Chapter

Economic Impacts of the Establishment of Alternative Water Retention Habitats on the Agricultural Holdings

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Abstract

The municipal spatial plan of the city of Ljubljana determined the location for the expansion of the Ljubljana Regional Waste Management Centre. The environmental condition for the expansion is the establishment of alternative water retention habitats (267.1 ha) on the northern edge of the Ljubljana Marsh. The study aimed to analyze possible mitigation measures for agriculture due to the envisaged changes in land use. The plan envisaged a change in the use of conventional agricultural land, overgrowth vegetation and forest for extensive grassland (172 ha), forest (86 ha), and water surfaces (8.9 ha). Results indicate that the income from subsidy payments will be higher due to establishing additional wetland meadows (28 ha) in the currently overgrown areas. The intervention will decrease the value of the crop produce (−61 to −71%) and thus the farm revenue (−34 to −43%). However, variable costs are lower due to the expected extensive land use. A larger area of protected habitats on agricultural land returns lower variable costs (−60 to −69), a positive balance of gross margin for the total area (+5 to +15%), and a lower gross margin per hectare of agricultural land (−4 to −12%), and thus the income of most agricultural holdings.

Keywords: alternative habitat, water retention, agriculture, income, wetland, economic calculation

1. Introduction

Agriculture has an important impact on biodiversity; both are interconnected through ecological functions and ecosystem services, such as soil structure, nutrient content, pollination, regulation of pests and diseases, water retention, and semi-natural habitats species, depending on Ref. [1]. With appropriate policies, it is possible to maintain and even enhance biodiversity while agriculture adjusts cultivation practices. However, the cost-effectiveness of different policies needs to be tested before implementation [1].

In most countries, national laws on nature conservation specify mitigation and compensatory measures to mitigate the obstruction of nature or its consequences or to compensate for the intended or caused degradation of nature. Among the possible

forms of these measures is establishing an alternative nature area with the same nature conservation characteristics as the area on which the intervention had a significant impact [2].

The effects of the establishment of alternative water retention areas and extensive wet grassland habitats can affect agriculture in several ways. The effects can be divided into direct and indirect, depending on the consequences. The direct adverse effects on agricultural land include a change in soil properties and, thus, a reduction in the production potential of agricultural land. This is due to the flooding of land and the habitat requirements of plant and animal organisms, which in a given case, require conditions similar to wetlands or wet meadows. The direct effects also include the loss of agricultural land due to the establishment of surface water bodies with permanent or intermittent standing water for habitat needs and surfaces for flood water storage. Indirect adverse effects include impacts that originate from changes in soil properties (soil temperature and soil water content). As a result, problems arise in soil cultivation (access to land), loss of yield and income, and land value.

On surfaces with a high-water table level, such as wet meadows, the water-saturated soil area is closer to the soil surface. All soil horizons are entirely saturated with water during most of the year. It creates special conditions in the soil that affect the growth of agricultural plants typical of the climate of the study area. Most agricultural plants in waterlogged soils lack oxygen for root growth. It should be emphasized that higher groundwater levels or deepening the terrain to retain flood water on agricultural land represents a reduction in the production potential of the agricultural land for crop production, regardless of whether market or nonmarket crop production takes place on the agricultural land. In order to achieve the suitability of the wet meadow habitats for the life of classification bird species, a constant high-water level in the area of wet meadows establishment is necessary. Lower-water levels are foreseen only during grass harvesting. By regulating the water regime, we are not establishing a natural system but an artificially made system that needs constant maintenance.

The location for the expansion of the Regional Waste Management Centre (RCERO) was determined by the municipal spatial plan of the city of Ljubljana. The spatial plan determines that one of the conditions for expanding the RCERO is establishing alternative areas for retaining flood water and habitats of extensive wet meadows on the northern edge of the Ljubljana Marsh.

The objectives of this study are (i) an analysis of the economic impact of establishing alternative water retention habitats on the income from agricultural activity and (ii) the analysis of possible mitigation measures for agriculture due to the establishment of alternative habitats. The study presents a spatial analysis of the existing and alternative economic situation analyzing the change in revenues, costs, and gross margins per hectare of agricultural land due to the establishment of alternative water retention habitats for the three proposed land use variants [3, 4].

2. Methodology and materials

2.1 Study area

The area proposed for implementing measures to establish alternative or replacement water retention habitats to ensure a favorable condition of the qualification species of Eurasian woodcock (*Scolopax rusticola*) was established to mitigate the expansion of the RCERO. The area is located in Slovenia in the municipality of

Ljubljana in the northern part of the Ljubljana Marsh, south of the A1/A2 highway, east of the regional center for waste management, west of Rakova Jelša settlement and north of the Ljubljanica river (**Figure 1a**). The area of 267.1 ha is flat, with an altitude between 277 and 278 m.

The climate in the area is classified as moderate continental of Central Slovenia, or the so-called sub-alpine climate [5]. Ljubljana lies in an extensive basin surrounded by the pre-alpine and Karst geology. The temperature inversion is characteristic of the area. The marsh is a source of cool air in the summer, as temperatures are, on average, four to five degrees lower than in the city [6]. Average annual weather parameters in Ljubljana for the period 1971–2000 are (i) temperature of 10.9°C, (ii) 1974 hours of sunshine, and (iii) 1362 mm of precipitation.

According to the soil map, the more significant part of the soil in the area is classified as low peat marshes, which are shallow to medium deep humified (40%)

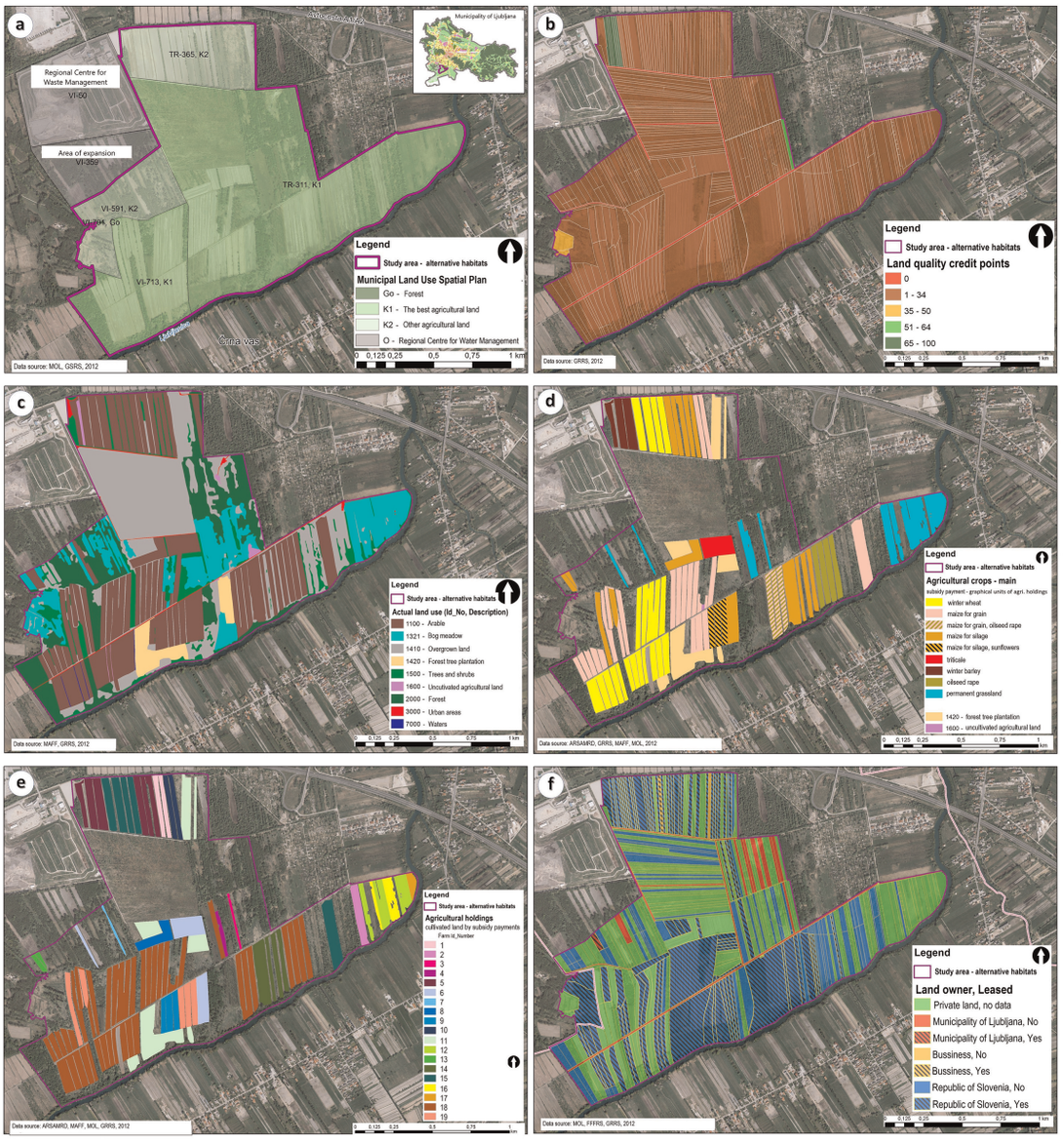

Figure 1.
Research area (a) land use by municipal spatial plan, (b) land quality credit points, (c) actual land use, (d) land use graphical units of agricultural holdings (GERK) with main crops in 2012, (e) land cultivated by agricultural holdings, and (f) ownership and lease of the land.

and mineral-organic clay loams of calcareous origin (38%). Other soils are strongly expressed gleysol on the organic subsoil (15%) and eutric mineral, medium to strongly expressed hypogleys (5%) [7]. The largest share of the area is represented by the land quality credit points class of 1–34 points with 255.31 ha (95.6%). Of this, 49.1% or 131.21 ha is agricultural land with a rating of 13 points (**Figure 1b**).

From the total area of 267 ha, in terms of actual land use, arable land presents 34% (92 ha), overgrown agricultural land 26% (70 ha), marshy wet meadows 14% (38 ha), forest 14% (37 ha), trees and shrubs 7% (18 ha), and forest tree plantations 3% (8 ha). The rest is uncultivated agricultural, urbanized land, and water surfaces (**Figure 1c**). There are 72 land-use graphical units of agricultural holdings (GERK) (109.85 ha), presenting 41% of the total study area (**Figure 1d**). Among all GERKs, 52 have arable land use (85.09 ha), 30 marsh/bog meadow land use (10.89 ha), and 7 forest tree plantation land use (10.53 ha).

Data on subsidy payments for agriculture shows that 98.27 ha of agricultural land was claimed in the study area (greening is not included). The agricultural crop code permanent meadow (204) is attributed to 12 GERKs (13 ha) (**Figure 1d**). Agricultural crop codes attributed to fields (001, 005, 006, 007, 009, 012, 014) in 2011 and 2012 were used on 52 GERKs (85.18 ha). In an average year, the highest share of land was planted by winter wheat, followed by silage maize, grain maize, oilseed rape, and other crops (**Table 1**). On average, other crops occupied less than 5% of the surface. The most common rotations in the area are two-year rotations (maize/wheat or barley or triticale), three-year rotations (maize/maize/wheat or triticale or barley), and four-year rotations (maize/oilseed rape/maize/wheat or triticale or barley).

Agricultural land was cultivated by 19 holders of agricultural activity registered in the register of agricultural holdings, which are included in the system of subsidy payments (**Figure 1e**). All agricultural holdings cultivated 719 ha of agricultural land of which 109.55 ha, or 15.24%, lie within the study area (**Figure 2**). Two agricultural holdings owned more than 50% of the agricultural land within the study area.

Crop		**Area (ha)**			
		Year 2011	**Year 2012**	**Average**	
Id	Name		Ha		%
001	winter wheat	17.98	32.31	25.15	22.52
005	maize—grain	19.06	22.92	20.99	18.80
006	maize—silage	19.99	23.06	21.53	19.28
007	triticale	2.31	2.60	2.46	2.20
009	winter barley	3.96	4.46	4.21	3.77
012	sunflower	2.12	0.99	1.56	1.39
014	oilseed rape	11.67	25.63	18.65	16.70
204	permanent grassland	12.54	13.70	13.12	11.75
206	clover-grass mixture	5.96	—	5.96	5.34
207	clover	2.05	—	2.05	1.84
	Sum	97.64	97.64	125.67	111.66

Table 1.
Areas (ha) of crops on fields for the research area, including greening, based on subsidy payments in 2011 and 2012.

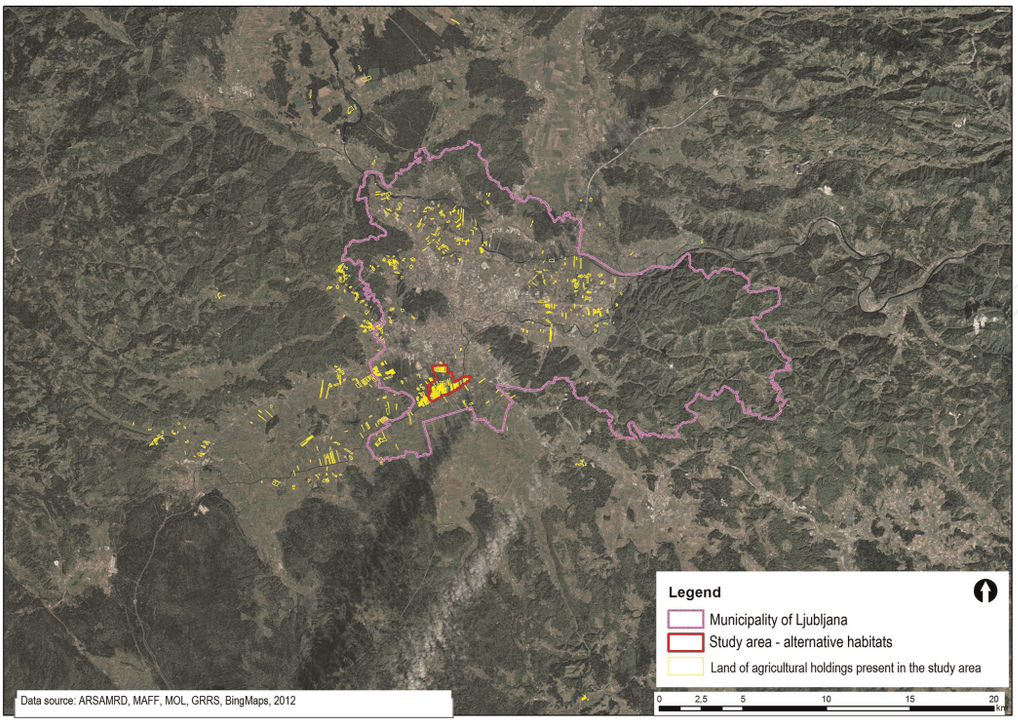

Figure 2.
All agricultural land cultivated by agricultural holdings present in the study area of alternative water retention habitats.

Agri-environmental measures (AEM) from the Rural Development Program (RDP) of the Republic of Slovenia (2007–2013) were implemented as the sub-measures of sustainable livestock production (SLP) on 7.5 ha, crop rotation (ROT) on 45.2 ha, and greening of arable land (GAL) on 26.38 ha. In addition, compensatory payments for less favored areas with limited opportunities for agricultural activity were applied to 88.3 ha. There are 374 land parcels in the area, most of which are owned by the Republic of Slovenia (146.94 ha, 55%) (**Figure 1f**).

There are no official drainage or irrigation systems in the area (**Figure 3**). The area is otherwise characterized by open drainage ditches, which drain excess soil and groundwater from the area and directly enable the cultivation of agricultural land. The area has three main drainage ditches: Curnovec, Lahov Graben, and Kansov Graben. The southern part of the area, which is agriculturally intensive, is exposed to frequent floods, the central part of rare floods, and the northern part to catastrophic floods. The high flood risk area covers 98 ha or 38% of the study area (south), the medium flood risk area covers 108 ha or 42% of the area (central), and the low flood risk area covers 44 ha or 17% of the area (north). The entire study area is classified as a NATURA 2000 area.

2.2 Data source

Both spatial and tabular data from various public sources are included in the analysis (**Table 2**). We edited the data using ESRI® ArcGIS 10.0 software (ArcMap, ArcInfo, ArcCatalog) and MS Excel. Using ArcGIS, we combined the tabular data with spatial layers and obtained additional information about the study area. Data are displayed spatially and tabularly with appropriate written explanations.

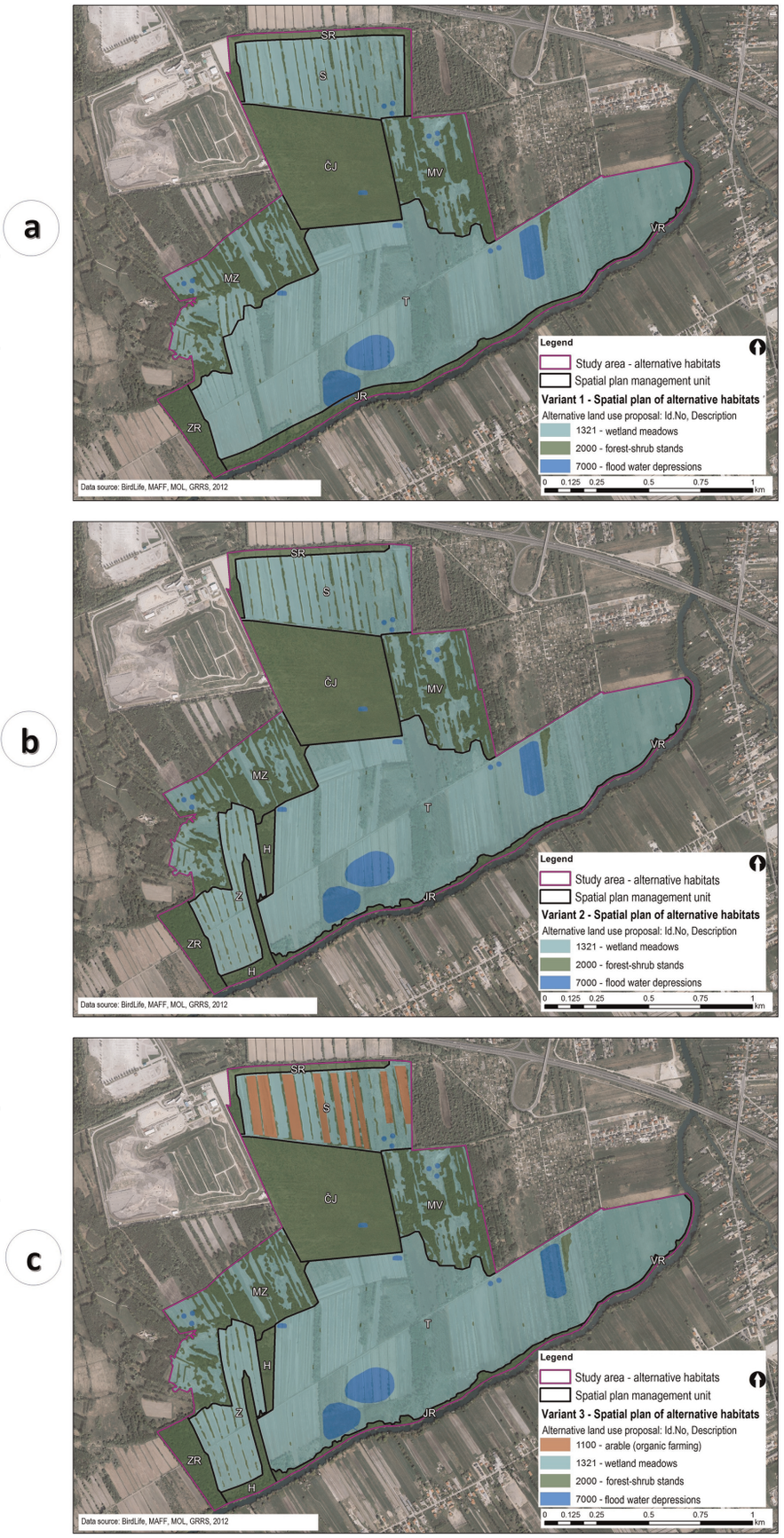

Figure 3.
Land use of three variant solutions for the establishment of alternative water retention habitats in the study area with the presented spatial management units.

Data	Type	Source
Municipal Spatial Plan of the City of Ljubljana (OPN); Flood risk; Water protection areas; Natura 2000; Ecologically important areas; Natural heritage—Landscape Park of the Ljubljansko barje; Cultural Heritage.	Spatial layer Tabular data	City Municipality of Ljubljana (MOL), Spatial planning department (2012); Ministry of the Environment and Spatial Planning (MESP) (2012).
Pedocartographic units; Digital soil number; Actual land use; Land use graphical units of agricultural holdings; Drainage and irrigation systems.	Spatial layer Tabular data	Ministry of Agriculture, Forestry and Food (MAFF) (2012) http://rkg.gov.si/GERK/
Land quality credit points State land lease contracts	Tabular data	Geodetic Survey of the Republic of Slovenia (GSRS) (2012) http://www.gu.gov.si/ Farmland forest Fund (FFFRS)
Subsidy payments Type of agricultural culture Agri-environmental measures payments Agricultural holdings	Tabular data	Agency of the Republic of Slovenia for Agricultural Markets and Rural Development (ARSAMRD) (2012) http://www.arsktrp.gov.si/si/

Table 2.
Data sources included in the analysis.

The methodology includes calculating the potential change in gross margin (gross margin = revenue – variable costs) due to changes in production and thus revenue and costs from agricultural activities for the area of permanent agricultural land occupation (eqs. 1 and 2). Permanent occupation means that agricultural land is managed by state policy-determined regulations under a special regime to establish alternative or replacement habitats and water surfaces to provide an alternative volume for retaining flood water. In the assessment of economic effects, we included: (a) the spatial location of the agricultural land in the study area; (b) agricultural land use, type of agricultural culture, and crop rotation; (c) three variant solutions for establishing alternative wetland habitats and replacement volume for flood waters; (d) involvement in agri-environmental measures (AEM) of the EU Common Agricultural Policy Rural Development Program.

An assessment of the change in economic parameters due to the permanent occupation of agricultural land of various types was made. Conventionally managed arable fields, marsh meadows, and forest tree plantations (**Figure 1c**) are to be replaced to a lesser or greater extent by types of extensive-organic agricultural land use (organic arable fields, marsh meadows), forests, trees and shrubs, and water surfaces. Changes in land use mean a change in the type of plants, the quantity of the crop yield, and crop quality. The potential change in gross margin for the average growing season and the average rotation was assessed, considering the Catalog of calculations for selected crops [8]. The catalog is also used by the Slovenian Chamber of Agriculture and Forestry and the Ministry of Agriculture, Forestry and Food (**Tables 3**–**5**).

From the calculations for individual crops, we prepared two average calculations for arable areas, which include the basic average values of revenue and variable costs

ARABLE FIELD, three-year rotation (K3), conventional farming winter wheat/grain maize/silage maize	Calculation (EUR/ha/year)
Value of the produce (EUR/ha)	1091.7
Subsidy payment (EUR/ha)	332.0
Revenue (EUR/ha)	1423.6
Variable Costs (EUR/ha)	1040.3
Gross margin (EUR/ha)	383.3
ARABLE, three-year rotation—organic—OA winter wheat/buckwheat/ grain maize	
Value of the produce (EUR/ha)	1225.0
Subsidy payment (EUR/ha)	630.0
Revenue (EUR/ha)	1855.0
Variable Costs (EUR/ha)	1031.3
Gross margin (EUR/ha)	823.7

Table 3.
Calculation of variable costs and gross margin for arable crop rotations.

Wood of non-forest plantation-P 15 years life span of the plantation. Chips, chopping every 5 years, 7 t dry matter/ha/year	Produce price (€/t)	Calculation (average yield)
Yield (m^3/ha)		7
Value of the produce (€/ha)	38	266
Subsidy payment (EUR/ha)		—
Revenue (EUR/ha)	38	266
Variable Costs (EUR/ha)		140
Gross margin (EUR/ha)	38	126

Table 4.
Calculation of variable costs and gross margin for the wood of non-forest plantation.

for calculating gross margin (**Table 3**). The basis for preparing these calculations was based on an average three-year rotation (wheat/grain maize/silage maize). For the alternative habitat variant 3, which envisages the preservation of 10 ha of organically managed arable fields, we used an organic three-year rotation (wheat/buckwheat/ grain maize).

For crops sold on a larger scale, the average produce prices detected on the market in the year of publication of the Catalog of Calculations are considered and, in some instances, do not reflect the actual situation [8]. Furthermore, prices on the market fluctuate annually and monthly depending on supply and demand, which means that the products can be sold at a higher or lower price than considered in the calculation.

The economic calculation for agricultural holdings is based on the subsidy payments applications at the Agency for Agricultural Markets and Rural Development. In order to compare the differences between the existing land use situation (ExU) and the three extensive variants of the alternative replacement habitats (V1, V2, V3) and

HAY, unfertlizied—conventional—M1 dried on the soil, baled, 2 cuts*; 85% final dry matter	**Produce price (€/t)**	**Calculation (average yield)**
Yield green (t/ha)		30.0
Yield hay (t/ha)		6.3
Value of the produce (€/ha)	87.34	550.2
Subsidy payment—REG (€/ha)		109.0
Subsidy payment—BH (€/ha)		121.4
Revenue (€/ha)		780.6
Variable costs (€/ha)		240.0
Gross margin (€/ha)		540.6
HAY, unfertlizied—organic—M3 dried on the soil, baled, 2 cuts*; 85% final dry matter; the first cut after July 1st—1/3 of the conventional one in terms of quality		
Yield hay (t/ha)		6.3
Value of the produce (€/ha)	52.6	331.5
Subsidy payment—REG and OA (€/ha)		336.0
Revenue (€/ha)		667.5
Variable costs (€/ha)		240.0
Gross margin (€/ha)		427.5
HAY, unfertlizied—organic—M5 dried on the soil, baled, 1–2 cuts; 85% final dry matter; first year, one cut after August 1st, suitable for bedding; the second year, two cuts—the first cut after July 1st, which is 1/3 of the conventional one in terms of quality		
Yield hay (t/ha)		5.1
Value of the produce (€/ha)	26.3	165.8
Subsidy payment—REG and OA (€/ha)		336.0
Revenue (€/ha)		501.8
Variable costs (€/ha)		178.8
Gross margin (€/ha)		323.0

**ratio in the hay crop ➔ first cut: second cut = 60:40.*
REG—subsidy payment for grassland; OA—agri-environmental measures of organic agriculture; BH—agri-environmental measures of preservation of butterfly grassland habitats, grass cut before July 1st and after August 20th.

Table 5.
Calculation of variable costs and gross margin for an unfertilized marsh meadow, where dried hay is grown for fodder, produced as bales in conventional and organic agriculture.

their economic effects on agriculture, in the case of arable land, meadow land, and forest tree plantations, we used data from the calculation tables (**Tables 3–5**) on the average annual produce yield (PY) and crop price (CP), average annual subsidy payments (NP), average annual revenue at a given price (R), average annual variable costs (VC), and average annual gross margin at a given price (GM) (**Tables 3–5**). The calculation does not include subsidy payments for less favored areas for agricultural activity (OMD), which greatly vary between agricultural holdings and differ depending on the average quality of land and its geographic position.

Equations and terms used in the calculation of the economic effects of the arrangement of alternative habitats on agricultural land:

$$GM = R–VC. \quad (1)$$

$$R = (PY \times CP) + SP \quad (2)$$

where

Gross margin (GM) = revenue [€/ha] – cost [€/ha].

Revenue (R) = (crop price [€/ha] × produce [t/ha]) + subsidy payments [€/ha] = [€/ha].

Variable cost (VC) = seeds, fertilizers, pesticides, machine hours, work hours [€/ha].

Produce yield (PY) = average harvested crop yield [t/ha].

Crop price (CP) = price of produce [€/ha].

Subsidy payments (SP) = EU Common Agricultural Policy Rural Development Program (2007–2013) Republic of Slovenia [€/ha].

2.3 Variant proposals for the establishment of alternative habitats

We designed three types of economic effects simulations described in the report entitled variant proposals for arranging alternative habitats due to the expansion of the Ljubljana landfill [3, 4]. The report presents three proposals for placing alternative habitats and replacing volumes for flood waters (**Figure 3**). Variants 1 (V1) and 2 (V2) propose that currently as marsh meadows (81.9 ha), forest (4.8 ha), and water surfaces (5.6 ha), with a land use ratio of 32.3:64.4:3.3. Variant 3 (V3) propose arable land (92.3 ha) to be managed organic fields (9.7 ha), marsh meadows (74.8 ha), forest (4.3 ha), and water surfaces (3.4 ha), with land use ratio of 32.3:60.3:3.3:4.1.

The proposed variants V1 and V2 fully follow the provisions of the Municipal Spatial Plan. In both variants, forest-shrub and meadow areas were arranged in a mosaic in the prescribed ratio of 30%:70%. The only differences are in the location of the forest-shrub vegetation on the northern edge of the area and the southern strip of existing riparian trees along the Ljubljanica River. The proposed variant 3 (V3) differs from V2 in approximately 11 ha of organically managed arable land for the production of low-growing agricultural crops (close-grown cereals, root crops). It prohibits the cultivation of maize and other tall grains. The use of plant protection products is restricted. It also envisages a second location for the floodwater depression in the eastern part, placing it on overgrown land. The most significant impact on agriculture is expected in areas where the proposal envisages forest-shrub stands and floodwater depressions. In those, agricultural activity will be completely disabled, which means that these agricultural lands will be permanently taken away or permanently occupied with alternative habitats, serving as floodwater retention areas during floods and as water surfaces for birds in normal conditions. These areas will be redesigned and deepened. To provide optimal conditions for the life of Natura 2000 classified plant and animal species, water in floodwater depressions will be present for most of the year, or the groundwater level will be so high that it will not allow agricultural activity.

In the area of management units (V1: MZ, MV; V2-V3: MZ, MV, H), where the establishment of mosaic land use pattern is envisaged, forest-shrub stands and wet marsh meadows are planned, which are not fertilized and are mowed maximal twice a

year (**Figure 3**). It is also envisaged that the management of the drain ditches network and overgrowth of the ditches that separate the plots will be discontinued. Therefore, agricultural activity will be limited in the wet marsh meadow management units (V1: T, S; V2-V3: T, S, Z) (**Figure 3**).

In the unit T area, all arable land will be converted to unfertilized alternately cut meadows, and all tree and shrub growth will be removed except for a few clusters of shrub vegetation. It is envisaged that the ditches will be preserved, but they will be equipped with sluice gates to maintain an appropriate groundwater level. In the eastern part of unit T, sheep grazing is expected to be preserved, but only if there are no adverse impacts on the classification species of Natura 2000.

All fields in management units S and Z will be turned into unfertilized, twice-a-year cut marsh meadows. It is envisaged that the parcel borders will be overgrown, and 10 clusters of shrubs and tree vegetation will be planted. It is also planned to discontinue the management of the drainage ditches to increase the soil moisture of the land. However, it foresees the renovation of the drainage ditches and the installation of sluice gates if mechanical grass cutting is impossible.

Agricultural activity will not be possible in units with forest cover and shading vegetation (V1: ZR, SR, JR, VR; V2-V3: ZR, SR, JR, VR, H) (**Figure 3**). The forest will be excluded from management and left to natural development. Most forest and shrub areas already exist, so no significant impact on agricultural activity is expected. The only exception is the northern edge of management unit S, where a new riparian strip of vegetation is established on agricultural land.

Variant 3 in management unit S proposed (**Figure 3**) organically managed crop production, no pesticides, low-growing cereals with o maize, and the preservation and maintenance of drainage ditches. According to BirdLife Slovenia, the complete ban on the cultivation of maize is related to the shape of the maize stand, which is not optimal habitat or has a negative impact on many Natura 2000 classification bird species. Based on our discussion with bird experts, we have included maize in the organic rotation (11 ha of fields in the area) due to its beneficial effect on production economics. However, with one condition, only organically produced local maize varieties can be grown in an alternating rotation with winter wheat and buckwheat.

From the description of the proposed management in the study area, it is clear that any agricultural activity will be limited and, in some places, even impossible compared to the existing practice after establishing alternative habitats and flood water retention areas. The proposed management restricts not only conventional but also organic cultivation. Production on arable fields is mainly prohibited, as is the fertilization of grassland areas. If a sluice gate system is established in the area to maintain a higher water table level and the water table is not higher than 20 cm below the ground level, this could favor grass production. However, it should be noted that grass from single-cut, late-season cut meadows is not suitable for animal consumption in intensive agricultural production. The fodder is only suitable for bedding or as supplementary fodder for horses.

3. Results and discussion

3.1 Existing situation

The existing land use situation results show that the average annual revenue (value of the crop and subsidy payments without agri-environmental measures) for the

three-year rotation varies around 164,425 EUR per year for the entire study area (**Table 6**). The produced crop value is estimated at over 125,000 EUR per year. Disregarding payments for less-favored areas and agri-environmental measures (AEM), the maximum possible annual amount of subsidy payments per area is estimated at over 39,000 EUR per year. Considering the AEM payments, a minimum of around 9000 EUR per year can be added to the revenue. A realistic average estimate of AEM payments is difficult, as it changes from year to year and depends on the agricultural policy and the voluntary willingness of farmers to join the AEM scheme. Variable costs average around 107,000 EUR per year. Thus, the average gross margin for agricultural land in the study area is estimated at 57,418 EUR per year. If we add the AEM payment, the estimated gross margin increases to a minimum of 66,684 EUR per year.

As already mentioned, the calculation did not include payments for less-favored areas and AEM payments, such as the preservation of the crop rotation (ROT) (91.84 EUR per ha annually), the greening of arable areas (GAL) (172.20 EUR per ha annually), and sustainable livestock production (SLP) (84.46 EUR per ha annually). If the entire study area fields were included in AEM, revenue would increase substantially (ROT by 8477 EUR annually; GAL by 15,894 EUR annually) and thus also the total coverage. However, receiving payments is conditioned with a required five-year crop rotation, which not all farmers can agree to due to the farming type specificity and cultivation technology. In the calculation, the AEM preservation of butterfly grassland habitats (BH) is considered, stipulating that grass cutting must not be done between July 1st and August 20th, enabling two quality grass cuts. In the study area, all agricultural holdings practice conventional production. Therefore, none of them applied for AEM payments for organic agriculture (OA).

3.2 Economic impact of alternative habitats on agriculture

The results of the analysis of alternative habitat variants 1, 2, and 3 show that total revenues would decrease by 43% (V1), 41% (V2), and 34% (V3), respectively, mainly due to a lower quantity and quality of crops (**Tables 6** and **7**, **Figures 4–6**). The revenue reduction would be most affected by the drop in crop produce value for the three-year rotation, as it would decrease on average by 71% (V1), 69% (V2), and 61% (V3) annually (less arable fields). Subsidy payments, on the other hand, would increase by 47% (V1, V2) and 55% (V3) due to the possibility of including extensively managed meadows in the AEM scheme for organic farming (OA). The AEM payments for the preservation of butterfly grassland habitats (BH), which can be enforced under the current scheme, were not considered, as the planned management measures of alternative habitats conflict with the requirements of the AEM scheme of the Rural Development Plan.

Variable costs would be reduced by 69% (V1), 68% (V2), and 60% (V3) due to extensive land management with only one or two late grass cuts (**Tables 6** and **7**). As a result, the total study area gross margin is estimated at +5% (V1), + 8% (V2), and + 15% (V3) in favor of the planned alternative habitats. By adding average AEM payments (GAL, ROT, SLP) for existing land use, as farmers applied for, the difference between gross margins are estimated at - 10% (V1), − 8% (V2), and - 1% (V3) for the planned alternative habitats in the study area. It is important to note that the gross margin per hectare of the study area would also decrease from −4 to −12%.

The planned establishment of alternative habitats will significantly impact agricultural holdings production by reducing the quantity and quality of the crop yield. Thus,

Land use	Are		Revenue (EUR)		Variable costs (EUR)		Gross margin (EUR)	
Description	**ha**	**%**	**ha**	**year**	**ha**	**year**	**ha**	**year**
Existing land use (ExU)								
Arable—conventional	92.3	64.1	1424	131,411	1040	96,029	383	35,382
Bog meadow	37.4	26.0	781	29,230	240	8987	541	20,243
Forest tree plantation	14.2	9.9	266	3785	140	1992	126	1793
Total	144	100	1142	164,425	743	107,008	399	57,418
Variant 1 (V1)—intended alternative land use								
Bog meadow	172	100	546	93,932	195	33,569	351	60,363
Total	172	100	546	93,932	195	33,569	351	60,363
Difference = V1 - ExU	+28		−596	−70,494	−548	−73,439	−48	+2945
Percentage change (%)	+19		−52	−43	−74	−69	−12	+5
Varianta 2 (V2)—intended alternative land use								
Bog meadow	172	100	559	96,204	200	34,410	359	61,794
Total	172	100	559	96,204	200	34,410	359	61,794
Difference = V2 - ExU	+28		−583	−68,222	−543	−72,598	−40	+4376
Percentage change (%)	+19		−51	−41	−73	−68	−10	+8
Varianta 3 (V3)—intended alternative land use								
Arable—organic	11	6.3	1.855	20,035	1031	11,139	824	8896
Bog meadow	161	93.8	554	89,180	198	31,884	356	57,295
Total	172	100	635	109,216	250	43,023	385	66,192
Difference = V3 - ExU	+28		−507	−55,210	−493	−63,984	−14	+8774
Percentage change (%)	+19		−44	−34	−66	−60	−4	+15

Table 6.
Calculation of the change in revenue for agriculture due to the establishment of alternative water retention habitats in the study area.

the value of produce on agricultural holdings decreases from –43 to –94% for V1, −38–94% for V2, and −21 to −94% for V3 (**Table 7**, **Figures 4**–**6**). Subsidy payments per individual agricultural holdings may change depending on the type of existing agricultural land management and the spatial placement of panned ecological elements of alternative habitats (marsh meadows, flood water depressions, shrub hedges, riparian vegetation on drainage ditches, and forest). Thus, all proposed variants (V1, V2, V3) range from an increase of +46% to a decrease of –59%. Revenues are also strongly negative for all agricultural holdings under all proposed variants. This trend also applies to the variable costs of all variants, as they are significantly lower than the existing ones (down to –93%). This is understandable since extensive use of marsh meadows results only in costs for grass cutting and transport. It is also interesting that the gross margins of all agricultural holdings in V1 and V2, except for one, are below negative. This means that the existing land use turns out to be more economically profitable. In V3, five farms have a gross margin higher under proposed alternative habitats. Higher gross margins resulting from the V3 envisage approximately 11 ha of

Farm ID	Alternative water retention habitat (% change from existing land use)														
	Variant 1					Variant 2					Variant 3				
	VP	SP	R	VC	GM	VP	SP	R	VC	GM	VP	SP	R	VC	GM
New agri. Land	−26	214	38	8	63	−24	210	38	8	64	−19	208	42	15	64
1	−75	−15	−61	−81	−7	−75	−15	−61	−81	−7	−42	21	−27	−50	36
2	−70	43	−37	−27	−41	−70	43	−37	−27	−41	−71	43	−37	−27	−42
3	−56	37	−29	−17	−34	−56	37	−29	−17	−34	−56	37	−29	−17	−34
4	−69	46	−35	−25	−40	−69	46	−35	−25	−40	−69	46	−35	−25	−40
5	−74	−13	−60	−80	−4	−74	−13	−60	−80	−4	−24	41	−9	−34	59
6	−83	2	−63	−81	−19	−83	2	−63	−81	−19	−83	2	−63	−81	−19
7	−54	11	−35	−24	−40	−54	11	−35	−24	−40	−54	11	−35	−24	−40
8	−85	1	−65	−83	−16	−85	1	−65	−83	−16	−85	1	−65	−83	−16
9	−94	−59	−86	−93	−65	−94	−59	−86	−93	−65	−94	−59	−86	−93	−65
10	−73	−12	−59	−80	−3	−73	−12	−59	−80	−3	−40	26	−25	−49	41
11	−43	*	46	−1	97	−38	*	58	7	114	−21	*	81	37	131
12	−71	42	−37	−28	−42	−71	42	−37	−28	−42	−71	42	−37	−27	−42
13	−76	−20	−63	−82	−12	−76	−20	−63	−82	−12	−76	−20	−63	−82	−12
14	−85	−2	−66	−83	−18	−85	−1	−65	−83	−17	−85	−1	−65	−83	−17
15	−77	−6	−60	−81	−6	−77	−6	−60	−81	−6	−63	6	−47	−68	10
16	−70	43	−37	−27	−41	−70	43	−37	−27	−41	−71	42	−37	−27	−42
17	−71	39	−39	−29	−43	−71	39	−39	−29	−43	−71	39	−39	−29	−43
18	−85	−4	−66	−83	−21	−82	−5	−64	−82	−15	−81	1	−62	−81	−11
19	−87	−26	−72	−87	−34	−83	−27	−70	−85	−28	−83	−27	−70	−85	−28
Avg.	**−71**	**47**	**−43**	**−69**	**5**	**−69**	**47**	**−41**	**−68**	**8**	**−61**	**55**	**−34**	**−60**	**15**

**no subsidy payments in existing use/increase in revenue due to subsidy payments.*
VP –Value of the Produce; SP: Subsidy Payments; R: Revenue; VC: Variable Costs; GM: Gross Margin; Avg.: average for the study area.

Table 7.
Calculation of the change in economic result (%) for agricultural holdings due to the establishment of alternative water retention habitats in the study area.

organically managed fields, with higher subsidy payments, a better selling price, and thus higher revenues.

It is important to note that 38 ha of study areas are not included in the system of subsidy payments due to their existing land use (uncultivated, overgrown). However, it represents a great potential for obtaining subsidy payments according to their existing and planned alternative use, thus having a considerable impact on the final economic calculation of the study area's gross margin (**Table 7**). Establishing alternative water retention habitats envisages 70% of wet marsh meadows, which are currently largely overgrown. In the entire study area, 49% of the land is currently in use as arable land or marsh meadow, which means that 21% of the study area needs to be cleared of overgrowth. This new agricultural land will be ready for extensive

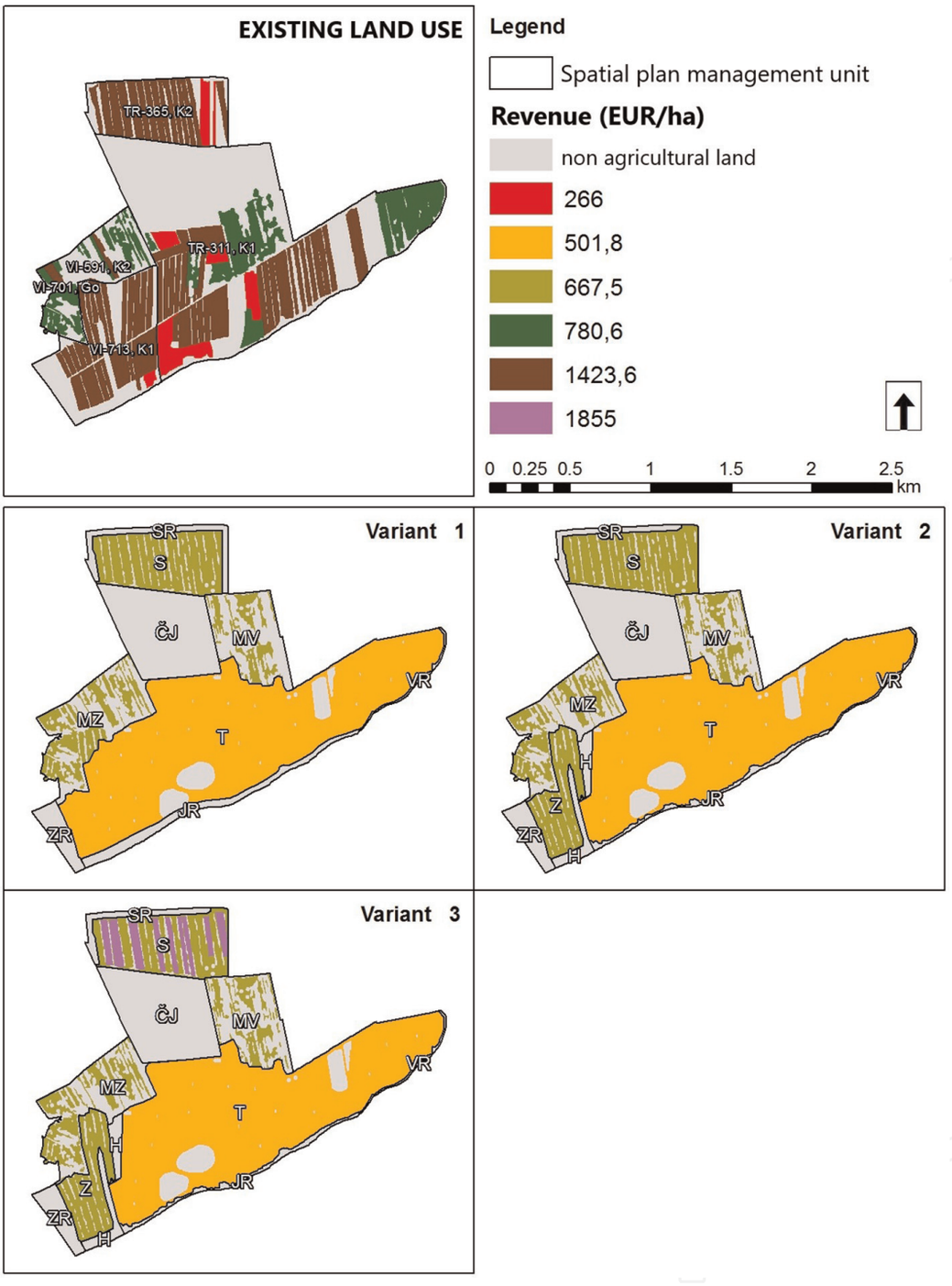

Figure 4.
Average revenue (value of the produce + subsidy payments) from agricultural land for the existing situation and variants of the alternative water retention habitats by individual spatial plan units in the study area.

management of marsh meadows after establishing alternative habitats and will thus be entitled to subsidy payments.

3.3 The impact of the alternative habitats on agriculture holdings

The planned alternative habitats will also affect individual agricultural holdings by reducing available land for production due to the establishment of permanent surface water bodies for floodwaters (depressions). In this way, some farms will be deprived

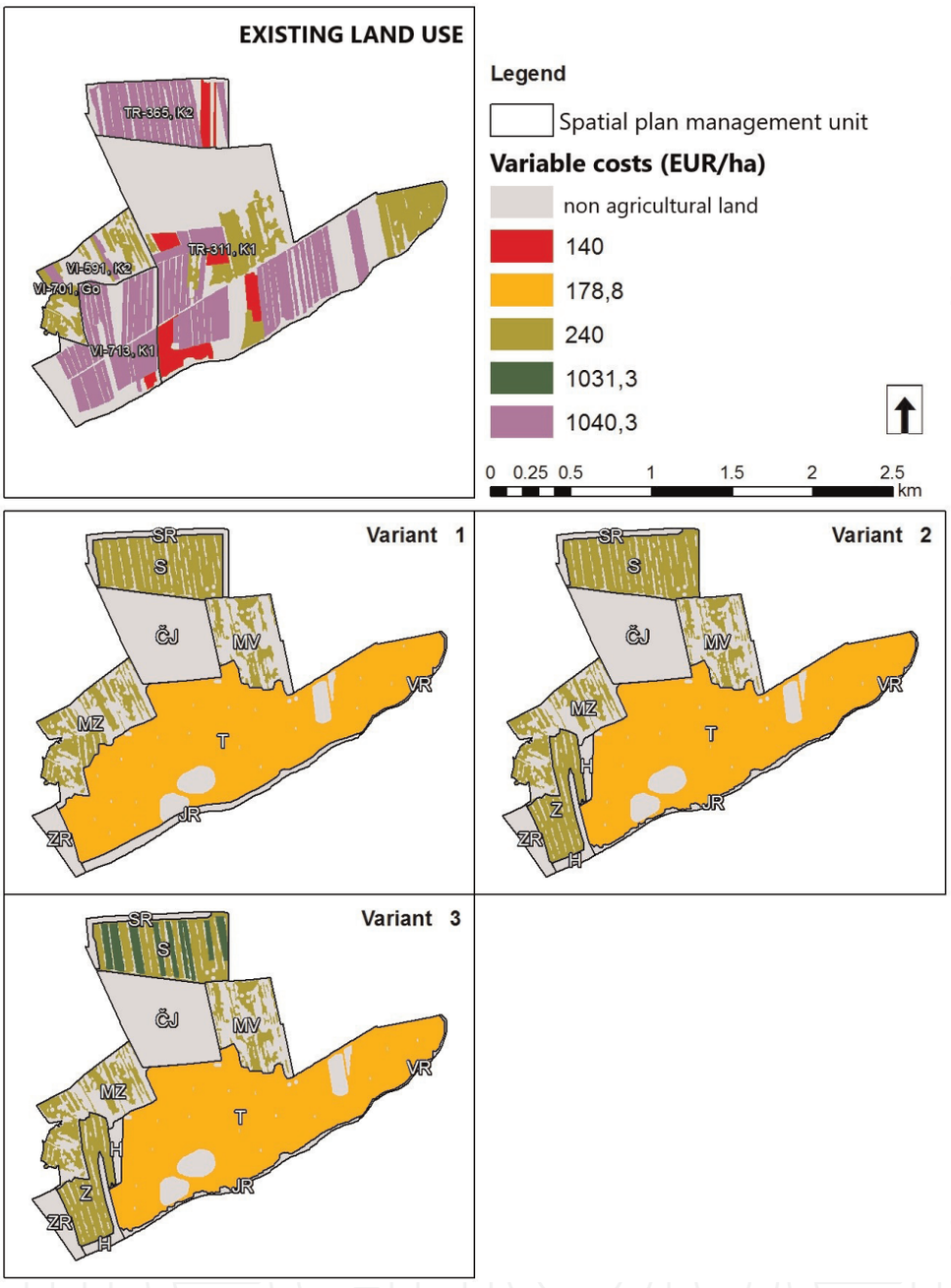

Figure 5.
Average variable costs from agricultural land for the existing situation and variants of the alternative water retention habitats by individual spatial plan units in the study area.

of practically all the agricultural land they cultivate in the area, while others will no longer be economically justifiable to cultivate the land. Such sharp interventions in the production scale can significantly impact the individual agricultural holding socioeconomic situation. Furthermore, less fodder production also leads to a reduction in livestock production.

Variants V1 and V2 with floodwater depressions are the same in terms of their impact on agricultural holdings, as they envisage the permanent occupation of 8.9 ha of agricultural land of which 5.6 ha are arable land, 2.3 ha are plantations of forest trees, and 1 ha of overgrown land. Thus, the total decrease of gross margin for V1 and V2 due to floodwater depressions is 2452 EUR annually without considering any of the

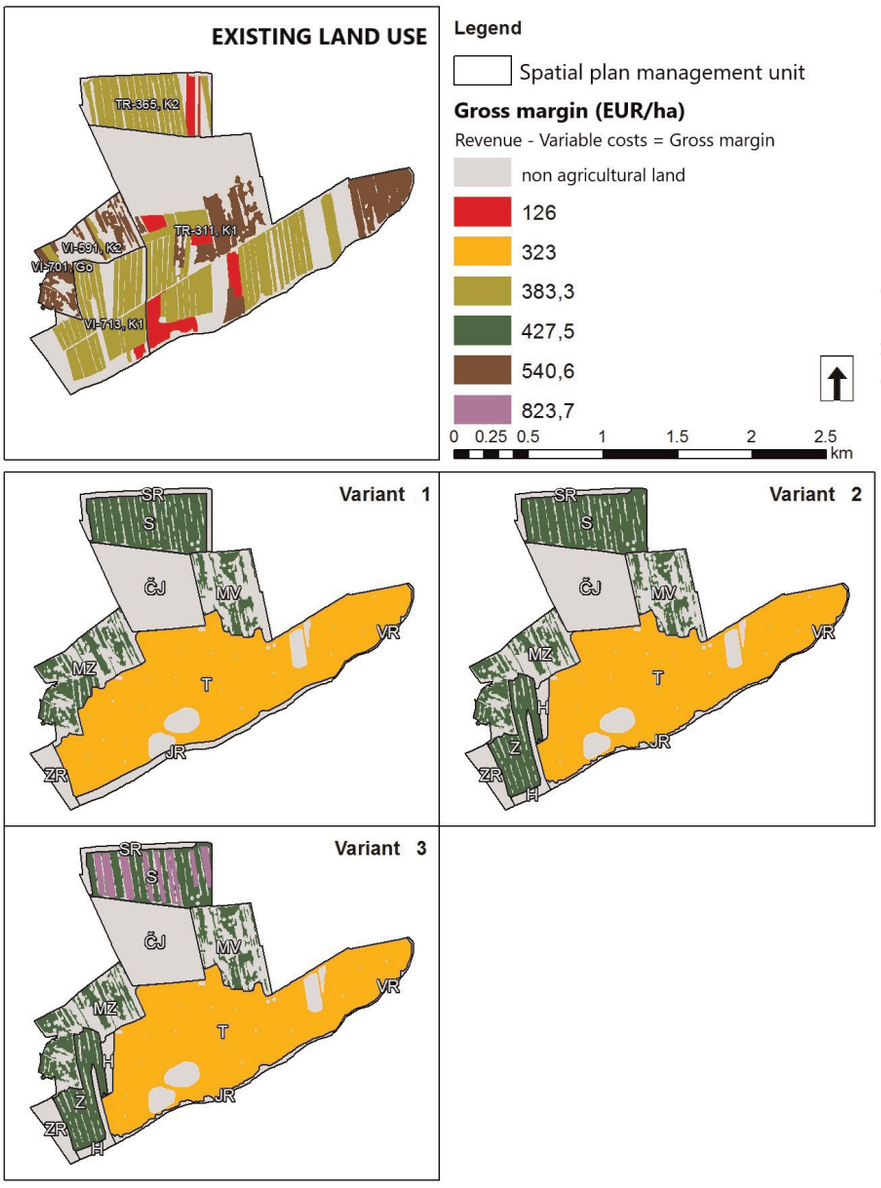

Figure 6.
Average gross margin (revenue—Variable costs) from agricultural land for the existing situation and variants of the alternative water retention habitats by individual spatial plan units in the study area.

AEM payments for arable lands. On the other hand, the V3 also envisages the permanent occupation of 8.9 ha of agricultural land, of which 3.4 ha is arable land, 2.3 ha is plantations of forest trees, and 2.7 ha is overgrown land. Thus, the decrease of gross margin for V3 would be lower - 1619 EUR annually without considering possible AEM payments for arable lands.

Seven farms will be affected to a certain degree by permanent land loss due to floodwater depressions. According to variants V1 and V2, the most affected agricultural holding No. 18 would permanently lose 2.24 ha of arable land, while according to variant V3, the loss would be minimal with only 0,09 ha of arable land. Agricultural holdings No. 9 and 19 that cultivate arable land would permanently lose 1.56 and 1.36 ha of fields, respectively, according to all three variants of the alternative habitats. The agricultural holding No. 11, which is engaged in producing wood on plantations of forest trees, would lose 2.24 ha of land according to all three variants.

In order to avoid the permanent destruction of the soil profile and potential for agricultural production, we suggest that the placement of permanent measures destroying agricultural soils (e.g., floodwater depressions, sedimentation basin) should avoid agricultural areas under cultivation with high production potential. Furthermore, given the extensiveness of areas intended for alternative habitats, they should be constructed in areas of overgrowth or forests.

4. Conclusions

This research is unique because it analyses the economic effects of establishing alternative water retention habitats in the area of existing conventional crop production on agricultural holdings. In doing so, it examines the effects on the value of the crop produce, revenue, variable costs and gross margins of agricultural holdings, and the effects of three variants of new land use distribution within the framework of alternative habitat establishment.

The economic calculation for alternative habitats includes subsidy payments for organic agriculture, which would make the most sense to apply for in an area with extensive use. However, the question is whether it is even possible to integrate these areas into organic agriculture from the point of view of the nutrient cycle since the planned management measures do not allow fertilization and grazing only on a small scale. Therefore, if we wanted to meet organic agriculture requirements, we would need 0.2 livestock units (LU) per hectare for the lowest payment for organic grasslands and 0.5 LU per ha for a higher payment on arable land. In the study area, where 172 ha of extensive wetland meadows are planned, this means either 35 or 86 LU, equal to the same number of cows (older than 2 years) and 233 or 573 sheep (older than 1 year), respectively. In case it would not be possible to apply for organic farming payments farming in the study area would be practically unprofitable.

The classification species Eurasian woodcock (*Scolopax rusticola*) in the study area requires special living conditions (grassland with soft wet soils and riparian vegetation on the edge of meadows). Due to that, the management regime of the planned alternative habitats (grass cutting at different dates) prevents the enforcement of AEM scheme subsidy payments from the Rural Development Programme for measures BH (butterfly grassland habitats) and STE (grassland cut in late summer), which further reduces the gross margin of alternative habitats variants. Furthermore, according to the spatial databases, the study area is preferentially protected for butterfly grassland habitats (BH) and grassland cut in late summer (STE) and not for the conservation of bird habitats of extensive wet grasslands (VTR) in Natura 2000 areas. In this case, the management defined in the Municipal Spatial Plan for the alternative habitats in the study area and the official State databases for protecting species do not match. Therefore, there are two options to preserve agriculture in this area: (i) a change in management measures in the Spatial Plan or (ii) designation of this area as a habitat for birds of extensive wet grasslands under Natura 2000.

It is expected that after establishing alternative habitats, most agricultural holdings renting or leasing agricultural land will cancel contracts with land owners. At the same time, we would like to point out that agricultural holdings farming agricultural land leased by the State Agricultural Land and Forest Fund (Fund) have the right to farm till the end of the lease contract, usually 10 years. However, Fund has the right to change the contract at any time.

When establishing alternative habitats, care must be taken that land use or management conditions do not affect the agriculture holdings contract with the state for the implementation of the AEM (organic farming, butterfly grassland habitats grassland cut in late summer, bird habitats of extensive wet grassland, and greening), which usually expires after 5 years. If the land use or land management changes or the lease contract is to be terminated earlier, it is necessary to provide the farmer with replacement land, where it is possible to implement the AEM for which the contract was signed. Otherwise, the reduction of the land area included in the AEM scheme could constitute a breach of the contract, and the agricultural holding would be sanctioned with a reduction of subsidy payments by a certain percentage.

Considering the planned management measures of alternative habitats envisaged in the study area, it can be argued that there are no development opportunities for conventional, integrated, or organic farming. The existence of any agricultural activity after the establishment of habitats in the area will depend entirely on subsidy payments. Due to the management requirements, subsidy payments would be significantly reduced by excluding AEM payment due to the different goals pursued in the study area by the Ministries responsible for agriculture and environment (butterfly habitats, meadow habitats) and Municipal Spatial Plan of the Municipality of Ljubljana (habitats for birds of wet meadows).

The only future development opportunity for agricultural holdings in the study area is providing ecosystem services for grass-cutting marsh meadows. Depending on the size of the study area and the number of cuts, it would be sufficient if one or two farms would provide their services. However, with such a management regime, it will be necessary to find additional funds to pay for the service.

Compared to the existing use, the arrangement of alternative water retention habitats with wet marsh meadows pursues an entirely different goal: the establishment of a habitat for classification species, especially the Eurasian woodcock (*S. rusticola*), which needs specific conditions for its survival. Furthermore, a nature protection goal differs from an agricultural one, which follows the provision of agricultural land for the economically justifiable performance of the agricultural activity and the provision of food and jobs. Thus, most of the development possibilities are in the local, green, organic, hiking, cycling, and photo tourism, which is not the primary domain of agriculture but offers new development opportunities in the diversification of activities on the agricultural holdings.

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