2 shows a clear difference between the ES provided by cultivated grasslands and those provided by permanent and semi-natural grasslands. Permanent and semi-natural grasslands have a key role in the provision of regulation and maintenance ES whereas cultivated grasslands show a high potential for provisioning ES.

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1.2.1 Assessment of ES supply applying the Viva Grass Tool: Viewer

The Viva Grass online tool allows assessing the provision of ES by grasslands in a spatially explicit way. By accessing the Viva Grass tool ***Viewer*** it is possible to spatially locate grassland classes and the ES they provide, as well as visualize the potential supply of ES through bar graphs. **Figure 1** shows an example of a grassland classes map generated by the Viva Grass Tool and one ES provided by grasslands. In order to view the full set of ES provided by grasslands in Lääne County, access the Viva Grass Tool *Viewer* (https://vgrass.hnit-baltic.lt/vgsites/vgviewer/). It is recommended to use the ***Viewer*** section of the Viva Grass Integrated Planning Tool as an initial step to understand the general patterns of grassland types and distribution as well as potential supply of ES. Moreover, the ***Viewer*** provides information on ES synergies and trade-offs. More detailed information about this topic is provide on the next section.

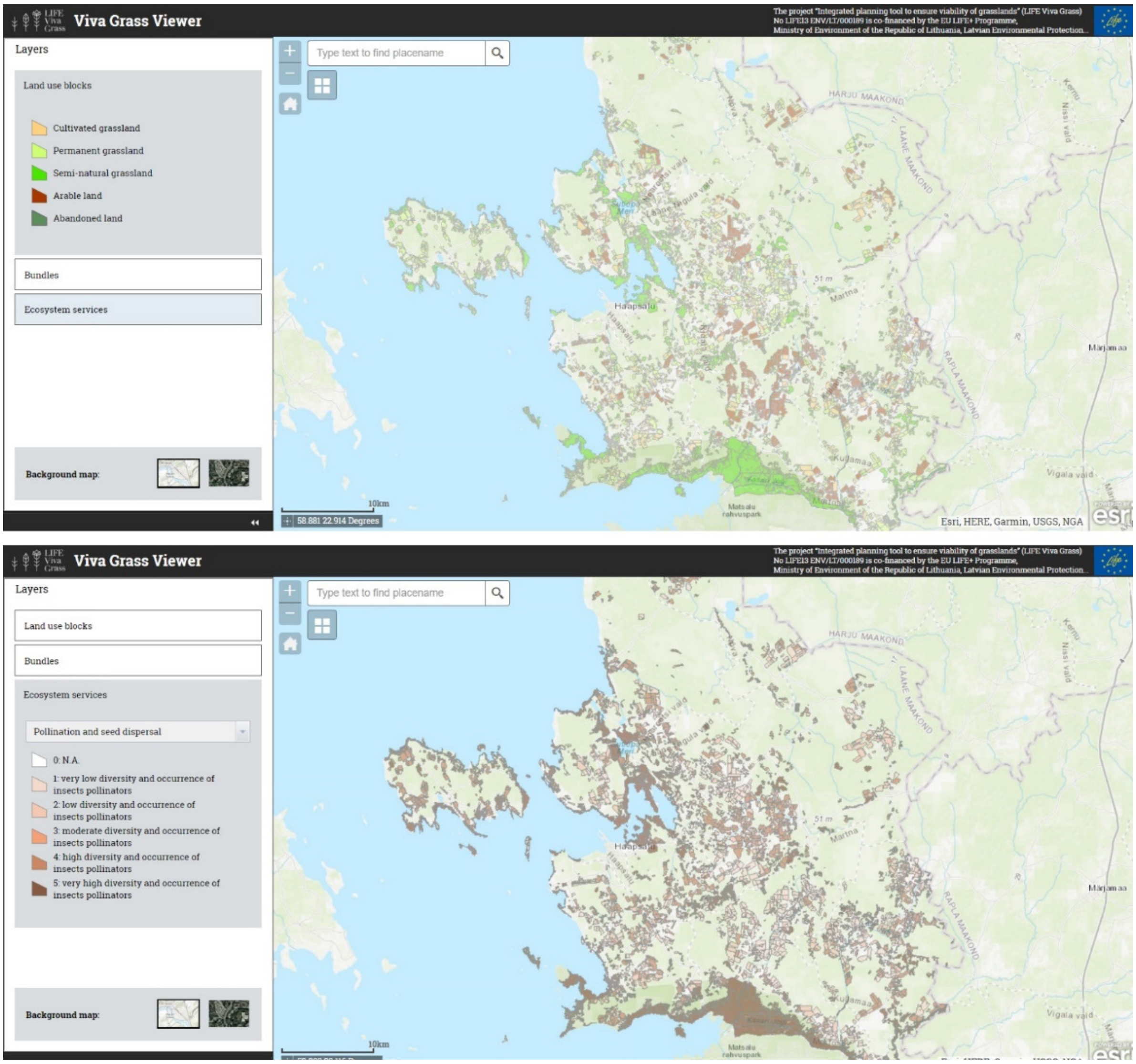

Figure 1. Viva Grass viewer displaying grassland classes (upper image) and one ES: *pollination and seed dispersal* (lower image).

1.2.2 ES bundles, synergies and tradeoffs

Not all ecosystem services occur together in the same location and time. On the other hand, certain ecosystem services repeatedly appear together in time and/or space. These groups of ES are known as bundles. The ES that form a bundle can interact together, leading to **synergies** and **trade-offs**, when the

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interaction is positive or negative respectively. We talk about **synergies** when the use of one ES would increase the benefits supplied by another service or group of services. The implications of this type of interaction are of high importance for planning and management strategies. For example, maintaining a high number of perennial grassland species in semi-natural grasslands both supports habitats but also attracts a high number of pollinators: bees, butterflies and bumblebees. By enhancing the population of pollinators, we also increase the pollination rate in nearby cultivars, highlighting the fact that the synergies can happen also at different locations. The term **trade-offs** refers to an interaction in which some ecosystem services are provided at the expense of others. This means that an increase in the production of a service would decrease the production and benefits of other service. A clear example in the context of grasslands is the tradeoff between biomass production and biodiversity and habitats: Increasing grasslands productivity usually requires a certain degree of intensification through fertilization, ploughing and reseeding with a mix of selected species. These intensification practices in turn simplify grasslands' structure and decrease the number of grassland species, leading to a loss of habitats for birds and arthropods.

Within Viva Grass project, three bundles have been identified in the study areas, namely:

Production synergy: This synergy is formed by five ecosystem services closely related to the productivity of ecosystems: *Reared animals and their outputs, fodder, biomass-based energy sources, weathering processes/soil fertility* and *cultivated crops*. In this particular synergy, the underlying ecosystem function that drives the production of the three ES is the net primary production, or biomass production. Therefore, the increase in one of the services in this bundle usually means an increase in the other two services. However, biomass for energy not only depends on the productivity of grasslands, but also on the calorific potential of grassland species.

Habitats synergy: Four ecosystem services interact in this bundle: *Herbs for medicine, maintaining habitats, global climate regulation* and *pollination and seed dispersal*. The increase in one of the services in this bundle usually means an increase in the other two services. For example, in species rich grasslands, we are also likely to find a wide range of herbs with a medicinal value. Moreover, grassland management practices that aim to increase biodiversity, such us the reduction or complete elimination of plowing, and fertilization, also increase the carbon sequestration capacity of soils, which is a key service for the regulation of climate.

Soil synergy: The four ecosystem services that form this bundle are related with the role of soil functions in ecosystem processes: *Bio-remediation, filtration/storage/accumulation* and *chemical condition of fresh waters and control of erosion rates*. The increase in one of the services in this bundle usually means an increase in the other two services.

A fourth interaction between ES was identified as a **trade-off** between production and habitat bundles: As explained before, management strategies that aim at increasing the productivity of ecosystems also lead to a decrease in the number of grassland species and consequently a decrease in pollination services.

Figure 2 shows the habitats synergy map in Lääne County grasslands as displayed in the Viva Grass Integrated Planning Tool viewer.

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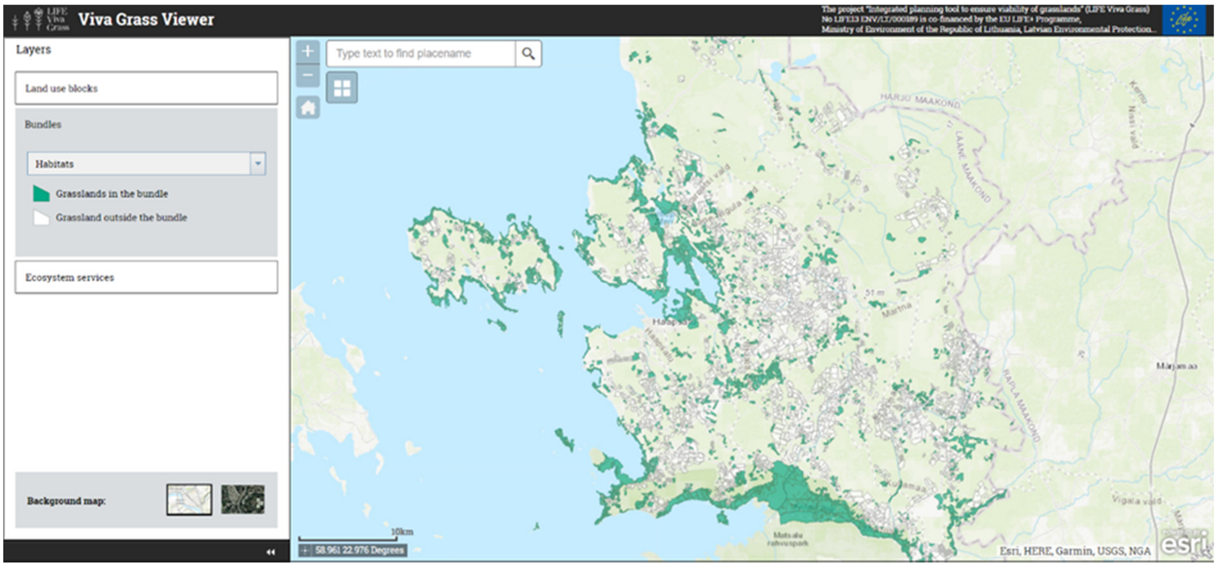

Figure 2. Habitats bundle in Lääne County visualized in the Viva Grass tool

1.2.3 Hotspots and coldspots of ecosystem services

Within Viva Grass, ecosystem services **hotspots** are understood as areas where a great number of services are provided at high or very high values. On the other hand, ecosystem services **coldspots** are understood as areas where a great number of services are provided at low or very low values. The user can explore 3 different layers under the hot/coldspots tab (see Fig. 3). The default layer *hotspots-coldspots* is the combination of *number of ES with high values* and *number of ES with low values.* The hot-cold spots analysis in Viva Grass gives an overview of the potential multifunctionality of the territory in terms of ES supply. As a general rule, hotspots are vulnerable to agricultural intensification due to their good agro-ecological conditions. It is recommended to use the hot-coldspots analysis as a tool to identify highly valuable areas with specific agro-environmental conditions. As an example, the alluvial and coastal meadows in Matsalu RP (Fig. 3) show high/very high values of multiple ES, indicating key areas of grasslands multifunctionality.

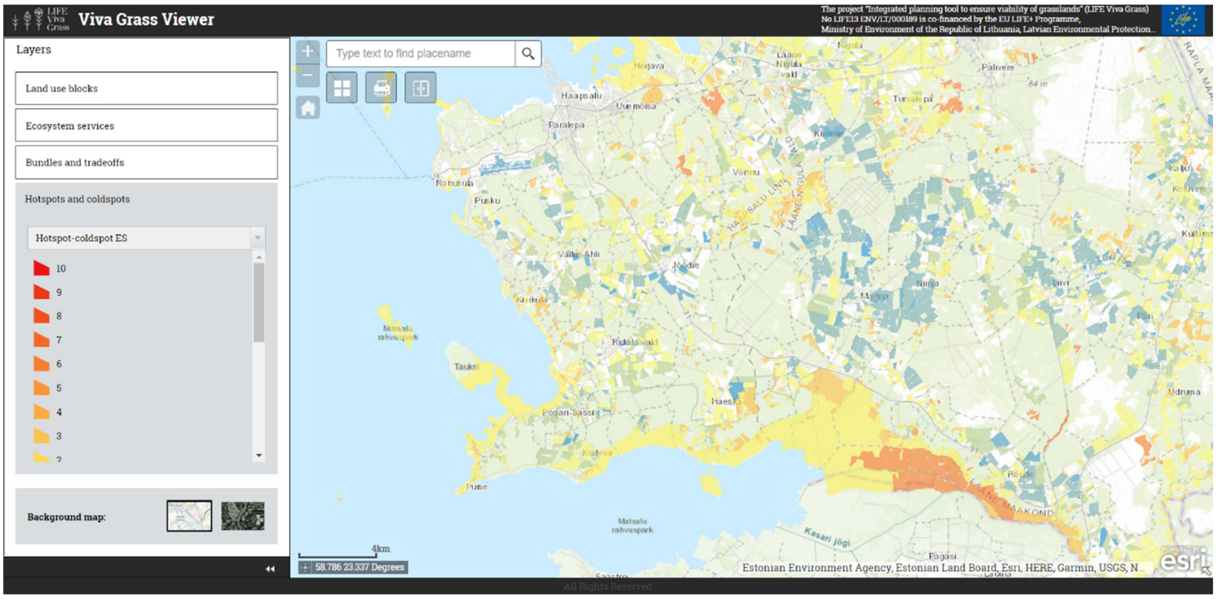

Figure 3. Ecosystem services hot and cold spots in Matsalu Bay and surrounding areas.

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1.2.4 Landuse change assessment

Tool users have the possibility to explore the estimated effects of landuse change on the potential supply of ES. By clicking on a land block of interest, the user can view ES provided by the selected grassland. The tool offers the possibility to select an alternative landuse (arable, cultivated, permanent, seminatural) from a drop down menu. The expected relative change of ES supply potential is shown next to each ES (Fig. 4). The change in ES supply is shown as a relative increase, decrease or no relative impact. This tool is helpful to explore the impacts of landuse change on ES supply. Specifically, changes in agricultural management practices affect the capacity of ecosystems to deliver services. For instance, higher intensity management factors aimed at increasing forage production such as increased use of organic and mineral fertilizers, ploughing, reseeding and drainage may, in turn, lead to an impoverishment of vascular plant species and soil biota diversity. As a consequence, significant decreases in the supply of key ecosystem services are triggered: lower pollination services associated to lower plant species diversity and lower capacity of soils to fix carbon and lower nutrient cycling capacity due to soil structure degradation and reduced soil biota).

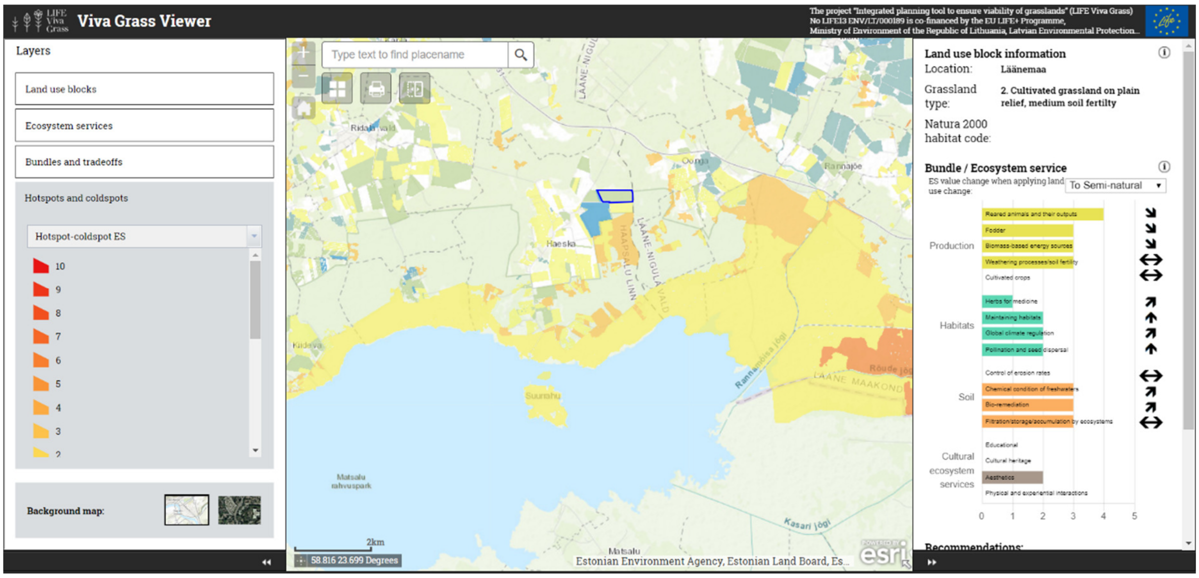

Figure 4. Landuse change assessment in the Viva Grass viewer.

2. GREEN NETWORK

2.1 Conservation status of semi-natural grasslands within the Lääne County Green Network

Semi-natural grasslands are a key element of the Green Network of Estonia and their preservation and conservation contribute to the objectives of the green network, as stated in the National Spatial Plan "Estonia 2030+" (Estonian Ministry of the Interior, 2012). The conservation status of semi-natural grasslands determines their value within the GN and helps identify degraded grasslands that require restoration measures. Moreover, degraded and abandoned grasslands considerably lose their capacity to provide key ES such as *pollination and seed dispersal* or *maintaining habitats*, therefore impoverishing the overall functionality of the green network.

Table 3 contains the extent and conservation status of all semi-natural grassland habitats in Lääne County. The classification of semi-natural grassland is based on the Habitats Directive Annex I codes. The conservation status codes are translated as follows:

A: Very high conservation value

B: High conservation value

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C: Average conservation value

D: Low conservation value

Table 3. Extent and conservation status of semi-natural grasslands in Lääne County

Habitat type	Conservation status										
	A (ha)	%	B (ha)	%	C (ha)	%	D (ha)	%	unknown (ha)	%	TOTAL (ha)
1630*	1587	*34*	1895	*41*	1001	*22*	-	-	154	*3*	4637
4030	2	*8*	5	*21*	13	*56*	-	-	4	*16*	23
5130	33	*11*	111	*39*	126	*44*	12	*4*	5	*2*	286
6210*	175	*29*	245	*41*	122	*21*	-	-	52	*9*	594
6270*	390	*47*	167	*20*	181	*22*	-	-	96	*12*	834
6280*	186	*30*	201	*32*	169	*27*	-	-	73	*12*	629
6410	11	*6*	78	*45*	58	*33*	-	-	27	*16*	174
6430	18	*6*	66	*23*	178	*63*	-	-	21	*8*	283
6450	1967	*54*	1149	*31*	534	*14*	-	-	11	*1*	3662
6510	53	*18*	30	*11*	138	*48*	-		66	*23*	288
6530*	144	*13*	295	*26*	422	*37*	-	-	271	*24*	1132
7230	565	*28*	707	*35*	469	*23*	-	-	276	*14*	2018
9070	54	*12*	202	*44*	177	*39*	6	*1*	15	*3*	454

European dry heaths (4030), *Juniperus communis formations on heaths or calcareous grasslands* (5130), *Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels* (6430) and *Lowland hay meadows* (6510) show the worst conservation status, with over 40% of their extension within the green network classified as conservation status C.

In the particular case of Lääne County, 95% of all semi-natural grasslands are included in the county GN. Therefore, the results shown in table 3 are also representative of the conservation status of semi-natural grasslands within Lääne County GN.

2.2 Prioritization DMS for Green Network: Oucomes and recommendations for application

The prioritization Decision Management System (DMS) developed within the framework of the Viva Grass integrated planning tool allows planners and a wider range of stakeholders to query information related to the role of grasslands within the Green Network of Estonia. The main objectives of the Green Network DMS are:

1. Guiding planners into the adoption of the County-level GN in rural municipality General Plan
2. Stressing the role of grasslands in the GN (delivery of ES, conservation status)
3. Detecting possible landuse conflicts in the GN implementation

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In Lääne County case study, the Green Network DMS provides a number of options or scenarios to implement Lääne County Green Network in the municipalities' general plans. The present report showcases the outputs of the Green Network DMS in Lääne County and outlines a number of recommendations on the use of the DMS and the implementation of the results.

2.2.1 Application of the prioritization DMS in Lääne County Green Network: Concept and theoretical framework

There is a need to keep healthy ecosystems inside the green network in order to ensure multifunctionality and the delivery of ES. In this regard, Viva Grass **prioritization DMS for Green Network** allows to simultaneously visualize potential ES delivered by grasslands and their conservation status.

In order to guide planners in the adoption of the County-level GN into the rural municipality General Plans, the **prioritization DMS for Green Network** proposes set of three predefined scenarios. The scenarios are understood as a gradually increasing (or decreasing) degree of inclusion and protection of grasslands in the GN. Scenario 3 represents the highest possible degree of ES supply, as all valuable grasslands belonging to the *habitats synergy* and the *soils synergy* plus grasslands containing protected species are incorporated in the Green Network. By including grasslands belonging to ES bundles in the green network, we ensure the protection of *regulating and maintenance* ecosystem services, which are essential to preserve the overall coherence and functioning of the Green Network.

The criteria for the inclusion of semi-natural grasslands in the GN of rural municipality General Plan is based on their capacity to potentially deliver a certain set of ES. This capacity reaches a high level of multifunctionality when a certain grassland is part of an ecosystem services synergy (see section 1.2.2). In grasslands belonging to an ES synergy, the increase of the supply in one ES means an increase in the supply of more ES. In terms of the role of semi-natural grasslands inside the green network, the *habitats synergy* and the *soils synergy* offer a wide array of environmental benefits. These benefits (soil protection, pollination, etc.) are not only constrained to the grassland plot itself, but have a wider spatial effect (e.g. increased pollination benefits also surrounding agricultural land).

The GN scenarios and the criteria used for the inclusion of grasslands in the scenarios are outlined below. **Figure 5** shows the different sets of ecosystem services enhanced under each GN scenario.

Scenario 1. Bare minimum: only grasslands in the **habitats bundle** are included in scenario 1.

Scenario 2. Medium ecological coherence: grasslands in the **habitats bundle** and grasslands that contain protected species are included in scenario 2.

Scenario 3. High ecological coherence: grasslands in the **habitats bundle**, grasslands in the **soils bundle** and grasslands that contain protected species are included in scenario 3. This represents the ideal scenario in terms of multiple ES delivery.

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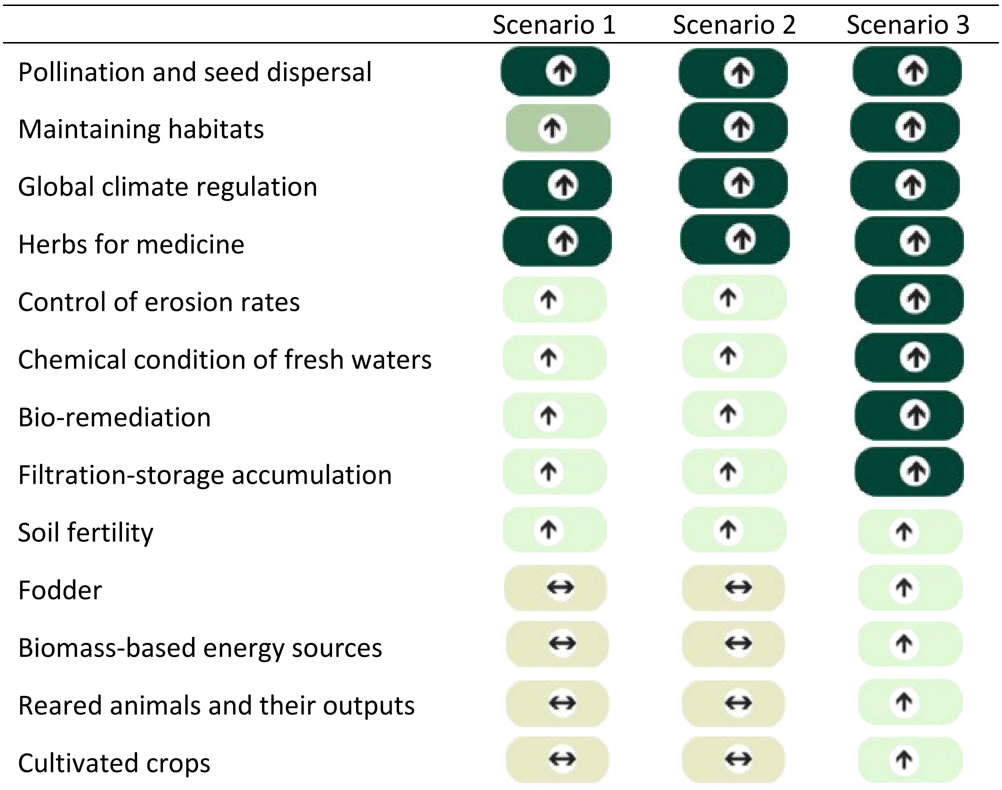

Figure 5. Relative of ES in different GN scenarios, where:

High increase

Medium increase

Low increase

No increase or decrease

2.2.2 Application of the prioritization DMS in the Lääne County Green Network: Outputs and interpretation of results

As outlined in the previous section, the Green Network DMS produces three scenarios with a gradually increasing degree of inclusion and protection of grasslands in the GN. The outputs are visualized in a spatially explicit manner through maps (**Figure 6).** Maps are complemented with information on the extent of grasslands included in each scenario and the degree of delivery of each ecosystem service (from 0 to 5) (**Figure 7**).

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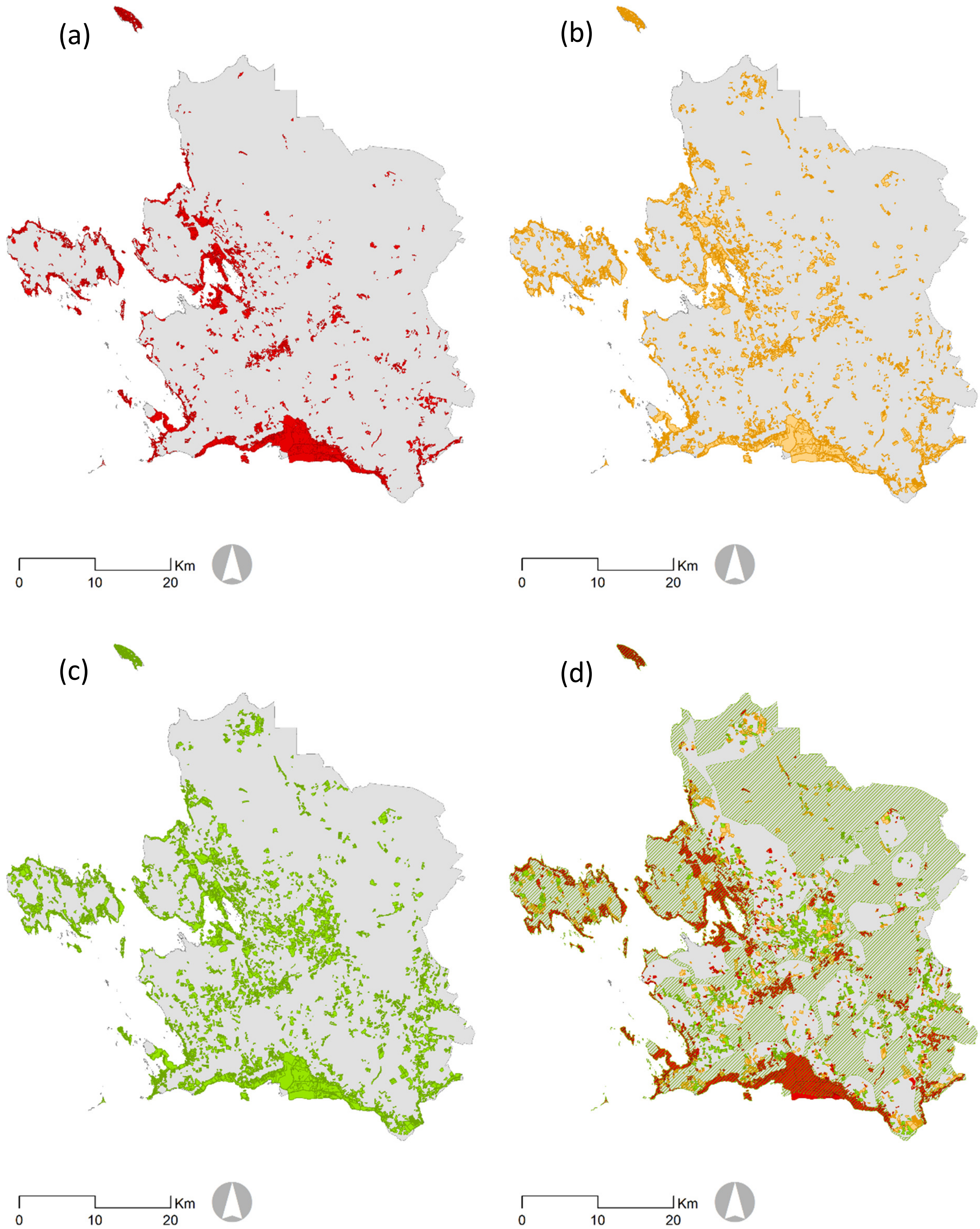

Figure 6. Three consecutive scenarios of grassland inclusion in Lääne County GN: (a) Scenario 1: bare minimum, (b) Scenario 2: medium ecological coherence, (c) Scenario 3: High ecological coherence. The overlap of the three scenarios with Lääne County GN is shown in image (d).

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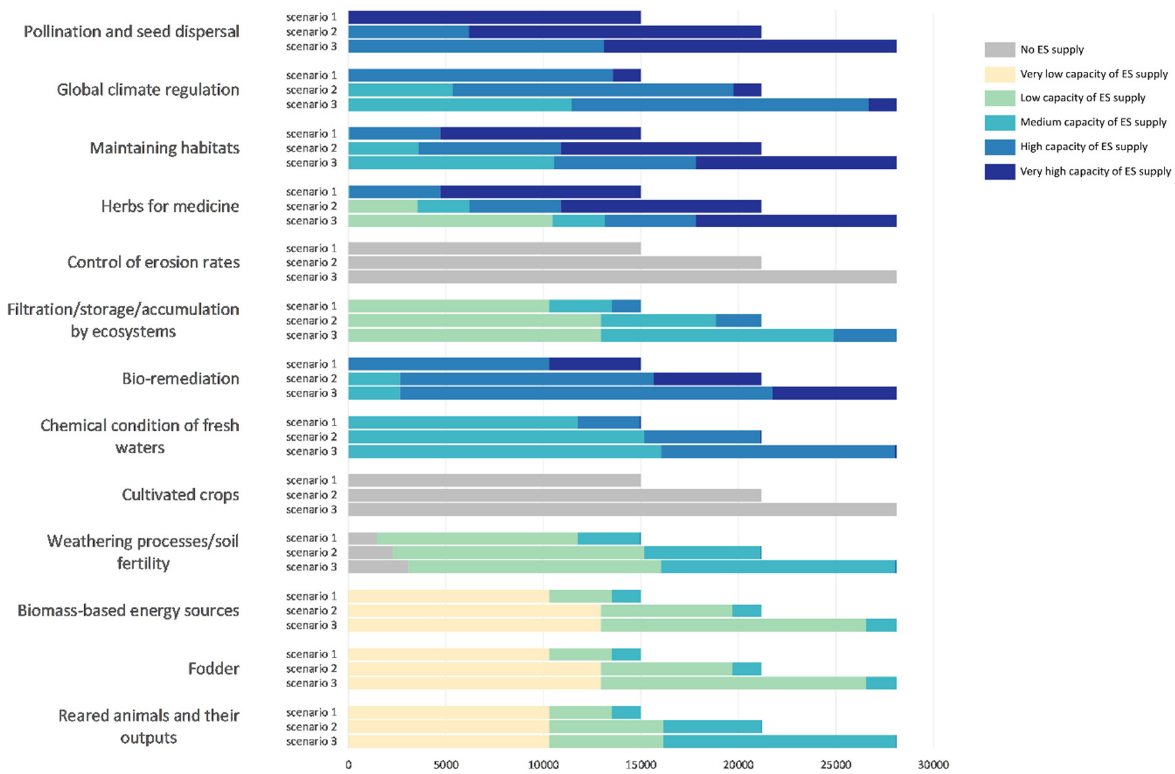

Figure 7. The supply of each ES under each GN scenario in Lääne County is shown. The Y axis displays the number of ha of grassland included under each scenario.

Figures 6 and **7** show how each GN scenario entails an increase in the area of grasslands included (15000, 21200 and 28100 ha respectively in scenarios 1, 2 and 3). This increase in the area of grasslands in the GN also encompass an increase in the supply of ES. For instance, in scenario 1, 15000 ha have a *very high capacity of delivery of* ***pollination and seed dispersal***. In scenario 2, additionally 6200 ha of grassland have a *high capacity of delivery of* ***pollination and seed dispersal***. In scenario 3 (high ecological coherence) the highest possible supply of ES is achieved with 15000 ha having a *very high capacity of delivery of* ***pollination and seed dispersal*** and 13100 ha having a *high capacity of delivery of* ***pollination and seed dispersal.***

The selection criteria for including grasslands in the GN highlight those ES related to the habitats synergy (see section 1.2.2). This can be clearly observed in **Figure 5:** Habitats and soil-related ES score the highest whereas production-related ES score the lowest, due to the inclusion of mainly semi-natural and permanent grasslands in the GN. As outlined in the previous section, including grasslands belonging to the habitats and soils synergies ensures the protection of regulating and maintenance ecosystem services.

Both the maps and the areas shown in **Figures 6** and **7** should work as guiding information for the planner, in order to gain a deeper understanding of which ES are provide by grasslands included in the GN and the extent to which these ES are provided.

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2.2.3 Application of the prioritization DMS in the Lääne County Green Network: Recommendations for use and detection of conflicts

The results presented here for Lääne County GN should work as a set of guiding rules for Lääne County municipalities. The three scenarios for grassland inclusion in the GN must be further assessed out of the Tool and used as additional input information for drafting the GN in rural municipalities General Plans. During the GN design process, other aspects should be considered, such as extent and conservation status of other ecosystems, connectivity and degree of fragmentation. The tool user should always download the results from the Viva Grass Integrated Planning Tool and visualize the maps on a GIS software and in combination with all other relevant spatial layers in order to:

- Assess how the three different scenarios complement other ecosystems (i.e. forest, wetlands, etc.) in order to achieve a balanced GN.
- Assess the role of the selected grasslands in the GN, whether they belong to a corridor or a core area.
- Detect conflicting landuses. A conflict of landuse is often seen as an overlap between the proposed grasslands and the designation of that grassland for a different use, i.e. Residential, production land, etc. The Green Network DMS offers the possibility to visualize these conflicts: the user uploads the potentially conflicting landuse layers and the tool visualizes the overlaps between these and the grasslands Green Network scenarios.

Once the user has carefully studied the three scenarios in terms grasslands included in the GN, delivery of ES and conflicting landuses, the user can proceed to creating a draft of the GN, including the abovementioned considerations.

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3. BIOMASS FOR ENERGY

As shown in **Figure 8**, Lääne and Saare Counties hold the highest area of semi-natural grasslands (approximately 20 300 and 24 100 ha respectively). This is a vast difference when compared to the area of semi-natural grassland in other counties. **Figure 9** shows the type distribution of semi-natural grassland habitats in Lääne County (County borders before the administrative reform).

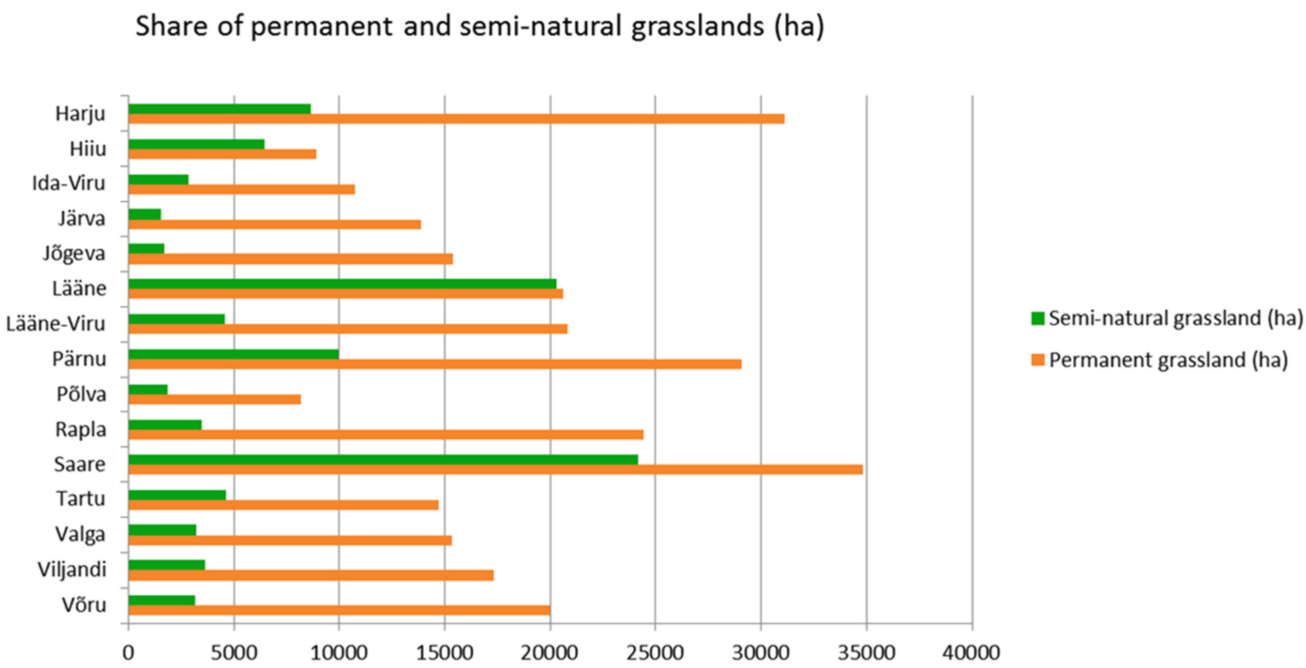

Figure 8. Area of permanent and semi-natural grassland in all Estonian Counties estimated from *KR_PLK* and *PKY niidud* datasets.

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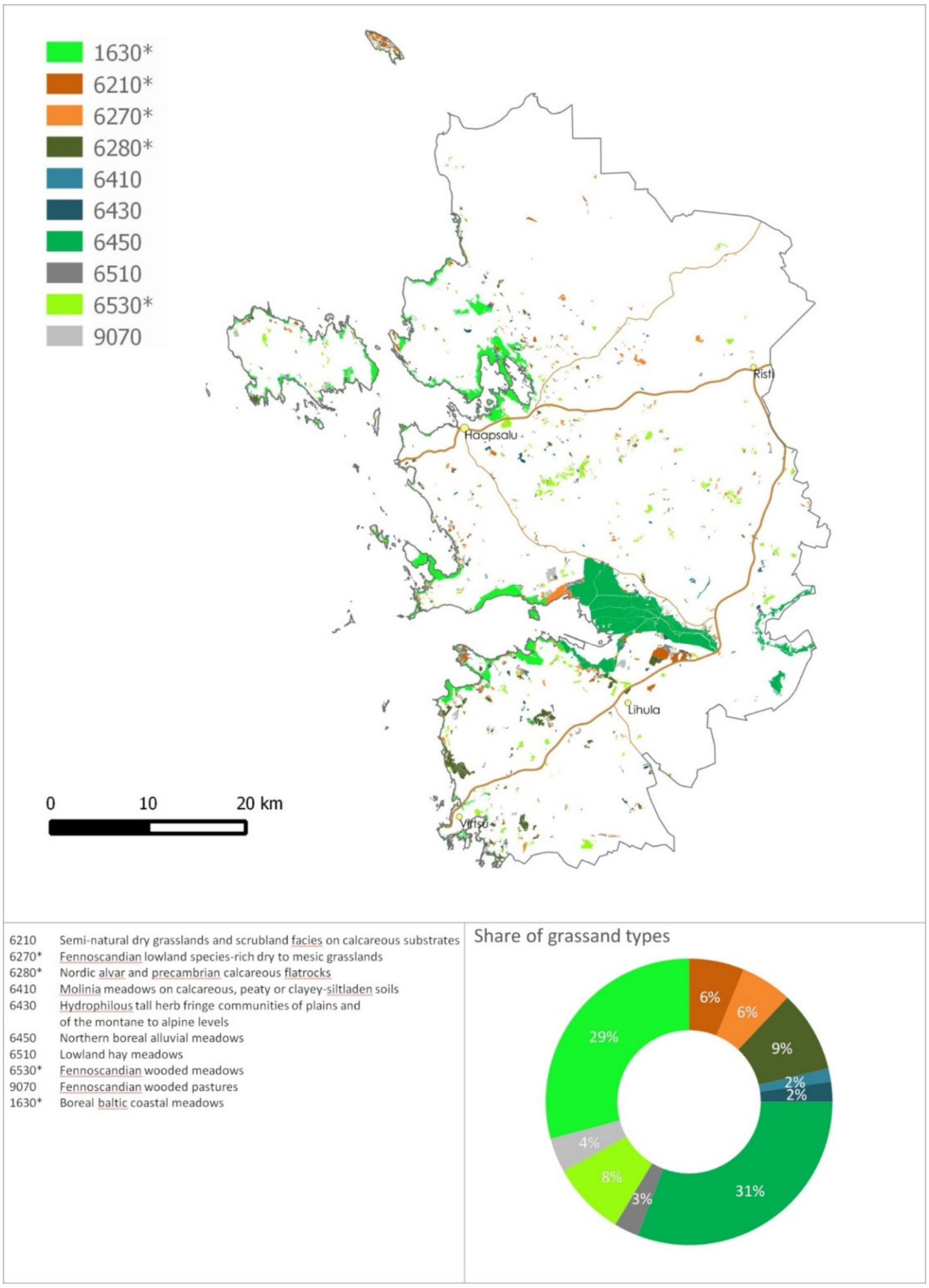

Figure 9. Distribution of semi-natural grasslands in Lääne County. The classification system follows the Habitats Directive annex I habitat codes.

Several studies have been published containing information about the productivity of semi-natural grasslands in Estonia and the potential of grass as a fuel for heat generation. Table 4 contains the potential biomass production of the main grassland types occurring in Lääne County, along with calorific power potentials. However, several important considerations must be taken into account when dealing with these data. Firstly, the productivity data refers to potential rather than actual productivity. Potential biomass production is the biomass production that would be achieved in a certain grassland type under its optimal

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management regime. Secondly, grassland productivity varies greatly both geographically and in time, depending on each year's weather conditions. Furthermore, some grassland types are more variable in terms of productivity than others. Specifically alvars, which due to the thinness of the soil and the limestone bedrock show high yearly variation in terms of productivity. Therefore, the data contained in Table 4 must be regarded as estimates with guidance purposes rather than precise calculations.

Table 4. Area and potential biomass production of semi-natural grasslands in Lääne County

Grassland type	Area (ha)	Estimated biomass production potential (kg/ha yr ±SD)*	Calorific potential (GJ/ha)*2
6210	1261	**3144** ±131	47
6270*	1181	**3144** ±131	47
6280*	**1869**	**1328** ±119	**-**
6410	311	-	-
6430	455	-	-
6450	**6266**	**7433** ±1716	104
6510	564	-	-
6530*	**1694**	**1986** ±300	29
9070	793	-	-
1630*	**5923**	**3050** ±360	110

*The estimates of potential biomass production have been compiled from several publications and studies carried out in Estonia. The full list is located in the references section.

*2 Melts (2014) estimated the energetic value for some of the semi-natural habitats present in Estonia

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Figure 10 shows the distance to main roads in Lääne County. Distance to roads should be an important criterion to take into account when planning the location of a plant for grassland processing, pelleting, burning or biogas/biofuel conversion. In Figure 8, those areas shown in yellow/orange/red are more "isolated" in terms of distance to main roads and therefore, grasslands located in those patches are more inaccessible.

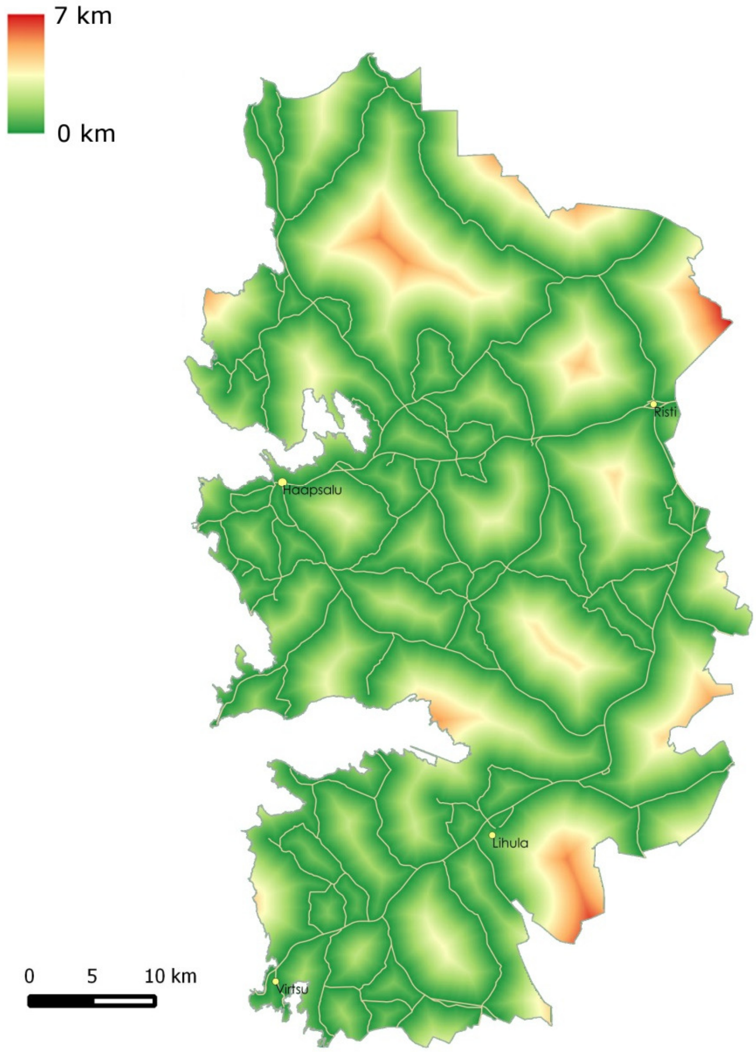

Figure 10. Distance to main roads in Lääne County (previous to Administrative reform).

Based on the information presented above, a **Bioenergy DMS** (https://vgrass.hnit-baltic.lt/vgsites/bioenergy/) has been developed within Viva Grass project. The main objectives of the DMS are:

1. Assess grass-based energy resources (area, production, calorific potential for district heating).
2. Inform relevant planners/stakeholders about areas with the highest potential for grass for energy (prioritizing).

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3.1 Application of the Viva Grass BioEnergy module in Lääne County and recommendations for use

The **Viva Grass BioEnergy** module (https://vgrass.hnit-baltic.lt/vgsites/bioenergy/) has been designed as an information tool and its intended use is basic guidance on grass-based energy sources. The bioenergy DMS provides the user with a number of information layers that the user can consult in two different ways:

- By clicking on a particular grassland
- Selecting several grasslands by drawing a selection polygon

The information provided by the tool is grouped in the following layers:

- Location of district heating plants
- Energy demands: Energy demands refer only to the demands for **district heating.** This layer is calculated as the number of inhabitants in district heated apartments per sq.km.
- Biomass potential: The potential production of grass in kg/ha by grassland habitat type
- Bioenergy potential: The calorific potential of grass to be used as solid fuel for heating in GJ/ha
- Recommended grazing pressure: This additional layer displays the recommended grazing as AU/ha (Animal Units). The recommended grazing pressure is understood as the optimal amount of grazing animals needed to maintain different grassland habitats in optimal conditions. This layer informs the user on the possible alternative management (grazing) when the calorific and production potential of certain grassland types do not meet the standards required for district heating.

In the particular case of Lääne County, the BioEnergy module shows the main locations of grass-based energy resources, primarily in Matsalu RP, but also in the coastal areas of Haapsalu laht and Silma LKA. Although this could be considered "hotspots" for the production of grass-based energy resources, there are other areas that should not be disregarded, such as Vormsi island or the alluvial meadows around Kasari and Vigala rivers.

Although the potential for grass-based energy resources in Lääne County is very high, only the boiler house located in Lihula town is adapted for hay bales combustion.

Any project aiming at the production of heat based on biomass resources from semi-natural grasslands should consider the (*Guidelines for biomass for energy Cost Benefit Analysis (CBA)*) (Villoslada Pecina, 2016). produced within Viva Grass project.

A brief description of the Viva Grass BioEnergy is included below (**Figure 11**):

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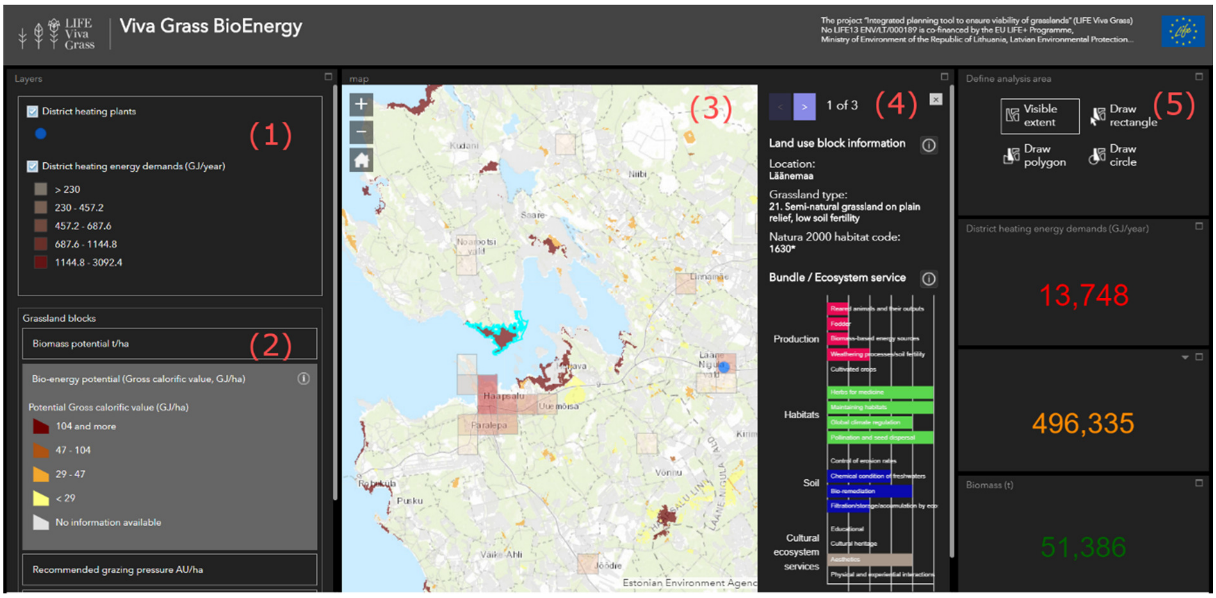

Figure 11. Viva Grass BioEnergy

(1) The first panel includes information regarding the location of district heating plants. Information on potential demands of energy for district heating is also included and aggregated at the sq. km (see previous section).

(2) The grasslands panel contains three layers of information: *Potential biomass production (t/ha)*, *potential calorific value (GJ/ha)* and *recommended grazing pressure (AU/ha).* The information contained in this layers is provided by habitat type and has been obtained from scientific literature review and technical management recommendations documents.

(3) In the visualization panel the selected layers can be displayed and consulted. When clicking on a specific grassland, the consultation panel opens:

(4) In the consultation panel, the specific information about the selected grassland is displayed, mainly: Grassland type and Annex I habitat code, ecosystem services provided, biomass and calorific potential and recommended grazing pressure.

(5) In the summary panel, the tool aggregates and summarizes information for a particular area. The user can choose from several area selection methods

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