MAGYAR AGRÁR- ÉS ÉLETTUDOMÁNYI EGYETEM

THESIS

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Thesis Title: EXPLORATORY LAND USE SUITABILITY AND VULNERABILITY FOR ECO-SCHEME PARTICIPATION WITH GIS

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1. INTRODUCTION

This section outlines the focus of the respective study and mentions its significance and what it aims to achieve.

1.1 Problem Statement

Agriculture must be both environmentally sustainable and economically viable for the food security of a growing population in light of environmental challenges. Environmentally friendly agricultural practices aim to prevent the depletion of necessary resources for farming and maintenance, or restoration, of ecosystem services. There are regulations, such as those provided by the European Unions' Common Agricultural Policy (CAP), to address sustainable food, fuel, and fibre production for a multifunctional agricultural sector. The new CAP contains updated regulations for farmers, such as enhanced conditionality, as well as optional practices, called 'Eco-Schemes'. Farmers, therefore, need to consider whether they will participate in the optional practices, and which practices they will apply on which area of the land. Hungary has designed their Eco-Schemes, as contained in their National Strategic Plan (NSP), according to agricultural land use, namely, arable land, grasslands, and permanent plantations. Recommendations by the Hungarian Chamber of Agriculture (NAK) further guide the Eco-Scheme selection according to areas that are vulnerable to soil, biodiversity and/or water degradation. Land suitability classification for agricultural use is important to consider for agricultural practices because land is an invaluable constituent for agriculture and connected to the environmental vulnerabilities related to agricultural practices. Land that is highly suitable for agricultural usage appropriate practices that minimise any environmental degradation by agricultural production. On the other hand, land that is less suitable or not suitable for agricultural usage necessitates ecosystem restoration or protection measures. Therefore, farmers in Hungary must consider many factors when deciding how to implement Eco-Schemes. GIS can be utilized to combine these factors using cartography.

The current study investigates how farmers perceive the updates of the new CAP (2023-2027) and their decisions about which Eco-Scheme measures to implement considering their land's suitability classification, agricultural usage, and environmental vulnerability. All three areas incorporated in this study, namely, the CAP, land suitability analysis and environmental vulnerabilities are complex themes and only considered within the limitations of this undergraduate research report.

It is challenging to implement complex policies, such as the CAP, to systematic themes, such as agriculture. Therefore, it is important to understand how such implementation is perceived at grassroots level. Additionally, it is crucial to support farmers in the decision making and administrative procedure of the CAP's implementation. Furthermore, farmers' perception and feedback to the policies could guide improved regulations. The findings of this study could possibly provide a format for the coherent combination of criteria contained in policy implementation.

The changes in the new CAP (2023-2027) are recent and there are limited publications available. However, much content was generated when the changes were decided. This study reflects factors to focus on in the upcoming years when studying the CAP. Stakeholders, such as extension officers and agri-business companies, as well as policymakers could benefit from the findings of the research.

The current study makes use of quantitative data for the suitability analysis in GIS and qualitative data for the discussion of the structured interview findings. Land suitability analysis is performed using the analytical hierarchy process (AHP) tool for multi-criteria decision making (MCDM) with QGIS software. This is relevant to the study because it provides a capability to combine heterogeneous information for strategic procedures. The qualitative results of the structured interviews are important because it reveals the grassroot experience of farmers concerning the CAP implementation.

Environmental issues are central to the new CAP (2023-2027) and farmers are becoming familiar with the respective focus. Farmers should adjust their practices accordingly. The timely investigation of this research, as the changes are being implemented, could assist organisations and farmers in their understanding and decision-making surrounding land use and agricultural practices.

1.2 Research Aims, Objectives and Questions

The aims, objectives and questions related to this research project are outlined in this section.

1.2.1 Aim

The aim of this study is to explore how farmers perceive the changes in the new CAP (2023-2027) and how they decide to implement Eco-Schemes. Furthermore, it aims to combine considerations for Eco-Scheme implementation using GIS and incorporate agricultural land use suitability classification with Eco-Scheme selection recommendation.

1.2.2 Objectives

The objectives of this study are the following:

i) To analyse changes in the new CAP (2023-2027) so that the implication for farmers' practices can be understood

ii) To explore the Eco-Schemes contained in Hungary's National Strategic Plan so that the options for farmers can be understood

iii) To create a land use suitability analysis for agricultural use of the sample area so that the suitability classification can be combined with other considerations for Eco-Scheme implementation

iv) To create a GIS containing agricultural land use analysis, land use, and vulnerability hotspots so that Eco-Scheme recommendations can be considered coherently

v) To show how GIS can be used to aggregate decision-making information for farmers

1.2.3. Research Questions

I. What are the important changes contained in the new CAP (2023 - 2027)?
II. What is the Eco-Scheme design in Hungary's National Strategic Plan?
III. How can the land suitability for agricultural use be classified in the sample area using GIS?
IV. What are the agricultural land use suitability classification results?
V. What is the feedback from local farmers on the results of the land suitability analysis for agricultural use and classification?
VI. How do farmers perceive the changes and implementation of the new CAP?
VII. How do farmers decide which options of the CAP Eco-Scheme to implement?
VIII. Do farmers agree with the Eco-Scheme recommendation for their farm location?

1.3 Pilot area

Three settlements in central northern Hungary are considered as a sample area for this study: Gödöllő, Isaszeg and Kerepes. These settlements are in the region of the main campus belonging to the Hungarian University of Agriculture and Life Sciences.

2. LITERATURE REVIEW

The literature review has two distinctive parts. Firstly, the CAP is discussed. Secondly, land suitability analysis for agricultural use is discussed.

2.1 Rationale for Eco-Scheme

Agri-environmental deterioration is sometimes addressed by strategies for improvement of agricultural practices. Imbalances in water, soil, air, and biodiversity have many negative consequences (Namiotko et al., 2022.). Namiotko et al. (2022) explains that a deteriorated agri-environmental situation is perpetuated by the growing worldwide demand for food, production intensity and increasing frequency of extreme weather events. On the other hand, favourable factors can promote a good agri-environmental situation such as improvements in agricultural technologies and increased demand for ecosystem services such as clean water, air, soil, rich biodiversity and attractive landscapes. Countries in the European Union have international commitments such as the European Green Deal (EGD) that aims to achieve zero pollution, halt biodiversity loss and design more sustainable food systems and reduce the adverse impact on the environment using more sustainable farming practices through Agri-Environment and Climate Schemes (AECSs) (Namiotko et al., 2022.). The new CAP (2023-2027) includes National Strategic Plans designed by Member States and includes Eco-Schemes which are voluntary participation practices for farmers (Viool, et al. 2021). Hungary's Eco-Scheme, called the Agro-Ökológiai Program (AÖP), is centred around land use categories (NAK, 2023) and NAK recommends that farmers implement the scheme according to their land's vulnerability to specific degradation: soil, water and/or biodiversity. The Eco-Scheme is further explored in Section 2.5.3.

2.2 Land Use in Hungary

Land is limited resource and under pressure by an increasing population and economic growth (Gong et al., 2012). Creemers et al. (2019) mention that the impact of different land use practices is much debated in sustainable agriculture. The SDG 15 ("Life on Land") targets protection and restoration of sustainable use of terrestrial ecosystems, fighting desertification, and halting land degradation (United Nations, 2016, cited in Ackerschott et al., 2023). Half of the world's habitable land (Richie, et al. 2022) and 39% of the total area of European land (EEA, 2017, p.46) is used for agriculture. Therefore, addressing agricultural land use is addressing a large portion of 'Life on Land'.

Agricultural land use is significant in Hungary with 5.3 million hectares part of agricultural cultivation (NAK, 2019, cited in Barath et al., 2024). However, Barath et al. (2024) mentions that access to land is highly concentrated and there are many small farms in Hungary. Additionally, agriculture is a crucial contributor to the country's exports and economic progress (EC, 2022). Hungary has natural resources that favour agricultural production with its soils, topography, and climate to the extent that the country may be nearly self-sufficient in producing primary agricultural products from the 1960s (Hoyk et al., 2022). However, Hoyk et al. summarise that climate change and complex land degradation processes significantly affect production and future predictions indicate adverse outcomes for the crop production sector in Hungary. The utilised agricultural area in Hungary decreased from 69.6% in 1990 to 57% in 2019 mainly due to infrastructure modernization and urban sprawl (Hoyk et al., 2022). There are soil, water and biodiversity degradation vulnerabilities related to land use and its relevance in the Hungarian context is further discussed.

2.2.2 Soil

The earth's soil resource is the cornerstone of food water production, water capture, and energy generation from biological systems. Soil degradation is directly related to declines in productivity which place soil at the forefront when considering increasing food, energy, and water security (Hatfield et al., 2017). The quality of soil in an area is a primary determinant parameter of land suitability evaluations (Kamkar et al., 2014). Approximately 81% of agricultural land in Hungary is used as arable land. However, arable farmers increasingly experience extreme weather events that result in water erosion of inadequate water in the production period. Eco-schemes provide specific support for soil conservation practices that enhance the transition and uptake of soil conservation farming practices (NAK, 2023; Baráth et al., 2024).

2.2.3 Water

Water's vulnerability to degradation and pollution is central to land use themes and agricultural practices. Water bodies are at risk of nutrient leaching from soil (Namiotko et al., 2022, Richie et al., 2022). Agriculture requires large amounts of water as input (Richie et al. 2022). In Hungary, as mentioned by Hoyk et al. (2022), droughts are an increasing challenge for farmers. They outline that in Hungary, between 1901 and 2019, there was a 24% decrease in the number of rainy days and a 26% increase in the average annual temperature. Furthermore, water usage in agriculture has increased over the last 20 years from 110.7 to 140.45 million m^3. Kamkar et al. (2014) affirm that precipitation and temperature are the most evident influences of weather on crop yield during the growing season and an principal determinant parameter of land suitability evaluations.

2.2.4 Biodiversity

Agricultural intensification contributes to biodiversity loss (Hoyk et al., 2022). One of the contributors of biodiversity reduction is the loss of natural habitat when land previously covered by wildlands and forests are now used for agriculture (Richie and Roser, 2019; Namiotko et al., 2022). The state of biodiversity in Hungary appears to be perpetually worsening. The proportion of high nature value farmland continuous to decrease, landscape features are actively removed and the share of landscape features and fallow land in agricultural areas is below the EU average (Baráth et al., 2024). Baráth, et al. (2024) mentions that the Farmland Bird Index for arable land declined from 100 to 76.06 between 2000 and 2018. Hoyk et al. (2022) ascribes this decline to the shrinkage of habitats, including the decreased habitat diversity associated with monoculture cultivation that adversely affects plant and animal communities.

2.3 Economics of Farmer Incentive Programmes

Policies that consider the needs of the natural environment as well as human society objectives demand a balance between agricultural producers and the best interest of the entire society (Rudnicki, et al., 2023). Financial incentives as a type of payment for ecosystem services is a transfer of public funds for farmers to adhere to environmentally friendly, less-intensive practices which is justified because the use of public money is to address the society's demand for agriculture to provide environmental outcomes (Kovács et al., 2021). The purpose of the payment is to overcome the economic opportunity cost of more intensive land use (Kovács et al., 2021). Subsidies do not create requirements or prohibitions for specific uses but the monetary value influences decision-making (Ackerschott et al., 2023). Ackerschott et al. (2023) performed a systematic overview of current research on the application of economic instruments in the context of land use. They found economic instruments, such as subsidies, have significant potential in the context of land use management. Also, the most common type of subsidies is 'Payment for Ecosystem Services' (PES). They note that there may be reduced effectives for PES when attributed to land that already achieves low yields and more intensive use of land applied to areas with no subsidy payments as well as land previously uncultivated and taken into production. On the other hand, intrinsic motivation of the subsidy recipient is a decisive factor for effectiveness of the payments. Section 2.4 mentions the importance of the financial aspect of the CAP for the EU and for farmers.

2.4 Background of the Common Agricultural Policy

The Common Agricultural Policy (CAP) was launched in 1962 with the aim to provide a fair standard of living for farmers and food security for European Union (EU) citizens (Viool et al., 2021). The legal basis is established in the Treaty of the Functioning of the European Union and the policy is managed at European level. It is funded by a substantial amount of the EU's budget. For instance, in 2020 the CAP comprised 35% of the 2020 EU budget (Massot, 2018, cited by Matthews, 2018). Currently, the new CAP, supports 7 million beneficiaries across the EU (EC-a, no date) and has a budget of 386.7 billion Euros which comprise a significant part of the EU budget (Drăgoi, 2022).

The CAP is organised in two pillars: Pillar I - Agriculture and Markets and Pillar II - Rural Development (Consilium, 2023a). Pillar 1 is financed by the European Agricultural Guarantee Fund (EAGF) and concerns farm income support and market management and. Pillar II, financed by the European Agricultural Fund for Rural Development (EAFRD) as well as Member States (MS), addresses rural development and Agri-environment-climate measures. The policy has three action measures (Consilium, 2023a). Firstly, *income support* is given to farmers through direct payments, remuneration for environmentally friendly farming practices and public service delivery that would not usually be covered by markets. The second action measure of the CAP is *market measures,* and third is *rural development measures*. Drăgoi (2022) notes that Direct Payments make up 12% of the total income for two-thirds of European farms. Michels et al. (2019) explains that direct payments remain pertinent for EU farmers, but societal goals are important seeing taxpayers contribute significantly to the CAP. Also, from 2023 onwards, both Pillar I, agricultural income and market support, and Pillar II, rural development, will be combined in one strategic plan for the CAP expenditure (Kelly and Mceldowney, 2019).

2.4.1 Reform of the CAP

There have been many adaptations to the CAP since it was founded. The CAP has transformed from a market-oriented policy and direct production support to, instead, promote sustainable rural development and environmentally friendly agriculture Drăgoi (2022). The focus on industrial agriculture was replaced by sustainable or multifunctional agriculture (Hoyk et al., 2022). Viool et al. (2021) outlines the reforms. The changes in 1984 directed at surplus production mitigation and changes in 1992 focused on direct support for farmers and environmental concern. The reform in 2013 promoted sustainable farming, innovation, and rural development. The latest reform of the new CAP is characterised by environment and climate action as well as modernisation and simplification (Viool et al., 2021). Although adopted in 2021, some of the new CAP measures are implemented from 2023.

2.4.2 Criticisms of the CAP

Pe'er et al. (2020) highlight the action needed for the CAP to address sustainability challenges. Sustainability in agriculture faces the challenge of intensification and abandonment occurring simultaneously. They also outline more than 3640 scientists signed a call for action to change the CAP. Also, more than a thousand publications had a common denominator indicating that the CAP failed to steer agriculture in the EU towards sustainability and that the instrumentation is often ineffective and inefficient. Petsakos et al. (2022) summarise critiques by previous analyses of the CAP such as its relevance to challenges, misalignments with the Sustainable Development Goals and inclusivity. Hyok et al. (2022) also highlight the failures of the CAP to address challenges of the food systems, climate change and efficient spending of subsidies. Runge et al. (2022) note that the new CAP is complex and error-prone in its implementation at farm level because of the complicated interplay of the policy instruments. They conclude that if the level of complexity exceeds farmers' cognitive capacity or willingness, they could abandon the CAP to the detriment of voluntary cash benefits and the environment.

2.4.3 The Common Agricultural Policy and the European Green Deal

The CAP is now centred on environmental and climate ambitions aligned with the EU Green Deal (EGD) (Hoyk et al., 2022) and in line with the UNs' SDGs (Petsakos et al., 2022). Farmers have an important function in the European Green Deal's key policy areas. Table 1 outlines these key policy areas and the related strategy, aim or action plan. For example, Farm to Fork Strategy (F2F) contributes to the EGD by endorsing a more sustainable EU food system by addressing pesticide use and organic farming and aquaculture (Hoyk et al., 2022; Petsakos et al., 2022). The EGD is a primary policy instrument of the EU with the goal to be the first climate-neutral continent by 2050 and utilises one-third of the funds in the Multiannual Financial Framework of the EU (MFF) and the Next Generation EU program (Hoyk et al., 2022).

Table 1. European Green Deal Policy Areas which Involve Farmers in its Related Strategy, Aim or Action Plan

(Source: Table created by author with information from Viool et al., 2021)

European Green Deal Policy Areas → Related Strategy, Aim or Action Plan	
Sustainable food system	→ Farm to Fork Strategy
Protecting and enhancing biodiversity in rural ecosystem	→ Biodiversity Strategy for 2030
Climate action	→ Net-zero emissions in EU by 2050
Maintaining healthy forests	→ Forestry Strategy
Safeguarding natural resources	→ Zero Pollution action plan

Drăgoi (2022) notes that the new CAP should contribute to the EU's climate and energy goals for 2030 and the European agricultural sector must contribute to the aim of 40% greenhouse gas emissions reductions. The CAP addresses five specific targets of the EGD by the year 2030 (Viool et al., 2021; EC, 2021). The first is the reduction of chemical pesticide use by 50% and second is achieving at least 25% of agricultural land in the EU under organic farming and an increase in organic aquaculture. Another target is reducing the sales of antimicrobials in aquaculture and for farmed animals by 50%. Furthermore, at least 50% reduction in nutrient losses and no soil fertility deterioration as well as minimum 20% reduction in fertiliser usage. Finally, the EGD target also addressed by the CAP is to return at least 10% of agricultural area under high-diversity landscape features by 2030. Drăgoi (2022) also notes that it might be challenging to reach the environmental ambitions of the CAP since Member states might find it difficult to be fully achieve the goals, but the CAP aims to remain committed with the EGD objectives.

2.5 The New Common Agricultural Policy (2023-2027)

There are ten key objectives of the CAP for the 2023-27 period that focus on environmental, social, and economic goals. The objectives involve fair income for farmers, competitiveness, food change, climate change, environment, landscape and biodiversity preservation, generational renewal, rural areas, food, and health quality as well as knowledge and innovation (EC-b, no date). The Member States design their National Strategic Plans on these objectives (Viool et al., 2021).

The new CAP is a more fair, greener and more performance-based policy (Consilium, 2023b). There are three important changes in the new CAP, mentioned by the Consilium, (2023b) and explained by Viool et al., (2021). The *first* is simplification and modernization. The simplification implies no detailed EU rules for individual beneficiaries and less prescriptive EU requirements to ease reporting requirements. Member States design a NSP to outline their actions to reach the EU goals which are further discussed in Section 2.5.2. Agricultural Knowledge and Innovation (AKIS) attempts to modernise the support method using technology for administrative procedures. The *second* important change is fairer and more effective distribution of income support across Member States. The new CAP strives to allocate direct payment towards farmers whose livelihoods depend on farming and is capping direct payments at 100 000 EUR per farm in addition to the enhanced conditionality requirements to obtain support. There are both voluntary and mandatory redistributive payment mechanisms for Member States (Petsakos et al., 2022; Consilium, 2023b). Hyok et al. (2022) mentions these social elements as part of a fairer CAP considering the long-term environmental and competitiveness goals. There is a shift away from production-based support and towards agronomic and economic sector needs. The *third* crucial change is the focus on the environmental efforts (Dessart et al., 2021). There is a focus on stronger climate and environmental ambitions to contribute to the EGD targets through enhanced conditionality and Eco-Schemes in Member States' NSP. Funds are allocated to support farmers to contribute to the objectives of the EGD. The new CAP budget allocates 40% of its budget to environmentally respectful farming. Member States must use at minimum 35% of their rural development budget for actions that benefit the climate and environment and 25% of their CAP direct income support budget for Eco-Schemes. The third change forms an important part of this study and is further explored in the following three subsections. In the following three sections, changes related to the actions of Member States and practices of farmers are discussed as it relates to the updates of the new CAP (2023-2027).

2.5.1 Enhanced Conditionality

Enhanced conditionality is the minimum requirements by farmers to receive financing, such as direct Payments, and replaces the greening measures that were introduced in the 2013 CAP reform (Petsakos et al., 2022). Enhanced conditionality links environment-friendly farming practices known as Good Agricultural and Environmental Conditions (GAECs) and Statutory Management Requirements (SMRs) to direct income support (Viool et al., 2021). SMRs refer to eleven legislative obligations concerning the environment, animal and plant health, food safety and animal welfare that all farmers must adhere to. GAEC, on the other hand, are applicable to farmers receiving CAP support and include a various standards concerning climate change mitigation, soil, habitats, and water (Department of Agriculture, Food and Marine 2022). There are nine GAECs, but EU Member States specify the standards for each GAEC based on the specific characteristics of the areas concerned as well as farm size, farm structures and (Department of Agriculture, Food and Marine, 2022).

2.5.2 National Strategic Plans

The new CAP has a decentralized design that abandons the uniform approach to policy implementation across the EU and therefore Member States design their own strategic plans (Viool et al., 2021). Kelly and Mceldowney (2019) explains that the EU outlines the fundamental parameters in terms of policies and Member States are responsible to meet the objectives. Therefore, Member States consider the EU environment and climate legislation policies and EU states provide monitoring and reporting on the results. The NSP is funded by both pillars. CAP Strategic Plans allow more flexibility between the two pillars which means Member States can allocate solutions for future crises or external shocks (Drăgoi, 2022). Becker and Grajeski (2022) note that the NSP reveals a significant diversity in the national implementation of the CAP which considers local conditions and needs but may undermine common objectives. This is an improvement from the very prescriptive preceding funding periods. However, they argue that the Commission would need to strike a balance between subsidiarity and common objectives. Drăgoi (2022) notes that the EU allowed flexibility in the CAP Strategic Plans to support European farmers' difficulty and agricultural production caused by the Russia and Ukraine conflict.

2.5.3 Eco-schemes

Eco-schemes are a novel instrument in the CAP to incentivise more sustainable farm and land management for moving towards a sustainable food system, protecting the environment and supporting efforts of the EU's climate objectives (Viool et al., 2021; IFOAM, 2020). Eco-Schemes are designed by Member States in their NSP, and it is voluntary for farmers to participate in Eco-Schemes (Petsakos et al., 2022). IFOAM (2020) published an Eco-Scheme guide for managing authorities. However, farmers are encouraged to participate in Eco-Schemes by granting per hectare payment for participation (Petsakos et al., 2022).

There is substantial funding available from the direct payment framework for sustainable farming practices. The new Eco-scheme use direct payments from Pillar 1, Agri-environment-climate measures use Rural development programmes from Pillar II and conditionality use both Pillar I and Pillar II (IFOAM, 2020). A quarter of the CAP Pillar I budget is allocated to the Eco-Scheme policy instrument (Runge et al., 2022). At least 25% of the national Direct Payments budget is directed to Eco-Scheme payments in each Member States (Petsakos et al., 2022).

Eco-Schemes vary between countries due to environmental preferences, diversity in natural resource settings, experiences with AECSs as well as Member States' choices (Runge et al. 2022). Runge et al. (2022) mention that Member States need to ensure that current CAP achievements are maintained while implementing attractive new measures for voluntary engagement by farmers. Furthermore, according to Runge et al. (2022), all Member States anticipated resolute measures for arable land and that the novel emphasis on arable land, as opposed to previously dominated grassland measures, provides arable farms with new opportunities to participate.

2.6 Hungary's National Strategic Plan

Member States set out their unique NSP using many options of measures guided by the EU legislation and commitments in relation to climate and the environment (Viool et al., 2021; EC, 2023). Hungary's NSP was approved on 8 November 2022 with EUR 468 million allocated for the Eco-Schemes and EUR 539 million for environmental and climate actions under Rural Development Programmes (RDP) (Drăgoi, 2022). Hoyk et al. (2022) outline that Hungary is facing a third noteworthy challenge regarding rural development and food production in the past 30 years. The first was deconstructing the socialist system, the second was the accession to the EU and the current challenge is readjusting production-oriented agri-food and rural development policies due to sustainability and compliance with the new CAP and EGD. They raise concerns for a preference of competitiveness-enhancing aspects of digitalization instead of the environmental concerns and social justice during the next budgetary period. The European Commission recommended that Hungary's NSP should maintain competitiveness in the agricultural sector and direct its growth pattern to take advantage of the opportunities of a greener and more sustainable agriculture (Baráth et al., 2024).

A glance of the Hungarian Strategic Plan is available on the EC interface (EC-c, no date). In the respective document it highlights the priorities of the NSP. There is a focus on fair income for farmers and fair distribution of financial support, i.e. the basic income support per hectare is EUR 150/hectare. The Strategy is aimed at supporting its rural areas with sustainable development, advancing modern technologies, and improving the market situation. Furthermore, it aims to contribute to job creation and assistance for small and medium-sized farms as well as infrastructure in rural settlements. Finally, also, it aims to address secure food supply while improving environmental conditions and contributing to the renewal of natural resources.

2.6.1 Hungary's Eco-Scheme: Agro-Ökológiai Program

The Hungarian Eco-Scheme is called Agro-Ökológiai Program (AÖP). Runge et al. (2022) surveyed the Eco-Scheme measurements in NSP of Member States. Hungary's Eco-Scheme targets arable land, grasslands, and permanent crops. The three measures originate from greening obligations and the environmental aspects target climate, water quality, soil protection and biodiversity as well as afforestation. Farmers annually select practices for all land use categories with a value of 2 point per category (NAK, 2023). There is a list of practices according to the three land use categories and these are outlined in the Appendices 9.2 Agro-Ökológiai Program (AÖP).

The Deputy State Secretary, Zsolt Feldman (2023), reported that more than four million hectares have been submitted to the AÖP by farmers in Hungary. The most popular practices chosen are crop diversification, microbiological soil preparations and soil and plan conditioner applications respectively. Table 2 reflects the land areas submitted to the practices of the AÖP in 2023. The percentage indicates the ratio of arable land under the practice to the total arable land cover in Hungary.

Table 2. Practices Farmers Participate in for the AÖP in 2023/24.

(Source: Table created by author with information provided by NAK, 2023)

AÖP Code	AÖP Practice	Total (ha)	Percentage
A1	Mulching	62 675	1.8
A2	Crop diversification	2 106 893	60.7
A3	Preserve landscape features	40 980	1.2
A4	Biodiversity (limit parcel size)	153 748	4.4
A5	Protection of pollinators	415 612	12.0
A6	Eco-friendly use of urea fertilizer	962 251	27.7
A7	Microbiological preparations for soil condition	1 217 748	35.1
A8	Soil and plant conditioners (N-fixation)	1 040 437	30.0
A9	Reduced / No Tillage	427 564	12.3
	Sum	3 472 149	100.0

2.6.2 NAK Recommendation for Selection of Eco-Scheme Practice

The National Ministry of Agriculture (NAK) designed a recommendation structure for farmers to decide which AÖP practice would provide the most environmental advantage to their land. This is based on three categories of land areas that are vulnerable to soil, water, and biodiversity degradation. NAK created three thematic overlay groups using the Agricultural Parcel Identification System, in Hungarian named ‘Mezőgazdasági Parcella Azonosító Rendszer (MePAR)’ and other layers with the technical assistance of the National Land Centre (NLC). The layers were combined for each vulnerability category. Table 3 details the layers used to indicate the respective vulnerability categories.

Table 3. Input Layers for Thematic Overlay Groups: Soil, Water and Biodiversity
(Source: Table created by author with information from NAK and NCL)

	Groups (Vulnerability Category)		
	Soil	**Water**	**Biodiversity**
Input Layers	MePAR thematic overlay: Risk of erosion	MePAR thematic overlay: Flood-prone	MePAR thematic overlay: High Natural Value
		MePAR thematic overlay: Further Development (Vásárhelyi Terv Továbbfejlesztésében)	Natura 2000
	Slope > 12%	MePAR thematic overlay: Inland water	Permanent grasslands

2.7 Previous Research on Farmers and the Common Agricultural Policy

There are various studies evaluating the CAP, its reforms and farmers’ implementation and perception. Here follows an overview of some specific literature findings.

2.7.1 Farmers’ disposition towards sustainability and the CAP

Dos Santos et al. (2010) studied the attitudes of the Portuguese farmers towards the CAP. They conducted interviews and used quantitative analysis in their research. The findings include that small farmers are concerned with credit access conditions and technical support. It highlights the importance of local farmer participation with infrastructure projects and policy. Michels et al. (2019) did research on German farmers’ perspectives of direct payments in the CAP. They concluded that direct payments are crucial for farmers’ income and necessary for structural change leading to diversified farms. Creemers et al. (2019) considered the relationship between farmers' perception of sustainability and future farming strategies for three commodities: sugar beet, diary, and feta cheese. They observed differences among the respective farmers and highlighted the importance of accurate policy measures towards more sustainable farming systems in the EU. Also, they conclude that farmers' attitudes towards sustainability affect their intention to implement certain farming strategies.

2.7.2 Policy's Economic and Environmental Impact

Petsakos et al. (2022) analyse farm-level economic and environmental impacts of the post-2020 reform of the CAP using scenario-based analysis. Petsakos et al. (2022) highlights that there are only few attempts of quantitative assessment of the economic and/or environmental impacts of the new CAP and that farm-level impacts have been overlooked in the policy debate. Their study used the IFM CAP model (Individual Farm Model for CAP Analysis). They conclude that enhanced conditionality might have a greater role than Eco-Schemes in achieving environmental improvements and that an ideal policy mix will necessitate balancing income support with environmental performance. Baráth et al. (2024) analysed the impact of participation in the Agri-environment scheme of Hungarian field crop farmers considering their eco-efficiency. They examined the studied impact of AES on environmental aspects from previous findings and found that approximately half of the schemes did not deliver positive effects. Additionally, there is a greater need for better, locally adapted AES. Eco-efficiency is measured as the ratio of economic value added to environmental damage, i.e. eco-efficiency = economic value added/environmental damage. They found that there are no significant differences in eco-efficiency between participating and non-participating farmers when considering the relationship of farm income to fertilizers, pesticide, and energy use. Therefore, they concluded that there are opportunities to increase eco-efficiency in Hungarian crop farms. Hyok et al. (2022) identified policy gaps in the Hungarian strategies. Their study analysed policies and publications affecting Hungarian agribusiness developments. They concluded that the Hungarian agribusiness sector and policymakers should include a comprehensive focus on environmental issues in a balanced development approach.

2.7.3 Decision-making and Behaviour

Kovács et al. (2021) studied the complicated decision-making of farmers to participate in a financial conservation incentive programme. Their study was set in the aftermath of cancelled Agri-environment payments by the Hungarian government in 2014. They found that farmers mostly evaluated rules around any direct cost of applying the rule and if rules lead to apparent and directly attributable environmental benefits. However, they found that only a few farmers were motivated by environmental concerns. They further confirm an unmet expectation that financial incentives serve as a 'learning process' to modify social norms. Additionally, farmers' willingness to participate in conservation programmes is a result of complex considerations and roles of support structures, institutional pressures, multi-level political context and farmer-state relationships. They also noted in their conclusion that the negotiation and institutional position of incentive programmes require further attention, especially, to citizen-state relations when schemes are mostly state-led. Rudnicki et al. (2022) aimed to present a multifaceted assessment of spatial differences in the engagement of farms with regards to the implementation of pro-environmental CAP measures as well as the identification of conditions that determine the above spatial distribution. Their study was conducted in Poland. They found that pro-environment activities of farmers are characterised by a remarkable geographical diversity. In their findings, farmers who mostly apply for payment from the CAP had a high level of pro-environment internal characteristics or the farms were located in municipalities with a lower level of socio-economic development or farms located in former Prussian Partition. Dessart et al. (2021) did an extensive behavioural experiment on farmers and the new green architecture of the CAP. They identified that there is a challenge to establish the right balance between mandatory measures (conditionality) and voluntary schemes (i.e. Eco-Schemes and Agri-environment-climate measures (AECMs). The objective of the study was to collect empirical evidence on farmers' behaviour and inform the implementation of the new CAP. They concluded, with caution and nuance, that enhanced conditionality may decrease level of enrolment by farmers in voluntary schemes but may increase the general adoption of environmentally friendly practices if there is a meaningful increase in conditionality. Also, reducing basic income support for sustainability (BISS) while increasing Eco-schemes may decrease the level of enrolment by farmers in voluntary schemes and total implementation of environmentally friendly practices when the payment for schemes do not entirely compensate opportunity cost. BISS is the allocation of decoupled payments and replaces the Basic Income Scheme (BPS) introduced with the 2013 CAP reform (Petsakos, et al., 2022). Runge et al. (2022) studied Eco-Schemes across the EU and noted in their conclusion that the success of Eco-Schemes will depends on the willingness of farmers to participate. Eco-Schemes must be amply attractive for farmers to engage voluntarily. Additionally, Runge et al. notes that there is a risk of increased administrative burden and cognitive load for both farmers and policy administrators.

2.8 Land Suitability Analysis for Agricultural Use

Land suitability, as defined by Gong et al. (2012), is the suitability of a provided land to support a specific land use, either in its present state or after improvements. Regional scale modelling of agriculture land suitability informs best decisions about designing sustainable management systems (Li et al., 2017; Tashayo, 2020). Land evaluation aims to determine the inherent capacity of a land unit for usage that would not lead to deterioration, socioeconomic or environmental costs (Kamkar et al., 2014; Li et al., 2017). Akinci et al. (2013) highlights that land is an irreproducible natural resource and rational and sustainable use is an important indicator of economic growth. Ostovari et al (2019) agrees with Akinci et al. (2013) that evaluating land suitability is the initial step in designing suitable land use and management systems to address adverse environmental effect on fertile lands for agriculture. Ostovari et al. 2019 explain that innovation and land management within agro-ecological potentialities and limitations may ensure agricultural production without deterioration. They found that, when comparing their findings to the results of other studies, land suitability models should be calibrated for the unique field conditions in different areas.

2.8.1 Preliminary Land Suitability Analysis

There is a vast amount of literature available on land use suitability analysis and it is beyond the scope of this paper to explore the extensive studies performed. However, the process and techniques of relevant studies that utilised Multi Criteria Decision Making (MCDM), such as Analytical Hierarchy Process (AHP), and GIS are considered. Singha and Swain (2016) reviews land suitability evaluation criteria for agricultural crop selection and describes factors such as GIS, AHP, MCDM, and Remote Sensing in previous studies. Land use suitability analysis is executed for agriculture in general (Akinci et al., 2013; Pramanik 2016; Li et al., 2017), for a category in agriculture such as arable land or a specific crop. Mishra et al. (2015) focused on suitable sites for organic farming, Ostovari et al. (2019) evaluated land suitability for rapeseed farming, Tashayo et al. (2020) for wheat farming and Kamkar et al. (2014) evaluated land suitability for canola and soybean rotation farming.

2.8.2 Input Data for Land Suitability Analysis

Akinci et al. (2013) explains that there is not a specific standard of criteria to be taken into consideration for land suitability assessment and that studies usually consider accessible data. However, many criteria should be considered together which have different levels of significance for land suitability analysis. Table 4 outlines the criteria considered in previous literature utilised.

Table 4. Criteria for Suitability Analysis in Previous Research

(Source: Created by author)

Author(s)	Criteria
Ostovari et al. (2019)	- Topography factors - Soil data
Akinci et al. (2013)	- Soil data (Great soil group; Soil depth; Erosion degree; Other) - Land use capability class and subclass - Topography factors (slope, aspect, elevation)
Tashayo et al. (2020)	- Climate factors (temperature) - Topography factors (slope and elevation) - Soil properties (texture, pH, EC, CCE and ESO)
Kamkar et al. (2014)	- Soil (texture, pH, EC) - Topographic (aspects and slope) - Climatic (precipitation, temperature)
Pramanik (2016)	- Topographic (slope, elevation, aspect) - LULC - Soil (Soil moisture; Drainage and transport network; Soil characteristics; Geology)
Li et al. (2017)	- Topography (slope) - Climatic (precipitation) - Soil (erosion, SOC, texture, pH, CEC, depth, drainage) - LULC

2.9 Geographical Information Systems (GIS)

GIS is a tool used for comprehensive area-based analyses and modelling, generating new information or knowledge as well as production of geographical databases (Belčáková et al., 2018, p.81). Furthermore, it is used to present results and cartographic presentations. Belčáková et al., (2018, p.78) explain that data in GIS is primarily related to spatially located objects, patterns, phenomena, or processes and are presented in the form of maps, digital images, and tables of geocoded data items. They conceptualise the definition of GIS with a systematic and integrative approach. GIS use computer graphics and work with information and data that relates the earth's surface (geo), visual (graphic) expression and spatial elements (entities). GIS creates spatially oriented systems that can be used to collect, store, manage, analyse, and present spatial data to model and describe space but also to create new information. Singha (2016) explains that GIS is useful in problem solving in addition to being a set of tools for the input, storage and retrieval, manipulation, analysis, and output of spatial data. GIS has two types of data models for graphic components: raster and vector (Belčáková et al., 2018, p. 79). Raster is a grid model with cells as spatial units and vector has three basic types of spatial data, namely, point, line, and polygon. Within the vector model, the non-graphical component is referred to as an attribute and descriptive data is attached to the graphic entities. Numerical values, thus not used to archive or manage data but perform analytical operations within spatial data, are used in the raster or grid data structure. Geographical Information System (GIS) can be combined with MCDM spatial analysis and presentation of the results because of its spatial data aggregation capability (Arabsheibani, 2016).

2.10 Multi-Criteria Decision-Making (MCDM)

MCDM is an interdisciplinary planning tool which is useful for dealing with multidimensional phenomena (Namiotko, et al., 2022). The basic concept of MCDM entails four processes (Thakker, 2021). The first is to establish the criteria and then, secondly, rating each item within the criteria. Thereafter, the data must be normalised and finally weights can be assigned to each criterion. Namiotko, et al. (2022) cite multiple resources to claim that MCDM methods are highly recommended to assess agri-environmental situations and evaluate its performance. There are different methods that can be applied to MCDM (Namiotko et al., 2022, Chabuk et al., 2017) and some studies use multiple methods to achieve accuracy of results (Villacreses et al., 2017; Li et al., 2017). The AHP method is utilised in the respective study and further discussed in Section 2.11.

2.11 The Analytical Hierarchy Process (AHP)

The analytical hierarchy process (AHP) was proposed by Saaty (1987). AHP divides complex decision problems into simpler decision problems to create a hierarchy of decision (Saaty 1987; Chabuk et al., 2017). In land suitability assessment, it incorporates heterogenous or multi-criteria factors to represent the relationship between Agri-ecological and environmental factors (Tashayo et al., 2020). Tashayo et al. (2020) explains that AHP, in combination with GIS, presents a novel approach for land suitability evaluation and assist to determine the relative importance of multicriteria factors. Kumar (2023) reviewed applications of AHP in agriculture and labels the AHP technique as ‘imperative’ for achieving SDG.

2.11.1 Pairwise comparisons

The AHP method by Saaty is well described by Akinci, et al. (2013) and summarised in a 5-step process by Kumar (2023). They apply AHP to sustainable agriculture and land suitability analysis for agriculture. The AHP method is based primarily on pairwise comparisons to create a pairwise comparison matrix (Saaty, 1987). Usually, a numerical 9-point scale is used, and Table 5. contains the respective scale. Each numerical value on the left is associated with a meaning of relative importance or preference between two factors as described on the right.

Table 5. Fundamental Scale of Relative Importance for Pairwise Comparison Matrix

(Source: Saaty, 1987)

Intensity of importance on an absolute scale	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8,	Intermediate values between the two adjacent judgements
Reciprocals	If activity *i* has one of the above numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*

2.11.2 Weights and normalisation

Akinci et al. (2013) and Mu and Pereyra-Rojas (2017) explain how to derive weights for the criteria. The pairwise comparison is normalised by dividing the column elements of the matrix by the sum of each column. Then, the row elements in the obtained matrix are added, and the total value is divided by the number of elements in the row. The weights are within the range of 0-1. A higher weight implies a higher importance of the factor.

2.11.3 Checking for Consistency

Saaty (1987) proposed a consistency ratio to check for consistency between the criteria in a matrix of pairwise comparisons. This measures logical inconsistencies of the judgements (Pramanik, 2016). The consistency ratio is obtained by dividing the average of consistency indices with a random index by Saaty. The Consistency Relationship depends on the Consistency Index and Random Index. λmax is the principle or highest eigenvector of the computed matrix. The Consistency Ratio (CR) is obtained by the formula CR = CI/RI, where the Consistency index (CI) is obtained by the formula CI = (λmax - *n*)/*n*-1) and the Random Index (RI) is provided by Saaty (1987) based on previous calculations. If CR > 0.10, then the weight values of the matrix indicate inconsistencies. Table 6. illustrates the random inconsistency indices (RI) for the respective sample size, labelled as *n*. In the respective study, *n* = 3 and therefore, RI = 0.58 is utilised.

Table 6: Random Inconsistency Indices (RI)

Source: Saaty (1987)

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.46	1.49

3. METHODS, TECHNIQUES AND MATERIAL

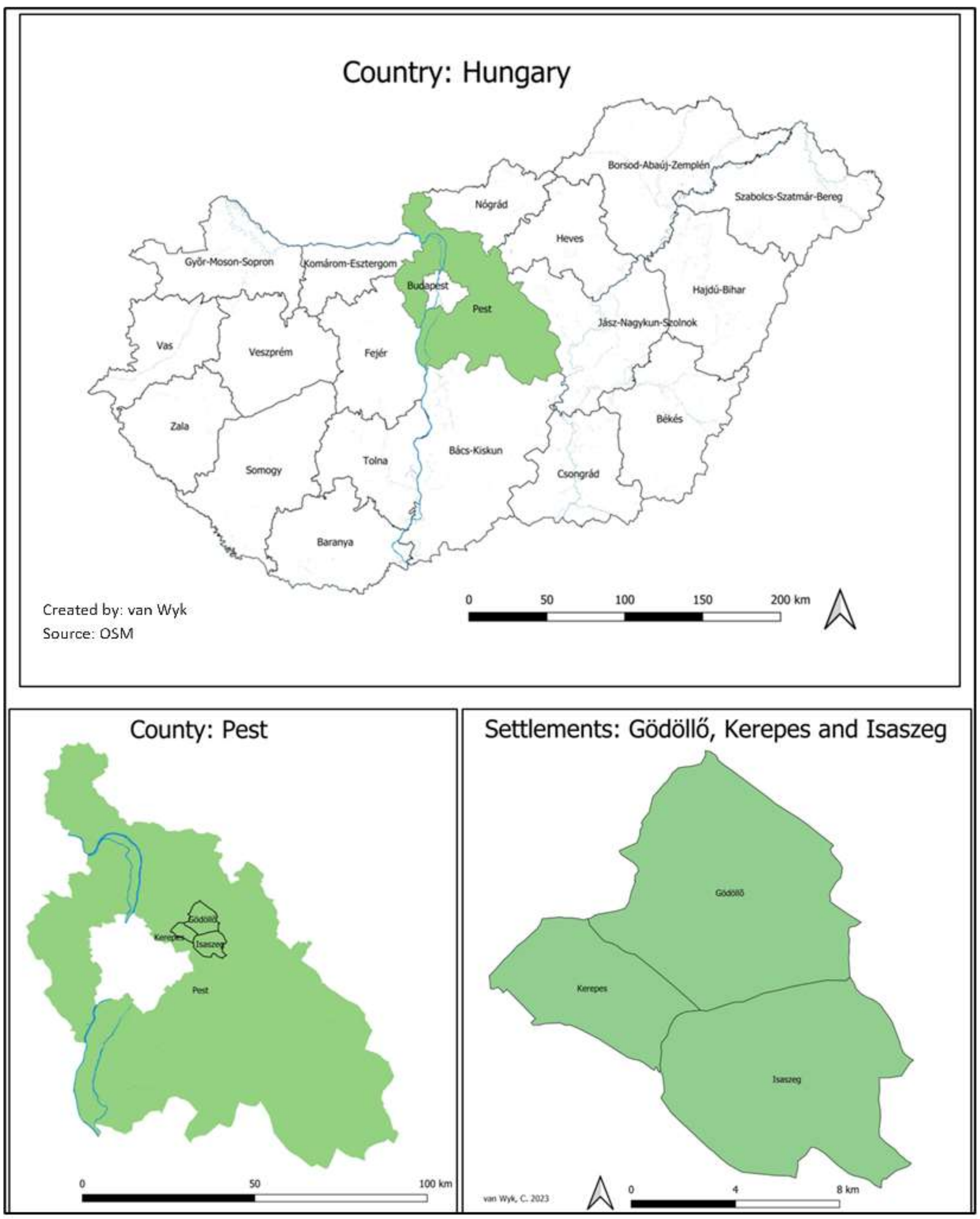
The following chapter explains the methodology and procedures of the respective study.

3.1 Study Area

The study area is located in central Europe, Hungary, and depicted in Figure 1. Gödöllő (61.74km^2), Isaszeg (54.69km^2) and Kerepes (24.01km^2) are three settlements, which are part of the Pest County, situated in the northern central part of Hungary. The study area is located north-east from the capital city, Budapest, and connected by the M3 highway.

Figure 1. Location of the Study Area Settlements in the Pest County of Hungary

(Source: Created by author in QGIS with information from Open Street Map)



3.2 Land Suitability Analysis

GIS is used to evaluate the land suitability for agricultural use with a weighted intersection approach in QGIS (version 3.10.9) software. The methodology used is MCDM, with the AHP as a tool. The land suitability analysis for agricultural use is conducted with three input factors, namely, soil suitability, slope, and precipitation. The layers in vector format are converted to raster, and homogeneously resized to a 10 x 10 m pixels resolution. Then, the raster values are normalised on a scale from 1 to 10. AHP is used to determine weights for each attribute and algebraic calculation (weighted overlay) is performed to obtain the results. Then, the results are classified into five categories to determine each area's suitability.

3.3 Geographical Information System

The software QGIS (version 3.10.9) is used to execute the work programme. The data to include into the spatial information system was recognised considering previous land suitability analysis and the implied information to discuss Hungary's Eco-Scheme (AÖP). Then, the data was collected and converted for operations and analyses. Afterwards, the results were discussed with the farmers during the structured interviews and presented in Chapter 4 of the research report.

3.4 Criteria for Suitability Analysis

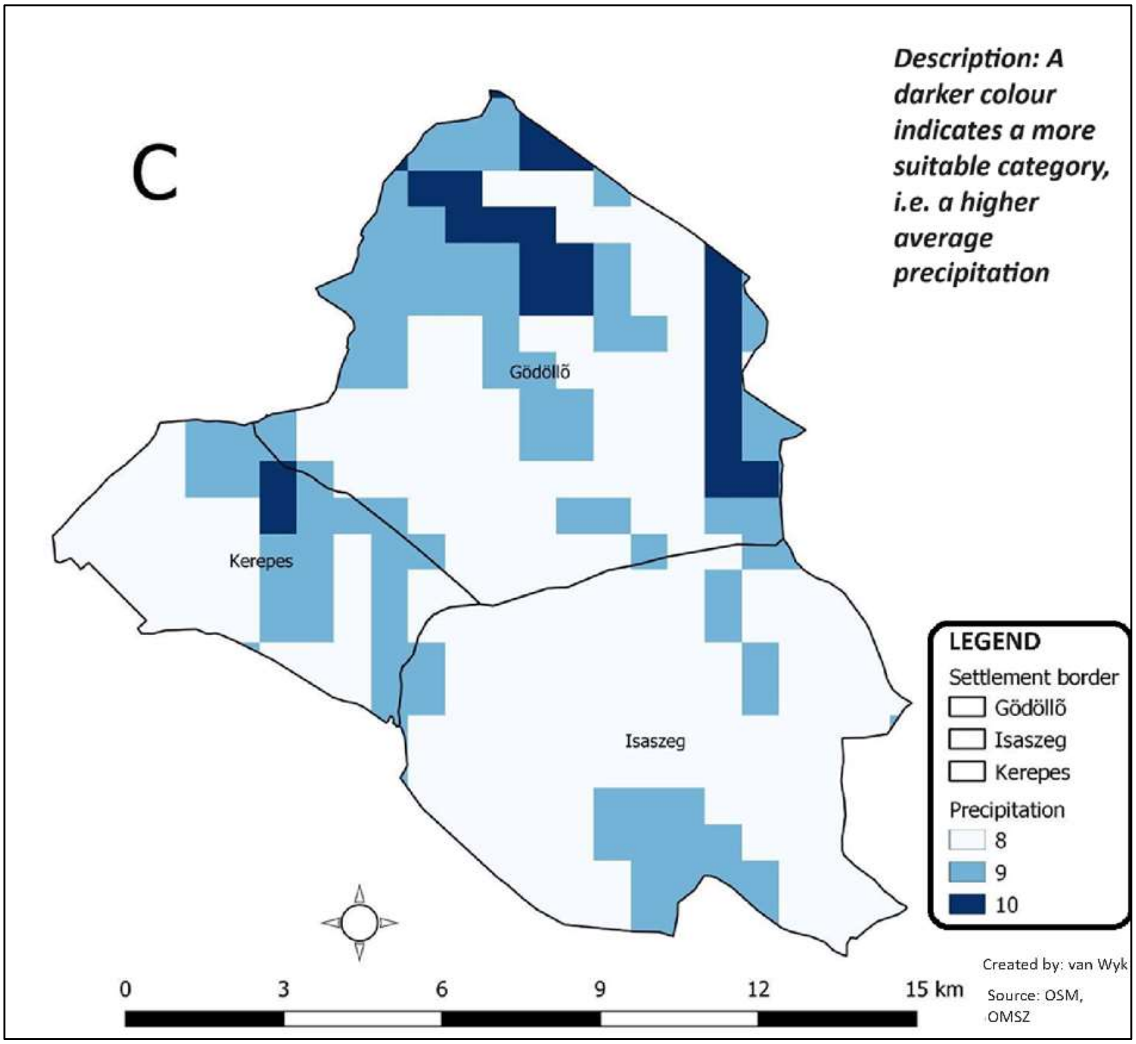
The criteria utilized for the land use suitability analysis is precipitation, soil suitability and slope. The data was obtained from the National Meteorological Service (OMSZ) through MATE, previous publications (Magyari, 2006) and the Copernicus EU (2019) interface.

3.4.1 Bio-physical component: Climate, precipitation

The average precipitation over 50 years were obtained through MATE from the National Meteorological Service (OMSZ). The data was derived from sample points and available in three groups of three months from April to November. The three different raster layers were combined using 'GRASS r. series which provides the average for each raster pixel. The raster image was clipped to the study area using 'SAGA vector <-> raster (clip raster with polygon)'. The data reclassification on the 1 – 10 range is depicted in Section 3.6. Upper values were assigned to all the precipitation categories to amplify its significance for agricultural land use areas. Figure 2. displays the resize and reclassification accordingly.

Figure 2. Average Precipitation Categorised from 1 to 10 for Agricultural Suitability

(Created by author with data provided by OMSZ and OMS)



3.4.2 Bio-physical component: Soil, arable suitability

Preliminary soil classification for field suitability were obtained from research by Magyari (2005). Field suitability classification is based on a matrix of chemical and physical parameters. The metadata is described by Magyari (2005). The primary data is obtained from the 1:25 000 Digital Kreybig Soil Information System. This system is based on a series of maps containing soil properties from the national survey. Table 7 illustrates the parameters and classification accordingly while the reclassification is depicted in Section 3.6.

Table 7. Physical and chemical properties as parameters determining suitability for arable production.

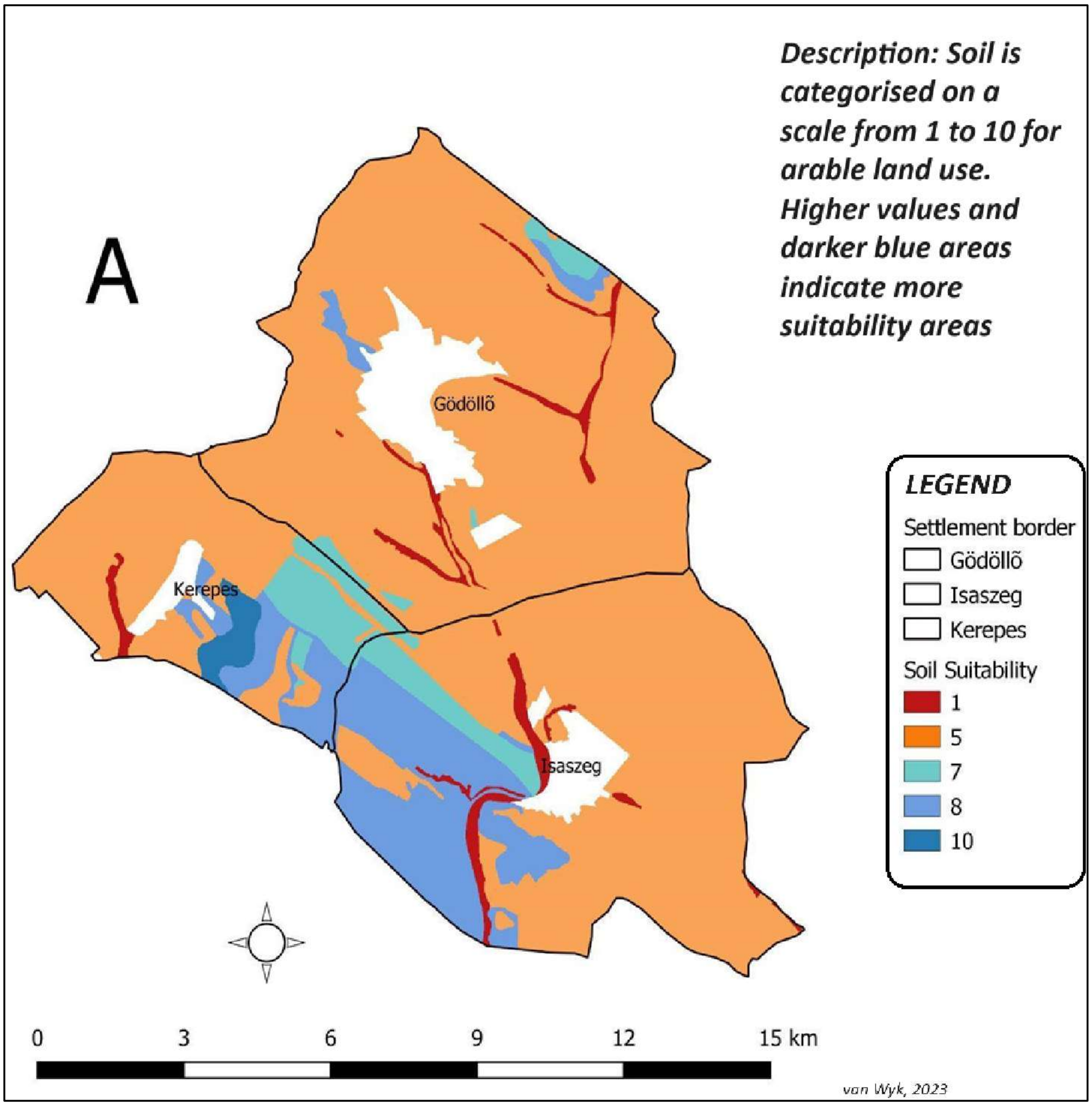
Source: Magyari (2005)

Explanation: (1) area not recommended for arable cultivation, (2) areas with very poor productivity, (3) area with poor productivity, (4) area of medium fertility, (5) an area of good production, (6) an area of high productivity, (x) excluded from investigation.		Physical parameters													
		Soils with good aquifer and water conductivity	Soils with medium water conductivity that hold water more strongly	It has poor water conductivity, holds water strongly, cracks more strongly.	Soils with high water conductivity, even good aquifer	Poorly aquifer soils with very high-water conductivity	Soils with good water conductivity and very strong water retention	Stony surface	Gravel surface	Saline soils	Peaty soils	Periodically waterlogged areas	Forests	Lakes, reedbeds, rivers	Settlements
Chemical parameters	Predominantly neutral or weakly alkaline soils saturated with lime	6	6	4	5	3	5				1				x
	Predominantly acidic soils with unsaturated lime containing carbonated lime already close to the surface in the subsoil.	5	5	3	4	3					1				x
	Predominantly more acidic, unsaturated soils, the subsoil of which near the surface does not contain carbonated lime.	4	3	3	3	2			1		1				x
	Saline t. suitable for arable cultivation. Their topsoil is usually acidic, they can mostly be improved with lime. The termer. iron. 50 cm or more.									3					x
	Saline soils with little or no potential for arable cultivation. They can be conditionally improved with lime. Termeur. iron. 30-50 cm									2					x
	Saline soils unsuitable for arable cultivation, cannot be improved with lime									1					x
	Quicksand														x
	Stony, rocky soils							1	1						x
	Periodically waterlogged areas											1			x
	Forests												3		x
	Lakes, reedbeds, rivers													1	x
	Settlements	x	x	x	x	x	x	x	x	x	x	x	x	x	x

The matrix from Table 7 was used to assign values to raster pixels according to their chemical and physical properties. Figure 3 displays the soil criteria that has been reclassified to the appropriate scale and resized to the appropriate resolution. A higher value indicates a more suitable soil category for agricultural use.

Figure 3. Soil Suitability Categorised from 1 to 10 for Agricultural Suitability

(Source: Created by author in QGIS with soil categories from Magyari, 2006. The metadata is from the Institute of Soil Sciences)

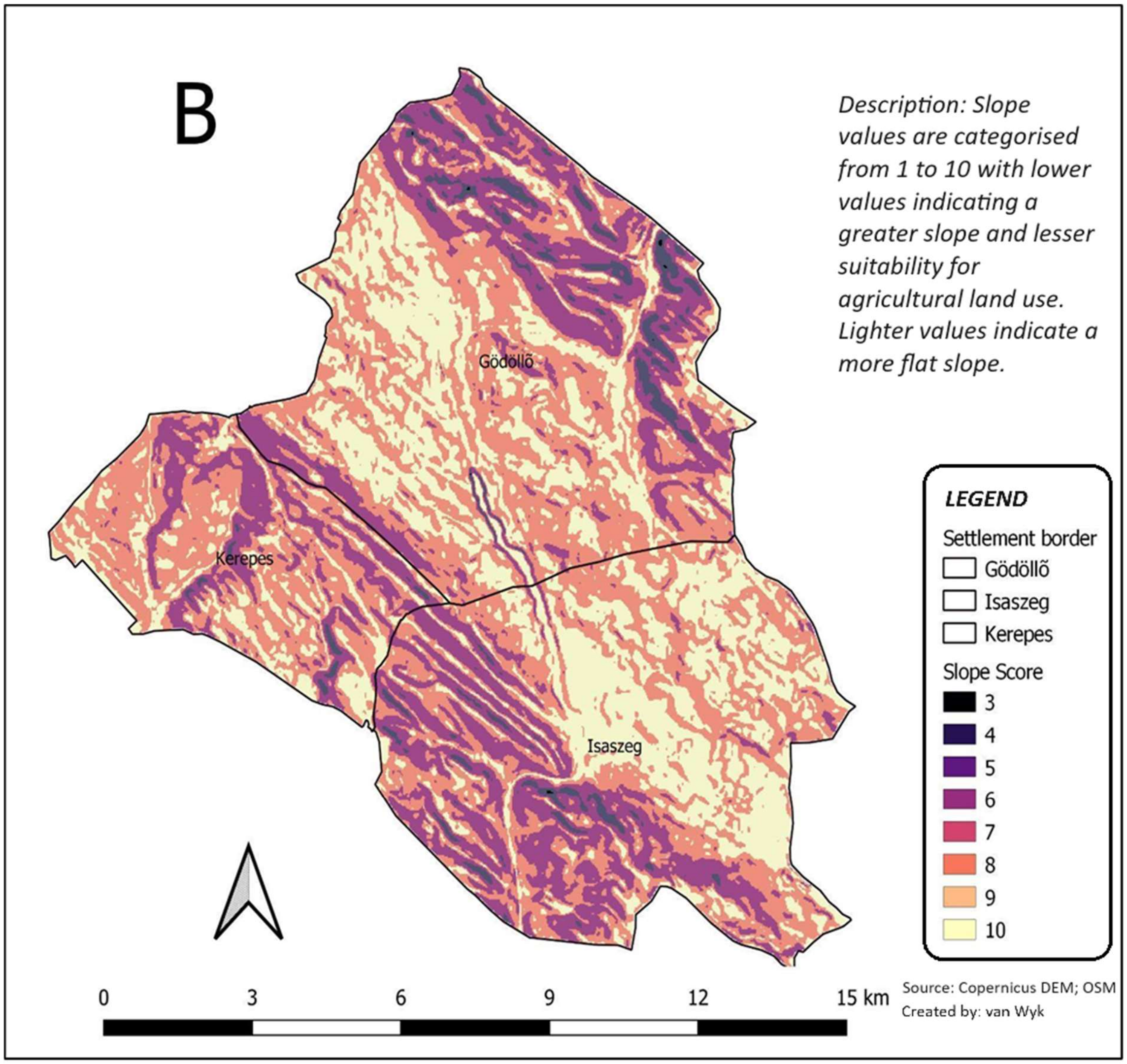


3.4.3 Geo-morphological components: Topography, Slope

The digital elevation model (DEM), with 25m x 25m resolution, is obtained from the Copernicus EU interface. Then, the territorial factor, slope, is derived from the DEM using Terrain Analysis (Slope) and resolution changed to 10 x 10 pixels using Raster extraction (Clip raster by extent). Reclassification is depicted in Section 3.6. Generally, a land more suitable for farming has low slope. Additionally, slope degree is the most effective factor for determining type of agricultural practices and drainage, irrigation, and erosion status (Ostovari, et al. 2019). Figure 4. displays the slope criteria resized and reclassified according to the appropriate scale and resolution.

Figure 4. Slope Criteria Categorised from 1 to 10 for Agricultural Suitability

(Source: Created by author in QGIS with information from Copernicus DEM, 2019)



3.5 Analytical Hierarchy Process

In previous analysis, expert's opinions were utilized to execute the AHP (Ostovari et al., 2019, Akini et al., 2013, Tashayo et al., 2020). The pairwise comparison values, as described in

Section 2.11.1, are assigned, and presented in Table 8. The comparisons are determined by the author in consideration of the determinants of importance in previous studies.

Table 8. Pairwise Comparison and Normalised Priorities
(Source: Author)

Criteria: Suitability	Slope	Soil	Rainfall	Priority/ Weight
Slope	1	1/3	3	0.26
Soil	3	1	5	0.63
Rainfall	1/3	1/5	1	0.11

Checking for consistency was performed as explained in Section 2.12.3 and figures are contained in Table 9. The CR < 0.10 and therefore the consistency is acceptable and priority values applied in the raster calculation.

Table 9. Checking for Consistency
(Source: Author)

Lmax	CI	CR
3.03871	0.01936	0.033375

3.6 Compilation of Land Suitability Criteria and Scores

All the criteria data are standardised to execute the raster calculation for suitability classification. The resolution is adjusted to 10 m x 10 m and the range rescaled to 1 - 10. The scales from 1 through 10 allocates a higher value to a category more suitable for agricultural use. Table 10 summarises the input data for the suitability analysis. The weight and influence values are derived from the AHP process explained in Section 2.11.1 and Section 3.5.

Table 10. Data for Land Suitability Analysis for Agricultural Use

(Source: Author)

Criteria	Weight	Influence (%)	Sub-criteria	Score
Slope	0.26	29%	0-2	10
			2-5	7
			5-12	5
			12-17	3
			17-30	1
Soil	0.63	61%	6	10
			5	8
			4	7
			3	5
			2	3
			1	1
			0	0
Rainfall	0.11	11%	$139 \leq x < 143$	8
			$143 \leq x < 147$	9
			$147 \leq x < 151$	10

The details of the precipitation, slope and soil classification data characterise the area. Table 11. contains the descriptive statistics for the suitability analysis input data and the letters A, B and C are matched accordingly in Figure 2., Figure 3. and Figure 4.

Table 11. Descriptive Statistics of Property Layers A, B and C
(Source: Author)

VALUES	Layer Property Statistics		
	Precipitation (C)	Slope (B)	Soil Classification (A)
Maximum	150.25	16.84	6
Minimum	139.387	0	1
Mean	142.63	3.79	3.27
Standard Deviation	N/A	2.96	0.82

3.7 Land Cover and Vulnerability Areas

GIS is used to combine the suitability classification with land use and areas that are vulnerable to soil, water, and biodiversity degradation. This is used to facilitate contemplation of Eco-Scheme recommendation and its application for farmers' land use management and agro-technical practices.

3.7.1 Socio-Economic Components: Land Cover and Land Use

The Ecosystem Map of Hungary is obtained through the NÖSZTÉP (2019) interface. The agricultural land use area for arable land, permanent plantation and grasslands is extracted. Then, the suitability analysis is clipped according to land use to create a presentable map for a prompt in the interview. Settlements, forests, wetlands, and waterbodies are indicated on the suitability classification map as constrained areas for agricultural suitability.

3.7.2 Vulnerability Areas

NAK identified land areas that are vulnerable to water, soil and biodiversity degradation using MePAR thematic and other layers. See Table 3 in Section 2.7.2 for the input layers that were combined for each vulnerability category. These three vulnerability aspects are incorporated into the Eco-Scheme recommendations. The vulnerability locations are overlaid on the current land use categories of arable land, permanent plantation, and grassland. The maps are used for discussion in the interviews with farmers.

3.8 Interviews

Two structured interviews (Elhami & Khoshnevisan, 2022) are conducted with farmers in the study area. The interviews are executed using a set of questions for discussion (see appendices) and the GIS results to explore the themes of the study. The interviews centre around feedback of the suitability analysis and the changes in the new CAP as well as the NAK recommendations for Eco-Schemes in Hungary's NSP. The farmers agreed to the interview with the independent consultant of the respective study. Farmers' identity remains anonymous in this report and careful consideration is taken that their identity is not implied in the information provided.

3.8.1 Interview Questions

The list of interview questions is attached in the appendices of this report. The interviews were conducted in Hungarian and translated to English for the author. Interviews took about two hours each and were translated between Hungarian and English. There are three themes contained in the interviews. Firstly, the land suitability analysis for agricultural land use and, secondly, the updated CAP and, finally, the Eco-Scheme implementation recommendations from the NAK. However, the questions in the interview are considered prompts for in-depth discussion on the themes.

3.8.2 Maps from the GIS Results

Three maps are presented to the farmer interviewees. Firstly is the classification of land suitability for agricultural use. Farmers provide their feedback on the classification. The second map that was presented is about the vulnerability areas within the current agricultural land use areas. Farmers provide their feedback on the vulnerability areas of or near their farm. Finally, a map containing the combined information is presented as well. This third map is used to discuss the recommendations of NAK for eco-scheme selection.

3.9 Data Analysis

The structured, in-depth interviews collect qualitative data and the descriptive feedback from the farmers are critically discussed and compared to the literature findings mentioned in Section 2.6. Answers to the list of questions were recorded on notepaper by the interviewer and further comments or discussions were noted as well. The information was summarised and compared to each other as well as to conclusions from literature sources.

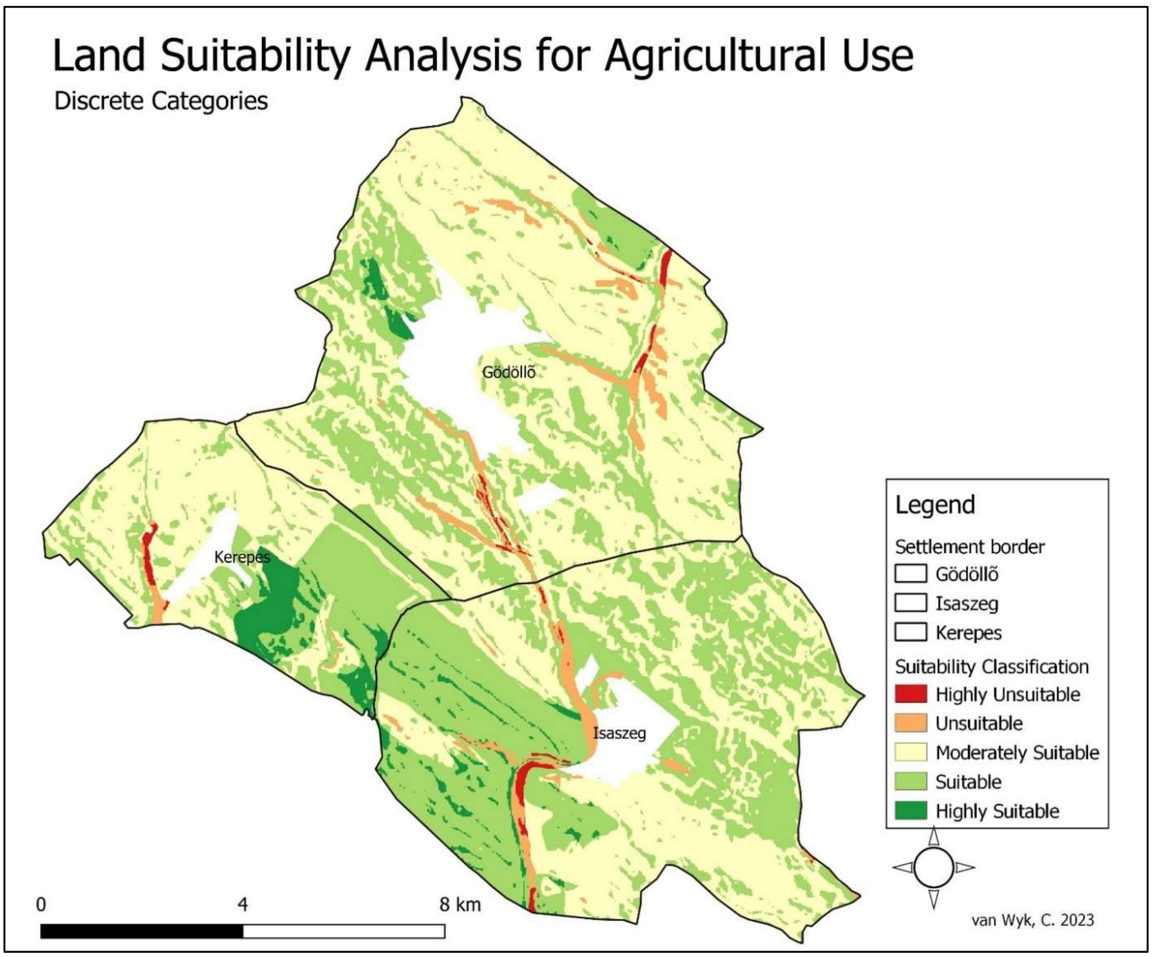
4. RESULTS AND DISCUSSION

This section precedes with the results of the suitability analysis. Following the cartography of the combined layers are presented and then the interview results are discussed.

4.1 Land Suitability Analysis for Agricultural Use

The data from the three layers displayed as Figure 2, Figure 3, and Figure 4 are assigned a weight using raster calculation and the suitability rescaled using discrete interpolation with continuous mode into 5 categories. Figure 5 illustrates the final suitability classification.

Figure 5. Land Suitability Classification for Agricultural Use with Discrete Categories
(Source: Created by author in QGIS with data from layer A, B and C in Section 3.4)



The statistics for the suitability classification is displayed in Table 12. As seen on the Table, 3.15 % is considered very suitable and 39.57 % and 53.45 % classified as suitable and moderately suitable respectively. Furthermore, 3.19 % is classified as poorly suitable and 0.63

% as very unsuitable. Therefore, the largest part of the study area is considered moderately suitable and suitable.

Table 12. Suitability Classification Statistics

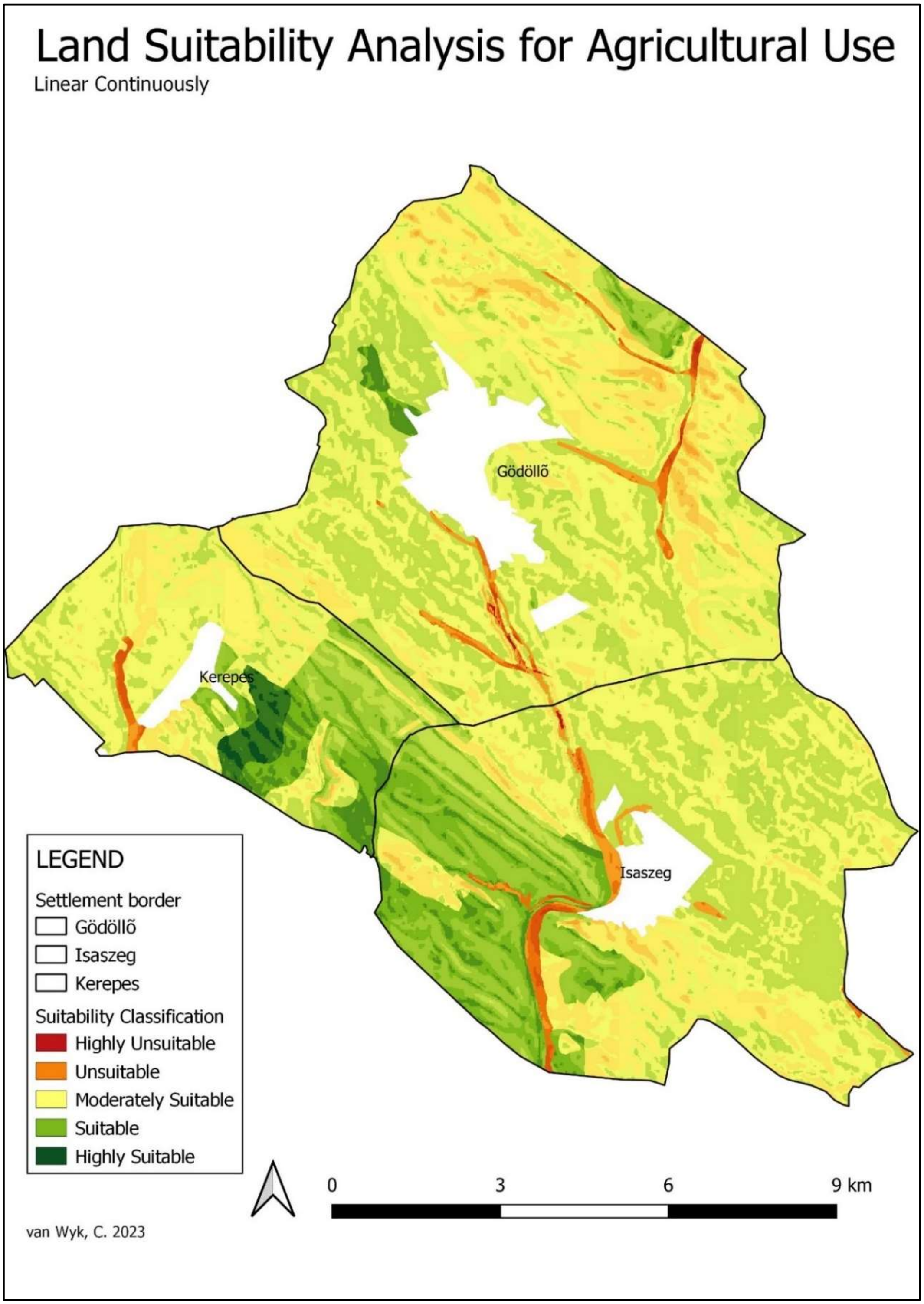
(Source: Author)

Suitability	**Agricultural Land Use**	
	Area (ha)	**% of total**
Very suitable	414	3,15
Suitable	5201	39,57
Moderately suitable	7025	53,45
poorly suitable	420	3,19
very unsuitable	83	0,63
Total area	**13143**	**100**

The results of the Suitability Analysis can also be symbolised with a continuous linear mode. This is illustrated in Figure 6.

Figure 6. Land Suitability Classification for Agricultural Use with Continuous Classification

(Source: Created by author in QGIS with data from layer A, B and C in Section 3.4)

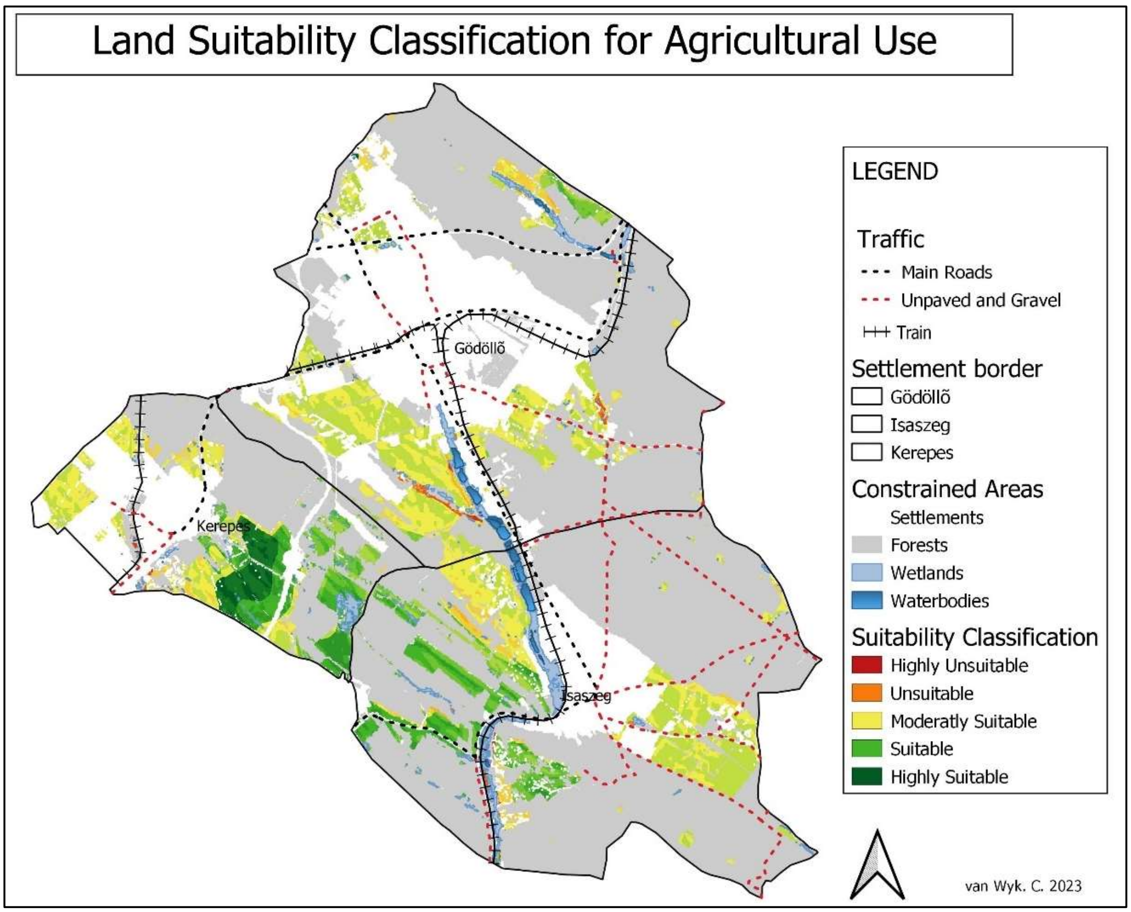


4.2 Agricultural Land Use and Vulnerability Areas

The suitability map for the interviews included the constrained areas, namely, settlements, forests, wetlands, and waterbodies. Traffic information as added for reference. This map is displayed as Figure 7 in the current section.

Figure 7. Land Suitability Classification for Agricultural Use with Constrained Areas

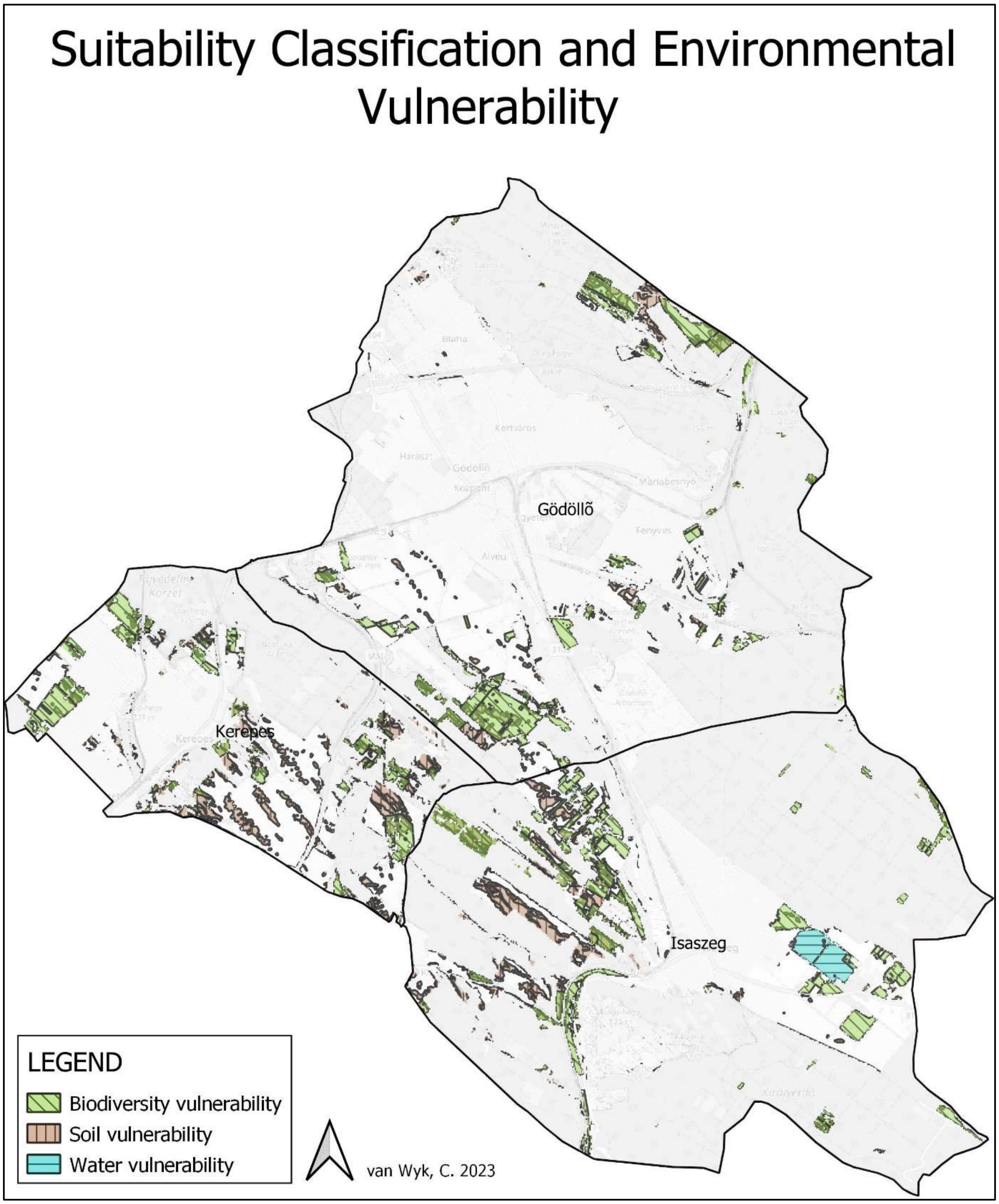
(Source: Created by author in QGIS with data from layer A, B and C in Section 3.4; NÖSZTÉP, 2019; OSM)



Areas that are vulnerable to soil, water and biodiversity degradation was delineated by the National Land Centre (NLC). These areas were overlaid (clipped) with the current agricultural land cover categories, namely arable land, permanent plantation, and grasslands. Figure 7 contains the vulnerability categories within the agricultural land use areas.

Figure 8. Agricultural Land Use Areas that are Vulnerable to Soil, Water and/or Biodiversity Degradation

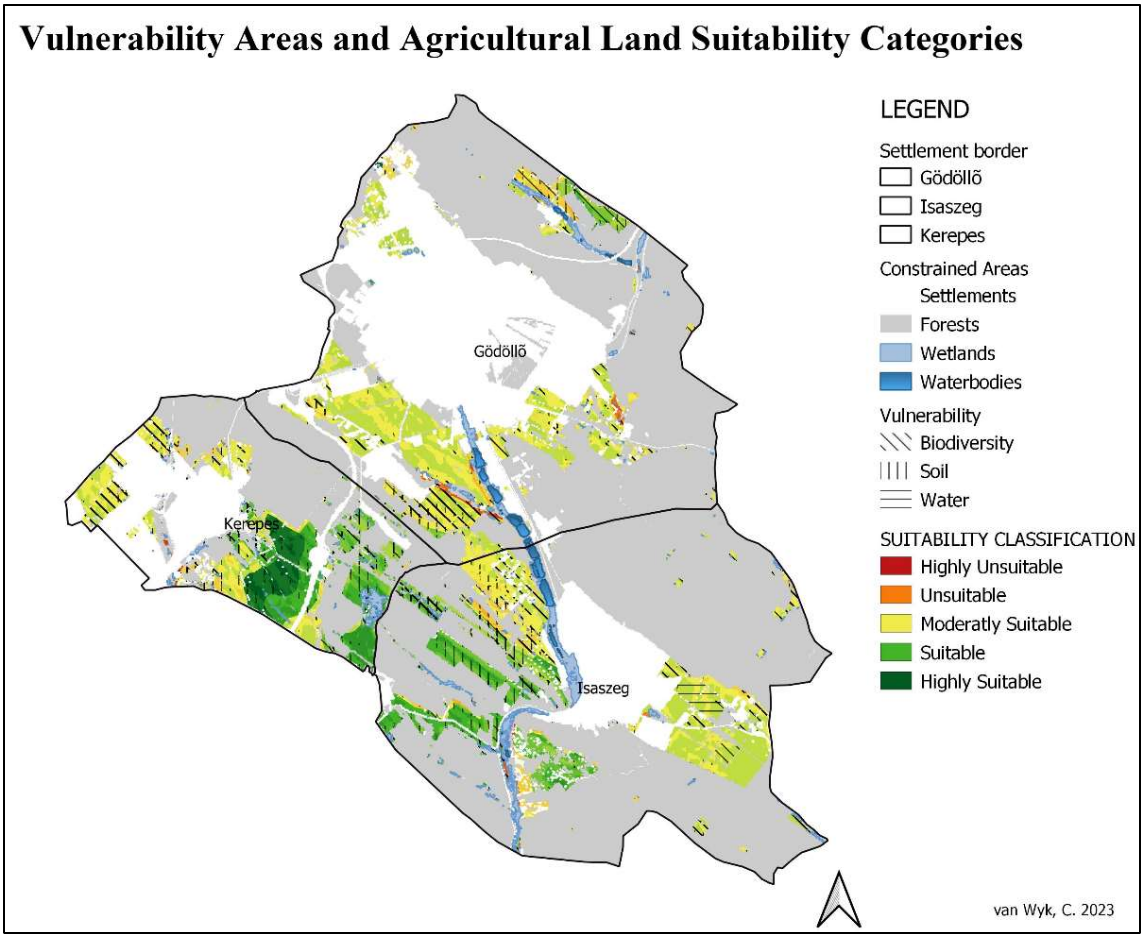
Source: Created by author in QGIS with information from NLC in Table 3; MePAR)



Finally then, GIS was used to aggregate all the information for discussing land suitability for agricultural use and Eco-Scheme selection. Figure 8 contains the suitability classification and the biodiversity classification for land currently used for agriculture while the constrained areas are indicated as well.

Figure 9. Agricultural Land Use Suitability Classification and Vulnerable Areas

(Source: Created by author in QGIS with data from layer A, B and C in Section 3.4; NÖSZTÉP, 2019; OSM; NLC; MePAR)



4.3 Farmer Interviews

The two farmers interviewed are diversified crop farmers using arable land primarily in Gödöllő. To distinguish between them, the terms 'Farmer 1' and 'Farmer 2' will be used. Farmer 1 has an operation of 50 hectares and Farmer 2 less than 50 hectares. This section outlines responses by the interviewees and mentions connections with the literature discussed in Chapter Two.

4.3.1 Suitability Analysis

The interviewees found that the land use suitability categories for agricultural use were fairly accurate. Both mentioned an area south-west in Gödöllő where the soil is very sandy and therefore less suitable for agricultural usage. Farmer 1 found that an area north-west in Isaszeg, bordering Gödöllő, is more suitable on the western side of the waterbody than proximal to the waterbody. Farmer 1 also pointed out that the southern area in Gödöllő is more suitable for agricultural use than some parts in Isaszeg.

The three factors used to determine suitability were evaluated. Farmer 1 found that slope is crucial from an economic point of view because of the increased fuel and energy cost to drive up a hill. However, he finds, that this is not important in the areas studied because there are not many steep slopes. Farmer 1 ranks precipitation as the most important factor in the area, followed by soil and slope. Similarly, Farmer 2 highlights the importance of precipitation as a suitability criterion. Additionally, Farmer 2 pointed out that the order of importance depends on the area considered. For instance, in Kerepes slope is a very important determining criteria while rainfall is very important in Gödöllő. Farmer 2 then mentions that land management influences the quality of suitability for agricultural use. For example, he points out an area in Gödöllő where winter wheat performed very well after two fallow seasons. Ostovari et al. (2019) highlights the importance of calibrating land suitability models for the variable field conditions that exist in different areas. Interestingly, both farmers mentioned the same concept.

The two interviewees discussed changes in climate, especially drought and flooding risk. Farmer 2 discussed that precipitation is less consistent than many years ago. He raised concern about the fluctuating temperatures and dry winters as well as extended dry periods followed by excessive rain which damage topsoil and cause erosion. Farmer 2 explained that there was an area in Gödöllő which were like a 'marsh' where he could plant vegetables without irrigation. This area is completely dry now. Also, the small Rakos stream does not contain water anymore. In Section 2.2 and the respective subsections, climate change as it's adverse implication for crop production were mentioned (Hoyk, et al., 2022).

4.3.2 Land Management

The interviewees discussed the changes in land use after the regime changes in Hungary. They explained that land in proximity to cities, especially the capital, were purchased for investment purposes instead of utilisation for farmland. Simultaneously, land that were historically shared for agricultural utilisation are now abandoned. Also, there are many small parcels of land (30-

40 hectare) that were divided when inherited while, at the same time, increase the landowners. Therefore, the land parcel size decrease and the number of owners increase. This complicates successful land management. For example, Farmer 2 explained that weed management is complicated by fallow land where weed seeds are multiplied. Furthermore, a small parcel of land cannot provide sufficient income from an agricultural operation to a support a family. As mentioned in Section 2.2, Baráth et al. (2024) explains that access to land is highly concentrated in Hungary and there are many small farms. Additionally, Hoyk et al. (2022) explains that land degradation processes indicate adverse outcomes for crop producers in Hungary. Hoyk et al. also mentions the decreased utilised agricultural area in Hungary due attributed to urban sprawl and infrastructure modernization. Baráth et al. (2024) highlights the importance of locally adapted Agri environmental schemes and Farmer 2 mentioned that the land use 'issues' closer to cities, such as Budapest, are different than areas far away from cities, such as the Great Plain.

4.3.3 Common Agricultural Policy

Both farmers interviewees mentioned that the income provided by the CAP is essential for small farmers. Farmer 1 interviewee said that ¼ of this income is from direct payments of the CAP. Michels et al. (2019) mentioned the essence of direct payments for farmers' income. Similarly, Dos Santos et al. (2010) highlighted the importance of financial support for small farmers. Farmer 2 reflected that if small farmers do not receive support, they cannot afford their farming inputs and it might not be worthwhile for farmers to carry out their activities.

The two interviewees ranked the complexity of the new CAP (2023-2027) an 8 on a scale from 1 to 10. As mentioned, Runge et al. (2022) notes that if the complexity exceeds farmers' cognitive capacity or willingness, they could abandon the CAP. Farmer 1 and Farmer 2 explain that the digitalization of the CAP is complicated for older generations that are not familiar with internet and technology. Farmer 1 explains that the administrative burden of submitting claims is manageable for large companies because they have the human capital to execute it, whereas small farmers do not have the capacity to complete much paperwork by him or herself. Farmer 1 receives communication about the CAP from NAK via email and Farmer 2 through the local NAK office.

4.3.4 Eco-Scheme (Agro-Ökológiai Program)

Farmer 1 did not participate the AÖP this year because he finds direct payments sufficient. However, after the interview and better understanding of the scheme, he raised interest in participating in the AÖP. Farmer 2 participated in the AÖP this year.

Farmer 1 claims that many farmers implement environmentally friendly practices but do not expect payment for this while others might only implement practices for the financial reward. Farmer 1 mentioned that older farmers might chose an Eco-Scheme that is the easiest to implement on their operation while younger farmers, interested in organic farming and permaculture, might choose the options that are most beneficial for the environment instead. However, he mentions that older farmers come from a background where increased fertilizer use was simply to achieve higher yields. Farmer 2 expects that farmers would select Eco-Scheme options that are most suitable to their farming system. Farmer 2 himself selected the options based on his current practices, ease of implementation and environmental benefit derived from the practice. It seems the interviewee's views reflect the findings of Creemers et al. (2019) that farmers' attitudes towards sustainability affect their intention to implement specific farming strategies and Ackerschott, et al. (2023) that intrinsic motivation of the subsidy recipient is a decisive factor for effectiveness of the payments.

Farmer 2 commented on the likelihood that farmers chose the Eco-Scheme option of 10% fallow for areas that are simply too unsuitable for agricultural use. Ackerschott, et al. (2023) mentioned that the effectiveness of subsidies may be reduced when attributed to land with low yields while other land use is intensified and uncultivated land is taken into production.

The nine practices contained in the Eco-Scheme for arable land were discussed with the interviewees and their response is captured in a table format in Table 13.

Table 13. Interviewee's Response to Eco-Scheme Practices for Arable Land

(Source: author)

Practice	Farmer 1	Farmer 2
A1) Mulching	Does not find advantageous: weed pressure	Does not find advantageous: autumn tillage preferred to spring tillage and weed pressure
A2) Crop Diversification	Implements this practice	Implements this practice: persistent weed pressure despite practice. *Agreed to this practice for the AÖP.* As mentioned in Section 2.7.1, this is also the most popular practice farmers signed up for.
A3) Preserve landscape features	Implements this and does not use pesticide on field margin	Implements this practice: favours this to 'rest' the soil because of perceived yield benefit after fallow period. Does not generally favour this practice in the sample area. *Agreed to this practice for the AÖP.*
A4) Biodiversity (limit field size)	Implements this practice: largest area is 4ha	Total land use less than 50 hectare

Practice	Farmer 1	Farmer 2
A5) Protection of pollinators	Implements this practice because the neighbours farms with bees	Implements this practice. *Agreed to this practice for the AÖP.*
A6) Eco-friendly use of urea fertilizer	Does not make use of urea fertilizer	Do not have necessary equipment to implement practice
A7) Microbiological preparations for soil condition	Attempted this but did not find success	Attempted this but did not find success: Corn maturity was delayed
A8) Soil and plant conditioners (N-fixation)	Unsure what this measure requires	Utilises manure from geese (obtained from a local farm)
A9) Reduced / No tillage	Implements this practice: additionally does not use pesticides and herbicide usage is limited to triticale and oat	Interested in this practice

4.3.5 Areas Vulnerable to Degradation

Biodiversity is the primary vulnerable category for Farmer 1. Farmer 1 explains that he is implementing practices to protect and enhance biodiversity. However, he is concerned about the number of predator animals, such as ravens and foxes, that are not controlled. Farmer 2 discussed the general vulnerabilities predominant in the sample area, namely, biodiversity and soil. As mentioned in Section 4.3.2, Farmer 2 explained that the small parcels of fallow land threaten biodiversity because of it's potential to multiply weed seeds. Weeds that are of particular concern include *Ambrosia artemisiifolia, Datura stramonium* and *Asclepias syriaca*. Farmer 2 also discussed the soil degradation vulnerability due to drought and the intensity of rain. Furthermore, he is concerned that historical practices, especially during the previous regime, that encouraged excessive use of fertilizer, pesticide and herbicide have degraded the land and soil. Farmer 2 explains that manure as a soil conditioner is currently difficult to obtain. Historically there was more animal husbandry practices in the area whereas currently there is less. Apart from fallow land, Farmer 2 considers cover crop practices as beneficial for soil improvement.

5. CONCLUSION AND RECOMMENDATION

This exploratory study cannot demand firm conclusions from the results obtained. Therefore, important factors noticed during the study area highlighted and could possibly guide themes to consider for future research endeavours.

5.1 Conclusions

Common themes were reflected in the literature and within the feedback from farmers. The feedback from farmers interviewed reflect conclusion drawn from previous research. These overlapping themes are outlined but further investigation would be required to confirm their usage in decision making. It seems that it is important to calibrate agricultural suitability analysis to the area investigated. The literature findings and the feedback from farmers indicate that certain criterion would have a different weight of importance depending on the area investigated. Furthermore, the theme of challenges in land management were reflected in the literature and interviews with specific reference to the concentrated land ownership and management of small parcels in proximity to urban areas.

The changes in the CAP are new, implemented in the same year as this research report was written. Important changes include the measures to address objectives of the EGD and SDG. There is a strong indication that farmers, especially small-scale farmers, are fairly dependant on the financial support of the CAP to maintain a financially viable agricultural operation. The literature indicated the risk of high complexity in the new CAP (2023-2027) and both interviewees echoed the concern about the digitalization for farmers that are not familiar with novel internet and technology. Furthermore, both the literature and the findings explain that there are diverse motivations and processes for deciding to and deciding which practices to participate in the Eco-Scheme programme.

The literature findings outlined the vulnerability for degradation in soil, water, and biodiversity conditions. Furthermore, the interviewees agreed and raised concern about some environmental challenges. Extended drought periods and increased intensity of rain within short periods were of particular distress. Accordingly then, the literature and the interviewees agree that implementing certain practices that favour or improve a sustainable agri-environmental condition would be advantageous.

Land suitability analysis for agricultural use is necessary for sustainable land management. The suitability analysis results indicate that majority of the study area, the three settlements namely Gödöllő, Isaszeg and Kerepes are moderately suitable or suitable for agricultural use.

This study highlights the usefulness of GIS for farmers, governmental institutions, policy makers or any person involved in land management. In this study, GIS proved a useful tool for analysing spatial data. Additionally, it proved a useful tool for aggregating different information to consider for decision-making. Cartography results demonstrated effectiveness as a prompt for discussion because farmers could discuss land management and agri-environmental issues of the space that they are familiar with.

5.1 Recommendations

A limitation to this study includes the small number of farmers interviewed. Although the interviews were long and in-depth, future studies could use a larger sample size. That is, a larger sample size interviewed with coded results could be useful to draw firm conclusions. Nevertheless, as an exploratory study the information obtained can be utilised for further research developments. Research concerning feedback to the CAP could also be extended to non-farmers in the future.

The suitability analysis incorporated three factors and the results were fairly accurate judging from farmers' feedback since they are very familiar with the area. However, considering their feedback, the ranking of criteria with the AHP could be more carefully calibrated for the specific area. For example, rainfall could be assigned a higher ranked and consequent weight of importance. A study designed with Participatory Geographical Information System could be appropriate for more precise feedback on suitability and land management. Additional information (layers) for analysing suitability could also be appropriate or incorporation of economic and social criteria. Furthermore, the suitability was focused on agriculture in general, except the soil layer was customed to arable land suitability. Future studies could do separate suitability analysis for grassland management of permanent plantations. The findings of this research report might be useful for considering future research by scholars, policy makers or government institutions. Noteworthy, the farmers interviewed were directed to the NAK interface (Hungarian Chamber of Agriculture) for more information and participation in the Hungarian Agro-Ökológiai Program (AÖP).

It is recommended that farmers consider all information available when selecting practices from the Agro-Ökológiai Program (AÖP) to implement on their farms. Information to consider includes land use categories, land suitability classification, constrained areas as well as areas that are vulnerable to environmental degradation. Farmers should consider practices that are environmentally beneficial to their land area but also suitable to their farming system. Finally, farmers should consider the assistance available by the Hungarian Chamber of Agriculture for selecting practices and executing the administrative requirements.

6. SUMMARY

The latest reforms in the European Union's Common Agricultural Policy (CAP) are instrumental to the European Green Deal (EGD) and Sustainable Development Goals (SDG). A novel aspect includes measures to incentivise farmers to implement environmentally friendly practices outlined in Eco-Schemes. Eco-Schemes are uniquely designed by Member States (MS) and contained in their National Strategic Plan (NSP). The Hungarian Ministry of Agriculture (NAK) designed their Eco-Scheme called Agro-Ökológiai Program (AÖP) around agricultural land use categories, namely, arable land, grasslands, and permanent crops. Hungarian farmers can choose from a list of practices to voluntary implement on their farm. The Hungarian Ministry of Agriculture (NAK), in collaboration with the National Land Centre (NLC) further designed a recommendation layout for farmers to choose which options of the Eco-Scheme practices are most suitable on their land based on three categories: Areas that are most vulnerable to soil, water and biodiversity degradation.

This study aimed to explore farmers' perception on the changes in the new CAP (2023-2027) and their decision making to select Eco-Scheme practice options. The area of research included three settlements in proximity of the Hungarian University of Agriculture and Life Sciences. Land suitability analysis for agricultural usage was incorporated into the study as a factor that farmers consider when selecting an Eco-Scheme option. Farmers must consider multiple factors when deciding how to participate in Eco - Schemes. GIS was used to aggregating the information available for consideration to select implementation practices of the Eco-Scheme. Then, two structured interviews with farmers in the sample area were conducted to obtain their feedback and perception. A list of interview questions together with the agricultural land use suitability classification, vulnerability categories and land use areas were presented to two farmers in a structured interview. Their feedback was discussed in comparison with each other as well as compared to the literature findings. This exploratory study cannot demand firm conclusions from the results obtained. Therefore, important factors noticed during the study area highlighted and could possibly guide themes to consider for future research endeavours.

The suitability analysis was performed considering climate, topography, and soil factors with a weighted overlay technique in QGIS. The weights were determined using the Analytical Hierarchy Process (AHP). Soil has the highest weight, followed by slope and precipitation. The results of the land suitability analysis for agricultural use indicate that most of the study area is suitable or moderately suitable for agricultural land use. Results of the aggregated information to consider for Eco-Scheme consideration is depicted in cartographic format. Farmers' feedback was positive about the results of the suitability analysis, but they highlighted the importance of precipitation for the study area.

There were common themes echoed in the interviews that were reflected in the literature. The support provided by the CAP are important for the viability of farmers' operation. However, it is possible that a complexity in the CAP could be difficult for farmers considering the administrative burden. The motivations and decision process for participation in Eco-Schemes are likely very diverse among farmers. Furthermore, it is important to calibrate agricultural suitability analysis to the area investigated. There is an indication that land management challenges are different in proximity to urban areas. Environmental challenges are important in the literature and for the farmers interviewed with special reference to decreased precipitation and fluctuating temperatures.

Limitations to the study include the small number of farmers interviewed and few input factors for the suitability analysis. The findings of the respective research proved the usefulness of GIS for aggregating information and decision-making for farmers, governmental institutions, policy makers or any person involved in agriculture or land management. Additionally, the cartographic result of GIS is a useful prompt for in-depth discussions with individuals that have expert knowledge on an area investigated.

The findings of the exploratory research could be helpful for considering future research themes or areas of investigation for scholars, policy makers or government institutions. Additionally, the farmers interviewed gained further understanding of the Hungarian Agro-Ökológiai Program (AÖP) and were directed to the NAK interface for participation information.

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8.1 Databases

Name of database	Source
Administrative boundaries	Open Street Map https://download.geofabrik.de/europe/hungary.html
Rivers, lakes	Open Street Map https://download.geofabrik.de/europe/hungary.html
Traffic lines	Open Street Map https://download.geofabrik.de/europe/hungary.html
Digital Kreybig Soil Information System	Institute for Soil Sciences Centre for Agricultural Research
Land Cover	NÖSZTÉP (2019) Ecosystem Base Map of Hungary. Ministry of Agriculture. (KEHOP-430-VEKOP-15-2016-00001) Available at: http://alapterkep.termeszetem.hu/ DOI: 10.34811/oss.alapterkep
Elevation	Copernicus DEM (2019) Available at: https://spacedata.copernicus.eu/collections/copernicus-digital-elevation-model DOI: https://doi.org/10.5270/ESA-c5d3d65
Precipitation	National Meteorological Service
Vulnerability areas	National Land Center (MePAR thematic layers)

9. APPENDICES

9.1 Interview Questions

Study: Consideration of land use suitability and environmental vulnerability when choosing a new support scheme

Student details: Cornelia van Wyk, Bachelor of Agricultural Engineering, MATE

The aim of this interview is to explore the implementation of the new Common Agricultural Policy (CAP) support scheme.

The questions consist of three parts: the first on the agricultural suitability of land and the second on ecosystem potential. The basic point of the new support system in the common agricultural policy is to increase environmental protection and environmental ambition. The third part of the question set is a hypothetical interpretation of the selection of a new system to implement the environmental protection of a given area in the best possible way.

1. See the classification of the suitability of land for agricultural purposes on the map shown in Figure 1.

    1.1 Do you consider that this classification accurately reflects the suitability of land for agricultural use?

    - Yes
    - No
    - Comment: ____

    1.2 Review the three factors used for classification and rank them according to the scale shown in Figure 2.

SOIL < = > SLOPE

SLOPE < = > PRECIPITATION

SOIL < = > PRECIPITATION

2. Questions related to the new CAP to be introduced in 2023-2027

    2.1 On a scale of one to ten, how complicated do you find changes to the CAP?

    2.2 Are you aware of the proposal of the NAK Eco-Scheme, AÖP?

        2.2.1 If so, where did you hear about it?

    2.3 Have you participated in the AÖP for 2023?

        2.3.1 If so, why

        2.3.2 If not, why not?

2.4 The proposal of the NAK agro-ecological program operates in a points system. Annexes 4 and 5 contain agro-ecological programme options; Please give your answer to the options relevant to your farm (arable land, grassland, plantation)

- I already use this practice on my farm
- It could easily be implemented on my farm
- It would be difficult to implement in my economy
- It would greatly improve the ecological condition of my farm

2.5 What do you think is the biggest incentive when choosing an agro-ecological program:

- Ease of implementation
- Economic benefit
- Improving the environmental status of the economy
- Other

2.6 Which category of environmental vulnerability is the biggest concern in your farm?

- Water
- Soil
- Biodiversity

3. This section applies to your farm. Identify the land plot in Figure 3. Take, for example, Figure 3, which shows the suitability and vulnerability of Gödöllő, Isaszeg and Kerepes, and Figures 4 and 5 with the recommendations from NAK for vulnerability categories.

3.1 Do you agree with the recommendations of NAK considering the vulnerability and suitability of your land?

3.2 What are your views on the recommendation?

3.3 Select the statement(s) for each recommendation:

- This practice would improve the environmental condition of my farm
- This practice could easily be implemented on my farm
- This practice would be difficult to implement in my economy
- I can benefit economically from this practice
- There should be no economic benefit from this practice

9.2 Agro-Ökológiai Program (AÖP)

The coloured sections indicate the recommended practices by NAK. The AÖP point is the Eco-Scheme point and the soil, water and biodiversity point indicate the order of recommendation for areas of the respective vulnerable to degradation category. The practices are numbered for the sake of reference in this study when discussing the practices in Section 4.3.4.

Land Use	Practice	AÖP Point	Soil	Water	Biodiversity
(1) Arable	For summer and autumn crops, if not autumn crops follow, provide mulching with cover crops or by maintaining stubble in culture condition until the start of preparatory work on spring crops of the following year, but at least until 28 February.	1	2	2	3
(2) Arable	Requirements for crop diversification in the case of arable crops: (a) farmers on arable land of 10 hectares or less must cultivate at least two different crops on arable land each year, with two crops occupying no more than 80 % of the arable land on the largest crop;	1	2	3	2
(3) Arable	Landscape elements corresponding to 10% of arable land protected under GAEC 8; forest strips and rows of trees protecting fields; field margins, erosion protection strips; water protection strips not under arable cultivation; terraces, erosion control facilities; wetland recorded in LPIS; land lying fallow; EFA secondary crops without the use of plant protection products; area under nitrogen-fixing crops without the use of plant protection products; or maintaining a combination of these.	2	1	1	1
(4) Arable	Where the total arable land on the holding exceeds 50 ha, the maximum size of arable fields shall not exceed 30 ha. Any overlap with the AKG "voluntary board size limitation" requirement is avoided by preventing the customer who has opted for this requirement in the AKG in the AÖP.	1	3	3	3
(5) Arable	During plant protection, the use of pesticides classified as specifically or moderately dangerous or risky for bees is prohibited according to the authorisation document. A regularly updated list of unusable substances is published by the MA for informational purposes.	1	3	2	2
(6) Arable	Immediate incorporation of urea fertilizer or, in case of liquid urea, application of an inhibitor during application.	1			
(7) Arable	Microbiological preparations applied and worked into the ground before sowing or in one pass with sowing or on stem residues on at least 50 % of arable land and mixed into the soil.	2			
(8) Arable	Application of soil conditioning, plant conditioning or N-fixing preparations on at least 50 % of arable land.	1			

(9) Arable	Non-rotational cultivation (minimum tillage, zero-till, direct sowing) on at least 50 % of the cultivated arable land with reduced pesticide active substance use. A regularly updated list of applicable plant protection products is published by the MA.	2	1	3	3
(10) Grassland	Conservation of grassland at field level compared to permanent grassland of the previous year. It is forbidden to break up or plough lawns. – Only available on non-Natura 2000 grasslands	1			
(11) Grassland	Continuation of pastoral or intermittent grazing on at least 50 % of grassland with a grazing plan. Grazing of one section should not exceed 12 days. - All grasslands are optional.	2			
(12) Grassland	Mowing lawns at least once a year. - Only available on non-Natura 2000 grasslands.	1			
(13) Grassland	Use only a reciprocating scythe. - All grasslands are optional	2			
(14) Grassland	wrapping with foil is prohibited. – Optional on all grasslands.	1			
(15) Plantation	Use of micro-irrigation techniques on at least 50 % of the orchard area	2			
(16) Plantation	During plant protection, the use of pesticides classified as specifically or moderately dangerous or risky for bees is prohibited according to the authorisation document. A regularly updated list of unusable substances is published by the MA for informational purposes.	1			
(17) Plantation	The use of authorised biological agents on at least 50 % of the orchard area	2			
(18) Plantation	Application of microbiological products as soil inoculation or stock treatment on at least 50 % of the orchard area	2			
(19) Plantation	Application of soil conditioners or plant conditioning preparations to at least 50 % of the orchard area.	1			
(20) Plantation	Mulching plantings by mulching, growing one-year inter-row cover crops.	1			
(21) Plantation	Mulching plantings with the maintenance of perennial crops or grassing.	2			
(22) Plantation	Immediate incorporation of urea fertilizer or, in case of liquid urea, application of an inhibitor during application.	1			

10. DECLARATIONS

DECLARATION

the public access and authenticity of the thesis/dissertation/portfolio[1]

Student's name:	Cornelia van Wyk
Student's Neptun code:	DPZZNJ
Title of thesis:	Exploratory Land Use Suitability and Vulnerability for Eco-Scheme Participation with GIS
Year of publication:	2023
Name of the consultant's institute:	Institute for Wildlife Management and Nature Conservation
Name of consultant's deparment:	Department of Nature Conservation and Landscape management

I declare that the final thesis/thesis/dissertation/portfolio submitted by me is an individual, original work of my own intellectual creation. I have clearly indicated the parts of my thesis or dissertation which I have taken from other authors' work and have included them in the bibliography.

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DECLARATION

As a supervisor of CORNELIA VAN WYK (DPZZNJ), I here declare that the thesis has been reviewed by me, the student was informed about the requirements of literary sources management and its legal and ethical rules.

I **<u>recommend</u>/don't recommend** the thesis be defended in a final exam.

The document contains state secrets or professional secrets: yes <u>no</u>

Place and date: Gödöllő, 2023. year 11. month 03. day

Tománé Kovács Eszter

insider consultant