EKONOMSKO VREDNOTENJE IZPLAČIL NADOMESTIL ZA KMETIJSTVO NA OBMOČJU SUHEGA ZADRŽEVALNIKA POPLAVNIH VODA

ECONOMIC EVALUATION OF THE COMPENSATION PAYMENTS FOR AGRICULTURE IN THE AREA OF A FLOOD WATER DRY DETENTION RESERVOIR

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IZVLEČEK

Cilj raziskave je bil na podlagi ocenjenih ekonomskih učinkov poplav, na območju bodočega suhega zadrževalnika poplavnih voda Brdnikova, izdelati vrednotenje različnih načinov izplačila nadomestil, kar bo investitorju omogočilo pregledno odločanje o izbiri najustreznejšega sistema. Pripravili smo štiri oblike nadomestil: (a) enkratno izplačilo, (b) letno rento, (c) izplačilo po škodnem dogodku in (d) odkup zemljišč. Izračunano enkratno izplačilo je konkurenčno letni renti za 40 let uporabe. Renta omogoča investitorju, da od pridelovalcev zahteva izpolnjevanje kmetijsko-okoljskih pogojev. Odkup zemljišč zahteva veliko finančnih sredstev. Izplačila ob nastanku škodnega dogodka zagotavljajo najbolj realno oceno škode in lahko v obdobju štirih desetletij močno variirajo. Ta možnost prinaša tudi dodatne obveznosti glede sanacije kmetijskih površin, pri čemer je zanemarjeno razvrednotenje zemljišč na trgu nepremičnin. Raziskava ponuja dobro podlago za pripravo metodologije za oceno odškodnin na državni ravni, ki je v skladu z zakonom o vodah in se nanaša na škodo na kmetijskih zemljiščih, nastalo zaradi gradnje suhih zadrževalnikov poplavnih voda.

ABSTRACT

The aim of the research was to evaluate different methods of compensation payment, at the future dry detention reservoir for flood waters Brdnikova, based on the estimated economic impact of floods, which will allow the investor to make transparent decision on selecting a proper scheme. We prepared four compensation types: (a) a single payment, (b) annuity, (c) the payment after the loss event; and (d) the purchase of land. Calculated single payment is competitive to annuity for 40 years of land utilization. Annuity allows the investor to require from producers the fulfilment of agri-environmental conditions. The purchase of land requires a lot of financial resources. Payment upon the occurrence of a loss event provides the most realistic assessment is highly variable during the four decades. It brings additional obligations like restoration of agricultural land and neglects the drop in the value of land in the property market. This research offers a good starting point for preparing methodology for evaluation of compensation payments on a national level under the Water Act for damage on agricultural land as a consequence of building flood water dry detention reservoirs.

KLJUČNE BESEDE

poplavne vode, suhi zadrževalnik, kmetijstvo, ekonomsko vrednotenje, odškodnina

KEY WORDS

flood waters, dry detention reservoir, agriculture, economic evaluation, compensation payment

1 INTRODUCTION

Dry detention reservoirs are very effective engineered solutions for limiting flood damage mitigation in populated areas, as they temporarily store flood water and release it after the peak period passes (Ngo et al., 2016).The area of a detention reservoir can be, from an agricultural perspective, divided into permanent occupation with permanent loss of farmland where infrastructure is constructed (dam, barriers and roads) and occasional occupation inside of the reservoir (inundation area) without the loss of farmland and occupation only in the event of flood (Glavan et al., 2014). However, a changed flood regime will in comparison to the present situation result in higher water levels, changed frequency of flooding and a limited spatial extent of the flooded area. The duration of the flooding depends on hydrological conditions in the whole catchment area, upstream and downstream. Financial effects in the form of loss of income from cultivation of agricultural land on agricultural holdings are expected. Whenever this kind of objects are placed in the space it is customary to prepare a platform and a plan of action that serve as baseline for the negotiation on compensation agreements between farmers (they are land owners, tenants or lessees) and investors (state, municipality) in the case of flood events.

Multiple impacts of flood water dry detention reservoirs on agriculture are expressed through yield quality and quantity, physical and chemical quality and production potential of soils, land prices and consequently impacts on the economic situation of agricultural holdings. Based on crop type and phenophase, land use and management practice flood water impacts on crops yield are divided into direct and indirect. Direct impacts on land or crops include inhibition of plant growth (Vodnik et al., 2009), physical damage (lodging) or destruction of plants due to the force of water (Chau et al., 2013; Peng et al., 2014) which results in germination impediment and seed loss (Tapia-Silva, 2011), and pollution of crops due to deposition of fine and coarse soil particles or other material (rocks, gravel, tree branches, etc.). Floods can during the ripening and the harvesting period cause yield contamination with chemicals such as mineral oils, polycyclic aromatic hydrocarbons and waste water (Pintar et al., 2012b). The chemicals in floodwater can have long-term effects through polluting the soil, and necessary soil remediation is costly and time consuming (Maliszewska-Kordybach et al., 2012). Indirect impacts include greater likelihood of occurrence for some plant diseases and pests. Flood can decrease in hydraulic conductivity (Knapič et al., 2011; Pintar et al., 2013), soil erosion and nutrient transport (Howe and White, 2003) (not studied in this research). Silt management is important, as soil become saturated with water and crops covered by river silt after the water recedes (Roca et al., 2009; Pintar et al., 2012a). All this makes plant production for human consumption riskier (Tirado et al., 2010), and tiresome for the farmer. It should be noted that flooding of farmland represents a reduction in the agricultural land potential for crop production, irrespective of whether the crop production is market orientated or not.

For the area of the future reservoir Brdnikova in the Municipality of Ljubljana (MOL), a decree on the municipal detailed spatial plan (OPPN) was adopted in 2012 (Official Gazette of RS, no. 63/2012). The third paragraph of Article 56 of the Decree states that the investor must compensate for the loss of income from agricultural activities on agricultural land in these cases: (1) if agricultural production is hindered during the construction and (2) if flood regime will be worsened in relation to the current situation causing the loss of income due to the exclusive features of the newly constructed reservoir. On

the basis of this article, the investor began with the activities of choosing the most suitable scheme of compensation payment (refund) for loss of income as a result of changed management conditions on agricultural land. A previously prepared expert study on the approach to assess damage on agricultural land in the area of the reservoir Brdnikova served as a starting point (Pintar et al., 2012; Glavan et al., 2012). The regulation in the spatial plan has its origin in the Water Act (Official Gazette of RS, no. 57/2012) which in the fifth paragraph of the 90th article states: 'When the dry reservoir is in function compensation belongs to the land owners or occupiers of land for damage caused by the destruction or decrease in the yield of agricultural or forest land during a damaging flood event, which is paid by the Ministry. For the assessment of compensation for damage under this paragraph mutatis mutandis to the regulations in the Siting of Spatial Arrangements of National Importance Act' shall apply (Official Gazette of RS, no. 106/2010). However the text in the act is not clear if compensation is understood as a one-time single payment or annuity or payment at repeated damaging events (flood) for certain yield losses on agricultural and forest land or loss of income. It is also not clear what are the relations between the state (ministry) and the municipal level as all dry detention reservoirs are not build under the National Spatial Plan but under the Municipal Detailed Spatial Plan. This implies that a methodology on a national level still needs to be developed.

The aim of this research was to develop a methodological approach for calculating and defining the optimal compensation payment scheme for the proposed new flood water dry detention reservoir. The expected results will give farmers a starting point for negotiating the compensation of income loss due to the introduction of a new flood measure on agricultural land, and investors the possibility of transparent decisions on the selection of the most appropriate compensation scheme.

2 MATERIALS AND METHODS

2.1 Study area: Dry detention reservoir Brdnikova

The study area of the intended dry detention reservoir lies at an altitude of 293 m to 309 m (Figure 1) and comprises of 69.09 hectares. The road on the southern part will have the function of the barrier damming the river Glinščica. In the case of maximum water levels, in the event with a hundred year return period (Q100) the inundation area of the reservoir will cover 42.3 ha with a detention volume of 451.600 m^3 (Figure 1). Another smaller dry reservoir is planned below the dam on the smaller right tributary of Glinščica with a detention volume of 6,100 m^3.

According to the digital soil map a major part of the soils in the study area is classified (Slovenian classification) as medium expressed mineral amphigley on eutric soils (60%). In a minor part medium expressed and medium deep planar pseudogley on eutric soils is present (depth of g horizon 40-60 cm) and along streams and local depressions moderately gley riverside eutric soils on clay alluvium appear (30%). The largest proportion of the area's cadastral parcels is classified (by Surveying and mapping authority of the Republic of Slovenia) with 40-49 land quality points (42 ha; 61.35%), followed by 50-59 land quality points (8.7 ha; 12.59%) and 60-69 land quality points (4.7 ha; 6.85%) (Figure 2a). Where 100 is the best and 1 is the worst land quality. If land quality points are over 40 the land is suitable for arable management.

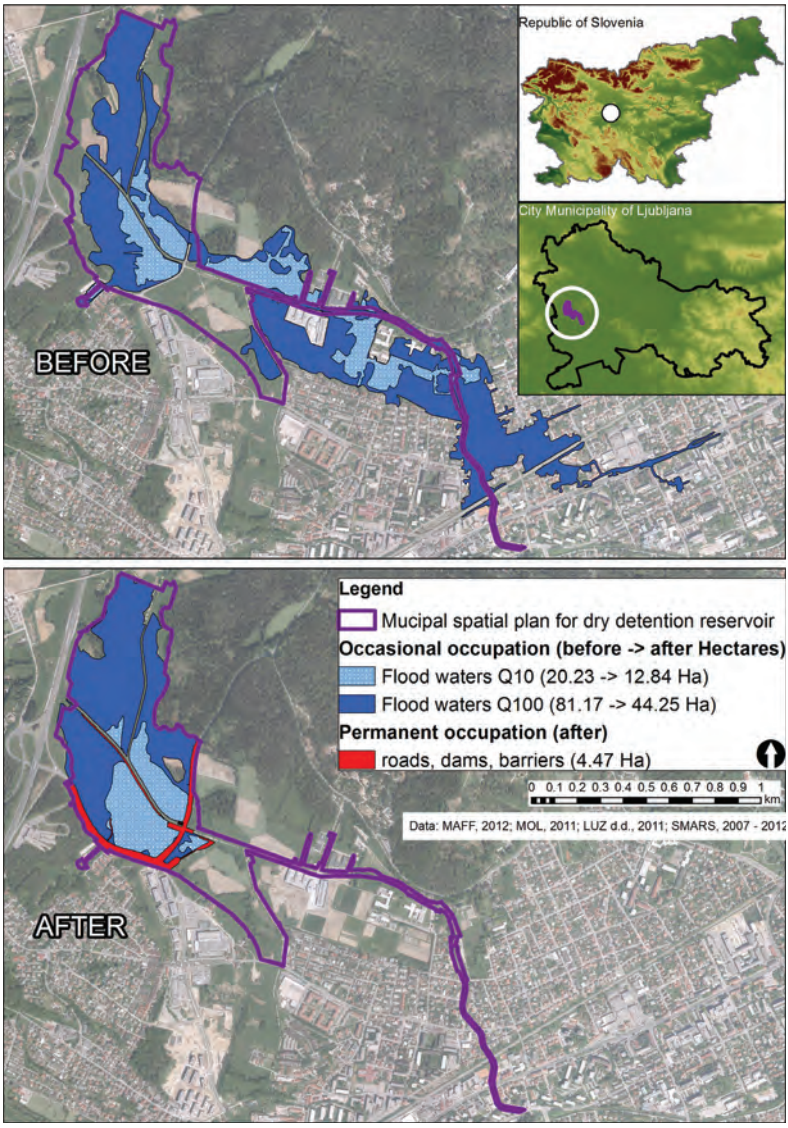

Figure 1: The area of the flood water dry detention reservoir Brdnikova and its spatial position with permanent occupation and occasional occupation at river flows Q10 and Q100 before and after the reservoir construction as defined in the Municipal Spatial Plan

The largest share of the actual land use is covered by grasslands (46%; 32 ha), arable land (29%; 20 ha), forests (8%; 5 ha) and urban areas (7%; 5 ha) (Figure 2b). In 2012 the impact area was 52 graphical land use units of agricultural holdings with a total area of 38 ha (all land uses), which is 55% of the total study area (Figure 1c). Of those, 25 ha was arable land and 13 ha was permanent grassland. In an average year (2006 – 2011) farmers grew almost 10 ha of silage maize (43.6%), more than 5 ha of grass-clover mixture (25.7%) and nearly 4 ha (16.1%) of grass on arable land. On average, other cultures occupied less than 1 hectare (4%) of the area.

Agricultural land in the area was managed by 12 farm holders, listed in the Slovenian Register of Agricultural Holdings (SRAH), which are at the same time included in the system of subsidy payments under the EU Common Agricultural Policy (CAP). All agricultural holdings together cultivated 272 ha of agricultural land in 2012 of which 34.99 ha (12.9%) was located inside the planned reservoir (inundation area). Four farm holders had more than 50% of their agricultural land inside the reservoir flood area. The majority of land parcels in the area was in 2012 owned by private owners (82.5%), followed by the municipality (14.7%), state (1.9%) and legal entities (0.9%).

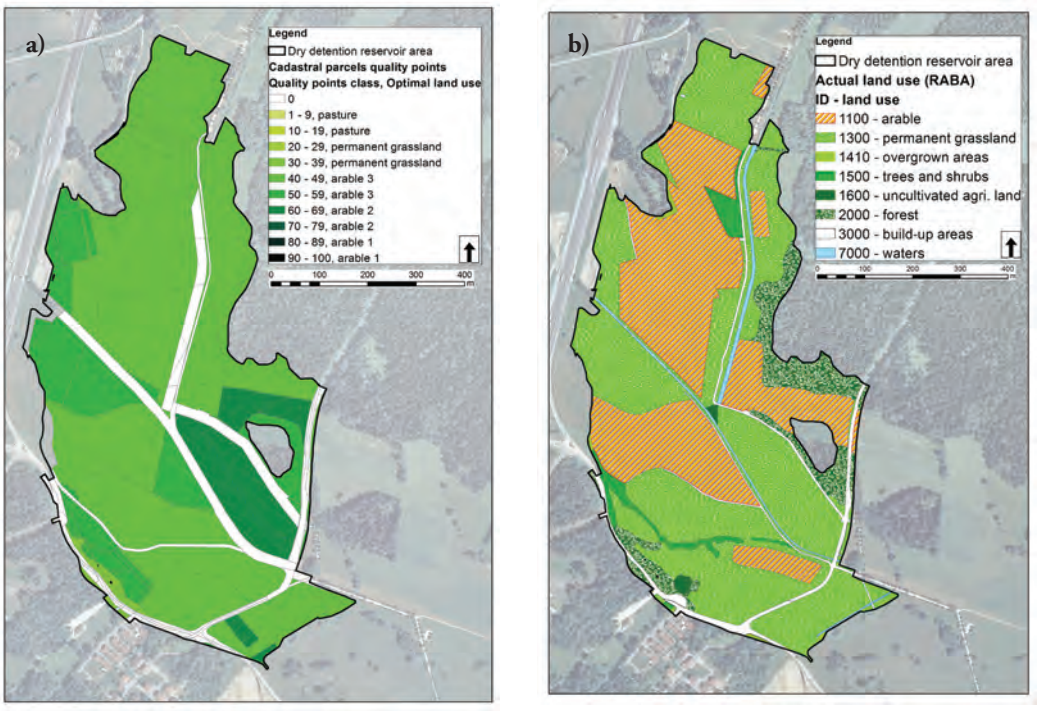

Figure 2: the area of the dry detention reservoir Brdnikova as defined in the Municipal Spatial Plan a) cadastral parcels land quality points and b) actual land use in 2012

2.2 Types of compensation payment schemes

Occasional occupation exclusively represents areas behind the dam and levees (inundation area) which are flooded in the case of emergency. The surface area of occasional occupation varies depending on the return period of the event. These land parcels are occupied for the duration of flooding and with agricultural activity disabled. This usually lasts from a few hours to a few days, if we take into account the time for normalisation of soil water properties. With appropriate regulation of rivers and channels it is possible to reduce floods with shorter return period to the extent when they have lower damaging impact on the area. However, the flood reservoir management needs to also take into account the water regime of the main watercourse and of all other tributaries in the watershed.

Compensation payment after the flood event is defined as a substitute (usually financial) which the

affected party receives as compensation for the damage that occurred as a result of direct or indirect impacts of floods. After the construction of the reservoir In this case the surface area and depth of flooding will exceed the present state. This will have an impact on the characteristics of agricultural soils, agricultural production and agricultural holdings since it is an artificial intervention in the hydrological regime of the area, which exacerbates the existing situation. Owners or tenants of such land are eligible for compensation payment. Compensation must be paid by the investor.

In this study we address the following compensation payment schemes:

(a) Single payment at reservoir construction

- flood event Q20, loss of one grass cut without baling
- flood event Q20, loss of three grass cuts without baling

(b) Payment for the loss event

- one loss event (loss of one grass cut without baling)
- one loss event (loss of three grass cuts without baling)
- one loss event (subsidy payment for livestock production, loss of one grass cut without baling)
- one loss event (subsidy payment for livestock production, loss of three grass cuts without baling)

(c) Annuity for a hectare of grassland or arable land

- without restrictions in land use (based on land use, flood water depth and return period)
- maximal - without restrictions in land use (based on land use)
- with restrictions in land use (based on land use, flood water depth and flood return period, permanent grassland is mandatory)
- maximal - with restrictions in land use (based on land use, permanent grassland is mandatory)

(d) Purchase of land

- purchase of land (agricultural land under occasional flood water occupation)
- partial purchase of land (pay-out difference in agricultural land parcels quality points between grassland and arable)

2.3 Economic calculation

The following parameters are included in the calculation of compensation payment for the area of occasional occupation (flooded area): (a) the area of influence of 10 (Q10) and 100 (Q100) years flood waters (surface area and depth of flooding), (b) agricultural land use (fields, grassland), (c) the most common agricultural crops - rotation (maize, grass), (d) the economic calculation for crops production (arable land, permanent grassland), (e) the average market value of agricultural land (Surveying and Mapping Authority of the Republic of Slovenia). The basis for the calculation of compensation payment was the catalogue of agricultural calculations (2011/12) (Jerič et al., 2011), the technological guide for farmers in flooded areas (KGZS, 2010), subsidy payment data of the Agency of the Republic of Slovenia for Agricultural Markets and Rural Development (2006-2011) and data of the Administration for Civil Protection and Disaster Relief (2012). The calculation takes into account the worst possible case outcome in production, which may be caused by a loss event. The equation and tables representing methodological approaches of compensation payment calculation are presented below.

2.3.1 Single payment

This scheme enables the owner to be paid out by the investor for all potential damages on land as a consequence of flood waters through a single instalment. Single payment (eq1) is methodologically based on production losses and the flood water return period (Table 1). The present and future owner of the land renounces all future financial claims.

$$SPC = d_{2.n} \times \left(\frac{y}{Q} \right) \tag{1}$$

Where *SPC* is – single payment compensation (EUR/ha), $d_{2.n}$ – gross margin with no baling costs (EUR/ha), y – number of years in n generation (one generation is 40 years) (year), and Q – the return period of a flood event (years).

2.3.2 Payment for the loss event

This scheme follows conventional practice in the areas of natural floods. The scheme provides compensation payments on the basis of assessing losses after a flood event by a special municipal commission (eq2) (Table 1). This scheme is closely related to the national system for estimating the impact of floods on agricultural products which is administrated by the Administration for civil protection and disaster relief.

$$LEC\left(d2.n\right) = \left(a - b_n\right) + c \tag{2}$$

Where LEC is *(d2.n)* – loss event compensation payment calculated as gross margin (EUR/ha), a - revenue (EUR/ha), b_n – changeable cost (EUR/ha) and c – cost for additional fodder needed in animal production. Gross margin is understood as compensation payment in the case of a loss event due to the flooding of agricultural land.

2.3.3 Annuity

Annuity compensation payment (*ACP*) calculation is a multi-step process (eq3). This process comprises the agro-economic calculation of the gross margin for the most common agricultural crops in the area, the evaluation of the costs related to soil quality improvement measures after flood, the flood water return period at which flooding will start to occur, the spatial position of land parcels in regard to water depth and return period as frequency of events and the impact of previous factors on crop production losses (Table 2). The costs of measures to improve soil quality after a flood event were calculated based on the minimal set of agricultural management measures that need to be undertaken on agricultural land after the flood event. We included in this calculated one third of average costs for liming, fertilisation, plant protection products and corresponding machine hours. This value represents approximately 20% of the total changeable costs in a normal year (Table 2). A flood water return period of 20 years (Q20) was chosen as the river channel capacity and the flood gates maximal discharge is limited to 18m^3/s, which is approximately a 20 years return period.

$$APC = \frac{\left(\left(\left(b_n \times 1.2\right) + c\right) - SUP\right)}{Q} \tag{3}$$

Where ACP is – annuity compensation payment (EUR/ha), b_n – changeable cost (EUR/ha), *1.2* – costs (20%) related to measures (liming, fertilization, pesticides, hoeing) to reduce the flood impact on the physical and chemical properties of the soil, *c* – cost for additional fodder needed in animal production (EUR/ha), *SUP* – agricultural subsidy payments (EUR/ha) *and Q* – flood water return period at which flooding starts to occur (years).

Table 1: Single payment and loss event compensation payment calculation for grass silage on permanent grassland and three year rotation on arable land

Compensation calculation (EUR/ha)				
Land use	**Normal**	**Loss event (LEC)**		**Single payment (SPC)**
GRASS SILAGE† (permanent grassland)		**total**	**additional fodder**	**(40 years/Q20)[2]**
Yield value	+1,186	0	0	
Subsidy payment *(SUP)*	+108.7	+108.7	+108.7	
Revenue *(a)*	+1,295	+108.7	+108.7	
Changeable cost *(b1)*	-1078	/	/	
Changeable cost reduced for baling *(b2)*	/	-597	-597	
Cost for additional fodder *(c)*	/	/	-1,186	
Gross margin – three cuts, baling *(d1.1)*	+217	/	/	
Gross margin – one cut, baling *(d1.2)*	+72	/	/	
Gross margin – three cuts loss, no baling[3] *(d2.1)*	/	-488	**-1,674**	**3,348**
Gross margin – one cut loss, no baling[1] *(d2.2)*	/	-18	**-413**	**826**
THREE YEARS ARABLE ROTATION† (silage maize/grass silage/silage maize)				
Yield value	+1,337	0	0	
Subsidy payment *(SUP)*	+332	+332	+332	
Revenue *(a)*	+1,669	+332	+332	
Changeable cost *(b1)*	-1,120	/	/	
Changeable cost reduced for baling *(b2)*	/	-960	-960	
Cost for additional fodder *(c)*	/	/	-1,337	
Gross margin – three cuts, baling *(d1.1)*	+549	/	/	
Gross margin – one cut, baling *(d1.2)*	+450	/	/	
Gross margin – three cuts loss, no baling[3] *(d2.1)*		-628	**-1,965**	**3,930**
Gross margin – one cut loss, no baling[1] *(d2.2)*		-472	**-1,545**	**3,090**

†silage maize (0.187 kg SU/kg green mass, 30 % SS) and grass silage (0.11 kg SU/kg green mass, 20 % dry matter at harvest, 35 % dry matter final content, 1 bale contains 600 kg of silage);

ŠU – starch unit;

* Yield value after Catalogue of calculations for planning farm management in Slovenia (2011) – silage maize 47.16 t/ha × 30 €/t, grass silage 20.6 t/ha × 57.56 €/t;

[1] – only one cut damaged, two cuts normal, additional fodder bought to cover one cut loss;

[2] – 40 years period of one generation and Q20 approximate return period of flood event in years;

[3] – all three cuts damaged, additional fodder bought to cover three cuts loss

Table 2: Maximal compensation payment calculation (EUR/ha) for the Annuity (ACP) and Annuity with restrictions in land use (ACPO) presented with flood impact classes based on land use, water depth and flood return period for the area of the dry detention reservoir

Annuity calculation (EUR/ha) – land use based							
Land use	**Changeable costs**				**Gross margin**		
	total loss *(b)*	**flood impact** *(+ 20%)*	**additional fodder** *(c)*	**SUP reduced**	**maximal Q20[2]** *(ACP)*	**difference in land use[4]** *(e)*	**maximal obligatory grassland[5]** *(ACPO)*
GRASS SILAGE (permanent grassland, no baling)							
three cuts loss[3]	597	716	1,186	1,684	84.20	0	84.20
one cut loss[1]	981	1,177	395	1,463	73.15	0	73.15
THREE YEARS ARABLE ROTATION (silage maize/grass silage/silage maize, no baling)							
three cuts loss	960	1,152	1,337	2,157	107.85	332	439.90
one cut loss	1,067	1,280	1,073	2,021	101.05	332	433.05

SUP – subsidy payment (Table 1);

[1] – only one cut damaged, two cuts normal, additional fodder bought to cover one cut loss;

[2] – Q20 approximate return period of flood event in years at which flooding starts to occur;

[3] – all three cuts damaged, additional fodder bought to cover three cuts;

[4] – difference in gross margin between arable and grassland;

[5] - due to environmental and health reasons (sedimentation) restrictions can be put on land use type and making permanent grassland obligatory

An investor can, due to environmental and health reasons (particles sedimentation on crops, health problems with harvested products), put a restriction on the type of land use and makes permanent grassland obligatory but compensation for production loss has to be offered to land owners/tenants. Compensation payment for obligatory land use (*ACPO*) is calculated as the difference between gross margins for a three years arable rotation and grass silage on permanent grassland (*e*) (Table 1, 2) and summed with *ACP* (eq4).

$$ACPO = ACP + d \tag{4}$$

Where *ACPO* is – the annuity compensation payment for restrictions in land use ~ obligatory grassland (EUR/ha), *e* – the difference in gross margins between arable and permanent grassland (EUR/ha).

After both types of maximal annuities were calculated these values were further adapted to the possible impact of the flood depth and return period (Table 3). Different depths of floods have a different impact on crops grown in the field or meadow. For example a flood that does not exceed 0.5 meters shouldn't affect maize as maize cobs in general grow higher on the stem. Majority of plants would get affected if soils would be fully saturated for few days disabling the breathing process. With deeper water the impact worsens as silt and clay particles settle and sediment on the plants, destroying them completely. It is the same for the flood water return period where more often floods mean a higher loss of yield and deterioration of soil quality. The percentages for defining the spatial distribution of compensation payment were based on subsidy payment for less-favoured

areas support scheme under CAP. The basic fixed part of the payment in 2012 was 34.43 EUR/ha for grassland areas with regular natural floods which is close to 50% of maximal ACP (36.58 EUR/ha) and served as the basis for other percentages which were set based on the expected impact on different crop types yield.

Table 3: Compensation payment values (EUR/ha) for the Annuity (ACP) and Annuity with restrictions in land use (ACPO) presented with flood impact classes based on land use, water depth and flood return period for the area of the dry detention reservoir

Annuity calculation (EUR/ha/year) – land use, water depth and flood return period based						
Flood impact classes		**Percent of Maximal (%)**		**No restriction** (ACP)		**Restrictions** (ACPO)
				Arable	**Grassland**	**Obligatory grassland**
return period = Q100; depth = 0.5–1.5 m impact on grasses, cereals and maize			65	65.68	47.55	397.68
return period = Q100 , depth = > 1.5 m impact on grasses, cereals and maize			65	65.68	47.55	397.68
return period = Q10 depth = < 0.5 m impact on grasses, low cereals	return period = Q100 depth = 0.5–1.5 m impact on grasses, cereals and maize	80	80	80.84	58.52	412.84
return period = Q10 depth = 0.5–1.5 m impact on grasses, cereals and maize	return period = Q100 depth = > 1.5 m impact on grasses, cereals and maize	100	100	101.05	73.15	433.05

2.3.4 Purchase of land

Only the purchase of land enables an investor to become the owner of the area and to fully enforce environmental measures and their vision of the future development of the area. An investor can also hire out the land to the former owners to keep agriculture production in the area but under investor terms. There is also an option of partial purchase (PPL) where only the type of land use is bought (eq5). Owners are based on a mutual agreement legally bound to practice and maintain specific land use. The calculation of land prices for Purchase of land compensation schemes (PL) was based on market prices collected by the Surveying and mapping authorities of Republic of Slovenia (Table 4).

$$PPL = PL - PL_{pg} \tag{5}$$

Where PPL is – partial purchase compensation payment to change land use from arable to grassland due to environmental and health risks (EUR/ha), *PL* – market price supplied by Surveying and mapping authorities (EUR/ha) and PL_{pg} – market price for permanent grassland with cadastral land parcels quality points between 30 and 39 supplied by Surveying and Mapping Authorities (EUR/ha).

Table 4: Average market value (EUR/ha) of agricultural land parcels in the area of a dry detention reservoir for the calculation of purchase of land (PL) and partial purchase of land (PPL) compensation schemes

Class	Land parcel quality points		Expected land use	Factor Index	Value	
					Market (PL) **(EUR/ha)***	**Land use difference** (PPL) **(EUR/ha)**
1	0	9	Pasture	0.1	2,880	0
2	10	19	Pasture	0.2	5,760	0
3	20	29	Permanent grassland	0.3	8,640	0
4	30	39	Permanent grassland	0.4	11,520	0
5	40	49	Arable 3	0.6	17,280	5,760
6	50	59	Arable 3	0.8	23,040	11,520
7	60	69	Arable 2	0.9	25,920	14,400
8	70	79	Arable 2	1	28,800	17,280
9	80	89	Arable 1	1.05	30,240	18,720
10	90	100	Arable 1	1.1	31,680	20,160

* Surveying and mapping authorities (2012)

3 RESULTS AND DISSCUSSION

An overview of the economic impact of all proposed compensation payment schemes for the inundation area of dry detention reservoir occasional occupation shows that the main difference between them lies in the time of the payment, restrictions in land use, and land ownership (Table 1). Single payment, annuity without limitation in land use type and the payment after loss event show similar economic impacts in the long-term (40 years). Differences occur in the time period of the payment, where in a single payment a total amount is paid out at the beginning of the construction, the annuity as annual instalments and the payment after loss event only once in about twenty years (loss event). With limitations in land use, the economics of the agricultural production is strongly changed, thereby annuity on long-term increases beyond the cost of purchasing of land. The purchase of land represents, in the long term, a middle way between the proposed compensation schemes. But only if the average market value of agricultural land is included in the calculation. Impact assessment of four different compensation payment schemes shows that the choice between one and another brings important differences in benefits and risks to investors as well as landowners.

3.1 Single payment

Single payment is primarily dependent on whether the calculation considers the loss of one or three cuts of grass (Table 1, Figure 3a). Taking into account the loss of three cuts instead of one increases the compensation payment by 71%. Single payment doesn't bring the investor free disposal with land despite the high costs. The disadvantage for land owners and investors is the fact that the total compensation is paid at the beginning of the construction or operation of the reservoir. Any additional costs of remediation of agricultural land into its former state after floods to reduce flood impact on the soil's physical and chemical properties after the event (removal of silt, additional fertilization, liming, hoeing, pesticides, sowing permanent pasture, etc.) is the responsibility of the investor unless otherwise agreed.

Regular and often flooding can lead to the changes in land quality points as soil characteristic are the base information in its calculation. We suggest that the investors commit themselves to making an analysis of loss events after the 40 years period of a new flood regime (with the dry detention reservoir) and thus redefine the level of compensation for the next period. If in this period the land would be damaged to the level that agricultural production would not feasible any more, has the owner the right (by 24th article of the Water Act) to require recultivation, new land or the financial compensation similar to the Full purchase of land (d) scheme (Official Gazette of RS, No. 67/2002).

Table 4: Overview of economic impacts of compensation payment schemes for the agricultural area of the flood water dry detention reservoir Brdnikova

Proposed compensation scheme - for all agricultural land in the study area - 17.05 ha of permanent grassland and 23.47 ha of arable land	**Compensation payment (EUR)** for total study area in relation to number of years or flood events	
(a) Single payment (SPC)	number of pay-out years	
	1	**40**
flood event Q20, loss of one grass cut without baling*	***82,401***	-
flood event Q20, loss of three grass cuts without baling	***140,909***	-
(b) Payment for loss event (LEC)	Number of events (≥ Q20)/period in years)	
	1/20	**2/40**
Payment for one loss event (loss of one grass cut without baling)	***10,887***	21,774
Payment for one loss event (loss of three grass cuts without baling)	***21,778***	43,556
Payment for one loss event (subsidy payment for livestock production, loss of one grass cut without baling)	***41,200***	82,401
Payment for one loss event (subsidy payment for livestock production, loss of three grass cuts without baling)	***70,454***	140,909
(c) Annuity (ACP, ACPO)		
without restriction in land use (based on land use, flood water depth and flood return period)	***2,462***	98,495
Maximal - without restrictions in land use (based on land use)	***3,420***	136,793
with restrictions in land use (based on land use, flood water depth and flood return period, permanent grassland is mandatory)	***9,921***	396,839
Maximal - with restrictions in land use (based on land use, permanent grassland is mandatory)	***10,878***	435,137
(d) Purchase of land (PP, PPL)		
Full (agricultural land under occasional flood water occupation)	***710,392***	-
Partial (pay-out difference in agricultural land parcels quality points between grassland and arable)	***285,005***	-

*Q20 – return period or magnitude of flood event with approximate reoccurrence once upon 20 years.

3.2 Payment for the loss event

Payment for the loss event primarily depends on the type of crop, the number of grassland cuts and on considering subsidy payment for the purchase of animal fodder for livestock farms (Table 1, Figure 3b). Taking into account the loss of three cuts instead of one increases the compensation for up to 100%. Buying fodder for livestock is more expensive than the cost of own production. Taking into account a fodder subsidy payment increases the compensation by 278%. Compensation payment can vary from flood to flood event. It can increase in the case of loss of crops with higher variable costs of production (corn silage) and decrease in the case of loss of crops with lower cost (grassland). Payment for a loss event provides the most realistic assessment of damage based on current land use, crop type and phenophase. This scheme is, in financial terms, the most favourable for investors. The disadvantage of this scheme is that it excludes depreciation of agricultural land parcels, which are subject to the modified flood regime on the real estate market. Making these land parcels practically unsellable. The costs of soil monitoring and restoration works after a flood are the responsibility of the investor unless otherwise agreed.

3.3 Annuity

Annuity depends on whether compensation payment is fixed by land use or also by the depth and return period of flood waters, and whether are proposed limitations in the use of agricultural land in the area (agro-environmental measures) (Table 1, Figure 3c). Taking into account only land use without the depth and return period, increases the compensation payment by 39%. Considering limitations in the land use type (agri-environmental measures) increases the compensation payment by 303%. The costs of additional remediation of agricultural land after a flood are included in the compensation payment. Annuity allows an investor to bind farmers with certain agri-environmental conditions and management regimes to obtain the payments. At the same time, the costs of yield loss, soil monitoring (soil physics and chemical analysis) and restoration works after a flood are already included in the compensation and are a responsibility of landowner. An example of the management regime could be changed from arable to permanent grassland land use. In this case, the preservation of arable land use loss or damage on arable crops would not be compensated. The advantage of this scheme is regular annual payment of compensation which goes directly to the farmer. Is floods cause serious events including spillage of harmful chemicals they need to be treated as is described in the Environmental Protection Act (Official Gazette of RS, Nos. 41/2004, 39/2006, 70/2008, 108/2009), the Regulation on waste (Official Gazette of RS, no. 103/2011) and Regulation limit, warning and critical levels of hazardous substances in the soil (Official Gazette of RS, Nos. 68/1996, 41/2004).

3.4 Purchase of land

The price of purchasing land depends on the average market value of the Surveying and Mapping Authority and land parcels quality points (Table 1, Figure 3d). The results are presented in such a way that the calculation includes all land parcels with that part which is intended to be inundated during a flood event. The part of the plot where flooding is not expected is excluded from the calculation. Determination of agricultural land prices can be completely independent from the average market value. The price may be a function of supply and demand or an agreement between the seller and the buyer.

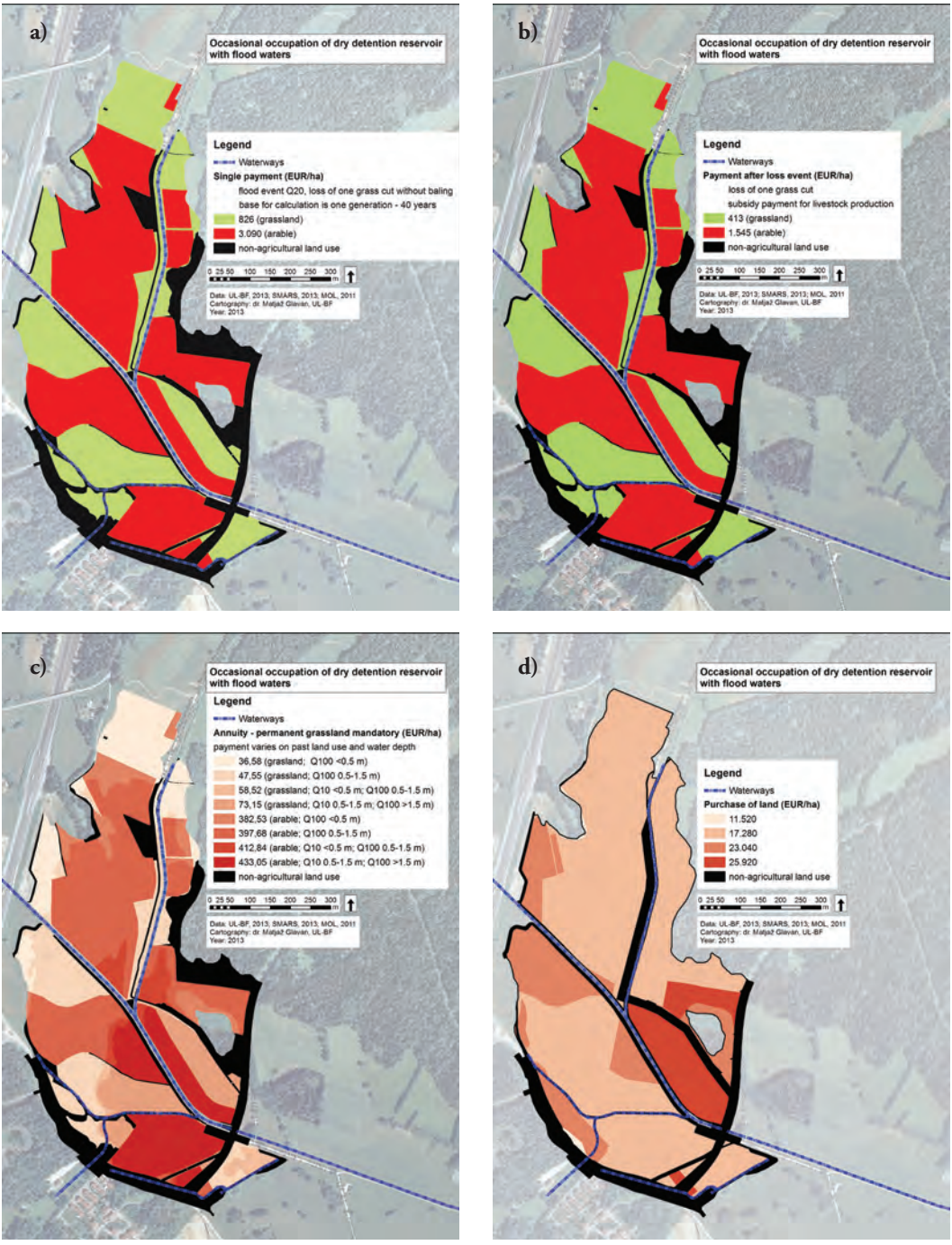

Figure 3: Spatial representation of compensation payment in the form of a) single payment, b) payment after the loss event c) annuity and d) purchase of land (EUR/ha) for the agricultural area of the dry detention reservoir Brdnikova

It is important that the investor becomes the owner of agricultural land in the area of inundation areas for practical management reasons. They can freely dispose, invest and govern the inundation area inside the dry detention reservoir all with the goal of proper functioning of the reservoir. Investors can give former landowners opportunities to lease land with long-term contracts and at the same time define the agricultural management regime in the area. Owners may also enforce a particular management regime on these lands. We propose a 100% discount on the rent in these areas, due to the possible flood events and the fact that farmers are not entitled to compensation payment in this case. Investors are responsible for covering the potential costs of additional remediation (removal of silt, fertilizer, sowing and permanent grassland, etc.) of the flooded area to the state before the loss events. A partial purchase scheme, in which an investor buys out the option for any other land use than permanent pasture, contributes in the long term to lower costs of compensation payment after a loss event. Losses and consequently compensations to farmers on permanent grassland are smaller than on arable land.

4 CONCLUSION

Flood risk management and flood adaptation are gaining importance due to proposed future climate change adaptation. Both topics cover a wide range of measures among them also flood water dry detention reservoirs which are rather poorly represented in scientific literature especially, if we take into account impacts on agricultural production and calculation of compensation payment. A lack of studies makes this research unique as scientific literature doesn't offer any calculation methods or data analysis which would cover dry detention reservoir impacts on agricultural land.

Uncertainties of this research can be found in generic three years rotation for all arable land where it would be better if individual rotation would be used for the representation of individual land parcels. However, due to a relatively small area and a limited number of farmers with almost similar rotational patterns we decided that this simplification has limited impact on the final calculation. If the area is represented by different types of production they should be distinguished in economic calculation. Uncertainties in economic calculation of gross margin (crop yield prices, additional fodder prices, costs) lie in changeable prices and costs from year to year and are a subject of supply and demand on the market. Additional problems on the market can occur when political decisions or natural disasters of greater proportion (flood, drought and frost) cause unbalances on the market. Currently is the knowledge of occasional flooding events influence on the soil quality of agricultural land in dry reservoirs under researched. There is no empirical data in literature dealing with soil quality changes trough the time. Uncertainties are also connected with additional costs for improving soil quality after the flood and to economic evaluation of ecosystem services of the agricultural soils. Different crop types or management types require a specific set of agricultural works for recultivation of soils and all proposed are perhaps not needed.

Future work should consider comprehensive economic calculation for individual agricultural holdings with land in the inundation area. This means that the total production, especially impacts on animal husbandry, like dairy cows, would be evaluated to check economic stability and viability of the holdings and if needed propose restructuration of the farms. Regular long-term monitoring of the soil quality should be considered to better understand flooding impacts. One of the important impacts of dams and levees, which is usually overlooked, are changes in microclimatic conditions inside of the detention

reservoir. This problem occurs when built structures exceed a certain height which prevents wind to mix the air inside of the inundation volume of the reservoir. This results in two possible outcomes: (1) in the summer, trapped moist air can induce plant disease development and (2) in winter or early spring, trapped cold air can induce frost development. We can expect in both cases harvested yield loss or reduction.

One of the most important lessons learned is that a final compensation scheme needs to be negotiated between private land owners and investors. The study showed that there is no single perfect system. Especially if we take into consideration constitutional rights over free disposal of property which mustn't be revoked or limited without proper in-kind or monetary compensation defined by law. Based on that, in the case of Slovenia, compensation payments are also mentioned in the 90th article of the Water Act (Official Gazette of RS, No. 57/2012) and in Siting of Spatial Arrangements of National Importance Act (Official Gazette of RS, No. 106/2010). However until now, the ministry responsible for environment didn't define the methodology or the system of compensation scheme despite frequent flood events and loss of crop yield in dry detention reservoirs and the fact that financial sources are available from the Water Fee paid by all water users. This research offers a good starting point for preparing methodology for evaluation of compensation payments on a national level for damage on agricultural land as a consequence of building flood water dry detention reservoirs.

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