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CONSOLIDATION OF SOIL EROSION RISK AREAS IN SEVERAL CADASTERS OF KOMÁRNO COUNTY

Pavol Bezák, Jaroslava Sobocká, Rastislav Skalský

National Agricultural and Food Centre – Soil Science and Conservation Research Institute Bratislava, Slovak Republic

Corresponding author: *doc. RNDr. Jaroslava Sobocká, CSc., National Agricultural and Food Centre, Soil Science and Conservation Research Institute, Trenčianska 55, 821 09 Bratislava, Slovakia, e-mail: jaroslava.sobocka@nppc.sk; ORCID ID: 0000-0001-5471-1519*

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Abstract

The process of semi-automated consolidation of agricultural land threated by water erosion solves issues on the level of individual farm/parcel. It is based on some prerequisites which involve: i) use of vectorised layers of land evaluation units (BPEJ) and digital terrain model (DTM), ii) land parcel identification system delineated as digitalized layers on actual orthophotomaps – LPIS agricultural land-use units (ALU). The basic scenario of land consolidation results from the legal regulations of agricultural land protection in Slovak Republic (Act No 220/2004 Coll., §5) and technical norm STN 75 4501: "Erosion control in agricultural land". The consolidation process consists of several processing steps: 1) identification of erosion risk areas, 2) design of the optimal arrangement of ALU (size and geometry, shape, accessibility for mechanization and combination of the above factors), and 3) recommendation of erosion control measures applied for individual ALUs. The presented system was tested and applied in selected cadasters of Komárno county (divided into 389 ALUs with a total area of 13,455 ha). Index of soil erosion risk degree (SOEP) was estimated with USLE-based model in GIS and resulted in new design of consolidated parcels. Combining this data and anti-erosion effect of cultivated crops (calculated as Cp factor), the priorities for soil erosion control were proposed and displayed on the map. Each priority was classified according to SOEP index and ALU size. Presented semi-automatic soil erosion consolidation algorithm can provide useful tool for land use planners, helping them facilitate implementation of measures eliminating unfavourable erosion processes.

Keywords: land-evaluation units (BPEJ), land consolidation, LPIS, agricultural land-use, anti-erosion measures

INTRODUCTION

Soil erosion is a hazard traditionally associated with agriculture, and it can be real risk for its long-term effects on soil and sustainable agriculture production. Mainly water erosion leads to environmental damage through sedimentation, pollution, water quality decreasing and generally soil and land degradation (McCool & Renard 1990, Dotterweich 2008, Chen *et al.* 2007, Issaka & Ashraf 2017). The costs associated with the movement and deposition of sediments in the landscape arises from long-term loss of soil material in eroding fields (Fulajtár & Janský 2001, Morgan 2005, Dechen *et al.* 2015). Soil and land erosion control including land consolidation represents one of the most effective instruments which have potential to mitigate impacts of predicted climate change. It can help sequester organic carbon as well as restoring degraded soils and improving water quality (Lal 2004, Morgan 2005, Xiao *et al.* 2019, Kabelka *et al.* 2019).

Water erosion of soil is of great importance in modelling the landscape terrain (Fu & Chen 1998, Sobocká & Jambor 2002) as well as in the degradation of the fertile properties of agricultural soils (Meng, Zhu, Yin *et al.* 2021). Water erosion is manifested by a reduction in the depth of the soil profile (especially the biologically active soil layer), a loss of organic matter and nutrients, as well as a deterioration of the soil structure (Muukkonen *et al.* 2009, Kabelka *et al.* 2019, Meng *et al.* 2021, Xiao *et al.* 2019).

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Because policy and management approaches include use of soil erosion assessment tools, soil erosion research directly affects the public in terms of providing information on natural hazards and human impacts, and also as the basis for regulatory policy on land management and conservation planning. Agricultural legislation defines maximum tolerable soil loss rates, and that requires soil erosion controls on many construction sites and agricultural land (Renschler & Harbor 2002).

Growing use of erosion models and Geographic Information Systems (GIS) raises concerns about how models are used and to what level they are reliable and predictive. This trend has a significant impact on the development of supporting Geographic Information System (GIS) and modeling tools. Complex, distributed, physics-based models are needed to improve understanding and prediction of landscape processes at any point in space and time (Mitasova & Mitas 2001).

Consolidation of agricultural areas with erosion risk can be presented as an algorithm for designing such an agricultural landscape in which the effects of soil erosion are observable and predictable. Streamlining of the soil resources spatial organization based on the evaluation of those factors driving the intensity of soil erosion (degree of erosion threat, size and shape of land, accessibility to land, etc.) are in the core of the consolidation process (Nearing *et al.* 1990, Shi *et al*. 2004, Fu & Chen 2000, Chartin *et al*. 2014).

Water erosion in Slovakia belongs into degradation processes which result in destructive and irreversible changes of soil cover, modifying morphologic and physical-chemical properties of soil. This topic was discussed in several previous studies of Sobocká & Jambor (2002), Sobocká & Skalský (2002), Fulajtár & Janský (2001), Petlušová *et al.* 2021 Petrikovičová, Rampašeková, Sobocká (2021). By the most recent results of the monitoring of agricultural land of Slovakia (Kobza *et al*. 2019) soil erosion is the biggest threat to farmers in term of percentage of agricultural soils potentially affected (44%), out of which about 20% can be influenced by extreme water erosion. Average soil loss in Slovakia estimated by Kobza *et al*. (2019) for 2018 is 13.57 $t.ha^{-1}$.

High and extreme potential soil erosion is present in sub-montane and montane regions, high and medium erosion can be observed mainly on arable land in hilly areas. Properly implemented anti-erosion measures, based on the design of agricultural land in terms of spatial differentiation of erosion risk in agricultural land, will help to reduce the intensity of these undesirable processes and ensure adequate crop production in line with sustainable management. In Slovakia erosion control is based upon evaluating the distribution of agricultural land in risk by water erosion and the soil erosion impact intensity (STN 75 4501: 2000, Alena 1991, Antal 2005, Ilavská, Jambor, Lazúr 2005). Problems of land consolidation in condition of Slovakia were discussed in some previously published works (Sobocká & Bielik 2009, Sobocká, Bezák, Skalský 2017). List of suitable measures to be applied on individual agricultural land can serve as a part of the soil erosion control plan (Džatko & Ilavská 2005, Ščepita 2011). A K-factor of land erodibility in a form of digital map layer was presented in work of Styk *et al.* (2008).

The main goal of this paper is to present the consolidation algorithm for agricultural land affected by water erosion. This approach was implemented and tested in several cadasters of Komárno county (Danubian lowland, SW Slovakia). Totally 6 cadasters (Bátorové Kosihy, Svätý Peter, Krátke Kesy, Modrany, Mudroňovo a Chotín) were selected for application and testing of the proposed algorithm to help farmers and land users/owners with consolidation of areas under soil erosion risk using generally available databases and tools. Principles of the algorithm presented here are also available on the SOIL PORTAL (www.podnemapy.sk/portal/verejnost/konsolidacia/konsolidacia.aspx) which serves as user-friendly instrument for farmers, land use designers, and planners providing a guideline for delineation of soil erosion risk areas and proposing anti-erosion measures.

MATERIAL AND METHODS

The study area is located in southeast Danubian lowland and is characterized by undulating terrain, especially in its northern part. Agricultural land within the LPIS (land parcel identification system of the CAP) is divided into 389 individual parcels (further referred to as agricultural land-use units – ALUs) with a total area of 13,455 ha (Fig. 1).

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Figure 1 Study area delineated according to the LPIS land parcel identification system ALUs (https://gsaa.mpsr.sk)

The slope steepness and slope orientation (exposure) in the study area are diverse. The most of the agricultural land is located on the plain terrain (83%, i.e. 11,221 ha). The most sloping areas falls to a range of slopes of 3° – 7° (14%, i.e. 1,868 ha). Slopes in the interval of 7° – 12° (3%, 340 ha) and slopes above 12° (<1%, 26 ha) are less frequent.

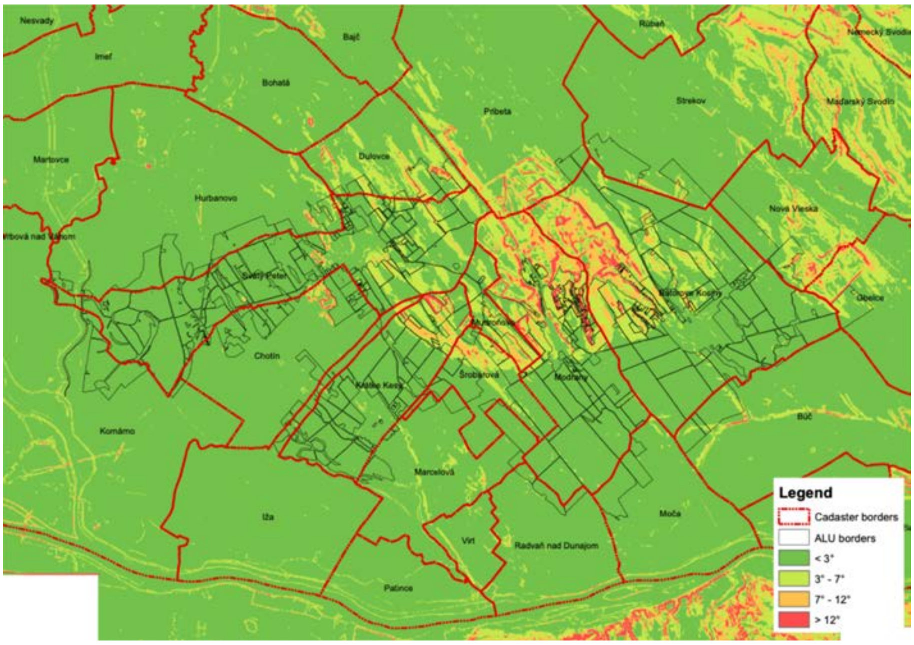

Figure 2 ALU borders displayed on the background of the slope class GIS layer

Agricultural land of the study area (Tab. 1, Fig. 3) is predominantly used as arable land (12,289 ha). Vineyards (745 ha) and permanent grasslands (203 ha) are also having significant shares. Other land uses with totally 157 ha are presented by orchards (53 ha) and backyard gardens (8 ha).

Table 1
Land use of agricultural land in the study area

Use of agricultural land	Acreage (ha)	Number of ALUs
OP (arable land)	12,289	282
VIN (vineyards)	745	50
TTP (permanent grassland)	203	23
PPF (land of other ways use)	157	21
SAD (orchards)	53	12
ZAH (gardens)	8	1
Total	**13,455**	**389**

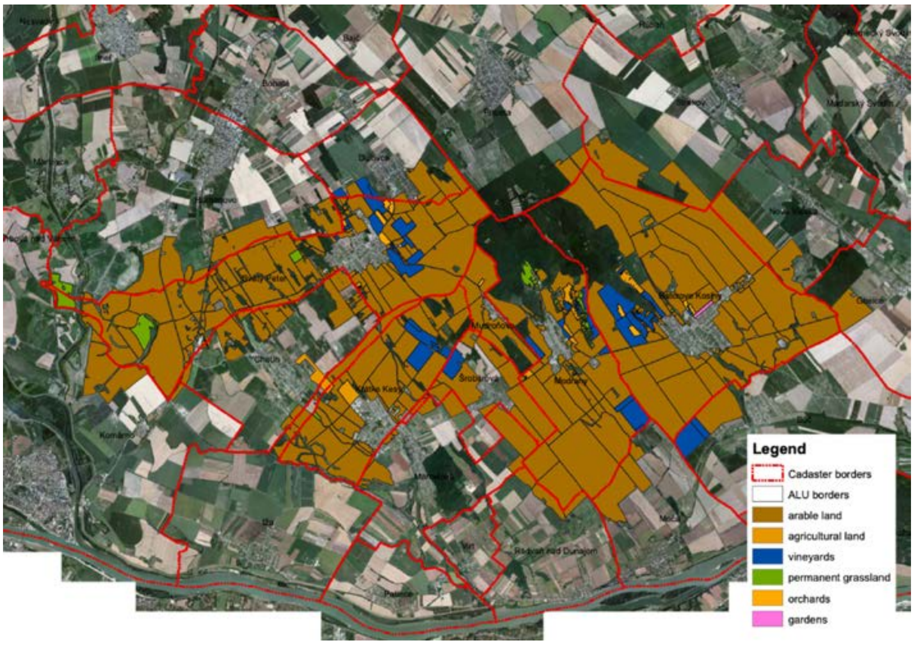

Figure 3 Land use in the study area (https://gsaa.mpsr.sk/)

Several digital georeferenced data layers are required as an input for the land consolidation algorithm:

- Digital layer of BPEJ (land (soil-ecological) evaluation units)
- Digital LPIS (land parcel identification system) as the base of agricultural land-use units
- Digital terrain model (DTM)
- Orthophotomaps
- Database of slopes (generated from DTM at some resolution)
- Land use database – arable land, permanent grassland, forest, or other landscape elements (can be generated from LPIS orthophotomaps maps)
- Database of soil erosion (soil erosion risk degree, USLE model).

BPEJ – soil-ecological evaluation unit represents a quasi-homogeneous spatial unit expressed by a 7-digit code containing: climate region, soil unit, slope and exposure, stoniness and depth, and soil texture.

Consolidation process (algorithm) consists of following processing steps identified and presented also in previous published case-studies (Sobocká & Bielik 2009, Sobocká, Bezák, Skalský 2017):

1. Identification of erosion risk areas: computation of extent and erosion risk intensity by using index of potential erosion risk, or USLE equation (Wishmeier & Smith 1978);

2. Designing optimal ALUs via determining a) the size of agricultural parcels, b) the shape of agricultural parcels (geometry), c) accessibility for machinery, and d) the combination of all above factors using STN 75 4501 technical norm;
3. Recommendation of the measures for soil erosion control (soil management practices, crop rotation systems, construction of green belts and terraces, etc.). Soil erosion control measures were selected from those recommended by Bielek (1996), and Demo and Bielek (2000). Here also some other measures such as appropriate crop composition in the crop rotations according to Alena (1991) were applied to secure that soil erosion does not exceed the limit values.

Consolidation of areas with erosion risk was constructed in accordance with a technical norm STN 75 4501: "*Erosion control of agricultural land*" and in related to Slovak legal act on soil protection (Act No. 220/2004 Coll.). The standard technical norm STN 75 4501 recommends size of individual agricultural parcels (ALUs) using slope ranges as defined for BPEJ database (Tab. 2).

Table 2
Recommended size of ALUs by slope categories (according to technical norm STN 75 4501)

Slope category	Length of AB (m)	Width of AB (m)	Size of AB (ha)	Erosion intensity
3° – 7°	550	250	10 – 20	Medium
7° – 12°	400	250	5 – 10	High
Above 12°	Delimitation to permanent grassland		Arbitrary	Extreme
Source: STN 75 4501				

The technical norm also recommends the shape of agricultural parcels (ALUs) – the longer sides of the ALUs are required to be parallel, perpendicular, or sloping to the sides at an angle of 60° – 120° (Tab. 3).

Table 3
Geometric shape of ALUs (according to technical norm STN 75 4501)

Geometric shape	Characteristics of ALUs
1	With parallel sides over 20 ha
2	The shape of irregular polygons
3	With parallel sides to 20 ha
4	Can be spread as a regular parallelogram
5	The shape of triangles, and of a regular polygons
Source: STN 75 4501	

Other important characteristics of the agricultural parcel is the accessibility by machinery. If the accessibility to agricultural fields is insufficient, the machinery passes through the field and thus can possibly deteriorate it. Accessibility to the agricultural parcel as recommended by standard technical norm STN 75 4501 is shown in the Tab. 4.

Table 4
Optimal accessibility to fields by size of the ALUs (according to technical norm STN 75 4501)

Type of ALUs	Type of terrain: flat to undulating	Type of terrain: hilly
Arable land	0 – 20 ha from 1 side	0 – 5 ha from 1 side
	21 – 80 ha from 2 sides	6 – 25 ha from 2 sides
	81 ha and more ha from 3 sides	26 ha and more ha from 3 sides
Source: STN 75 4501		

While performing land consolidation (combining the size, shape and accessibility of ALUs) it is important to take into account also existing (whether natural or technical) obstacles and to accept as many other land allocation principles as possible:

(i) parcel size (minimum economic area of 2 ha, minimum width of 40 – 50 m, and minimum economic length 200 m), for optimal parcel size see also Tab. 2;

(ii) most suitable shape (rectangle with internal angles >50° with the longer parcel side in the machinery move direction).

RESULTS AND DISCUSSION

Index of potential soil erosion risk

The calculation with USLE model (Wishmeier & Smith 1978) in GIS environment allows to determine the extent and spatial pattern of soil erosion risk in the landscape. The result of the soil erosion risk index calculation for the study area and its subsequent classification is shown on Figure 4.

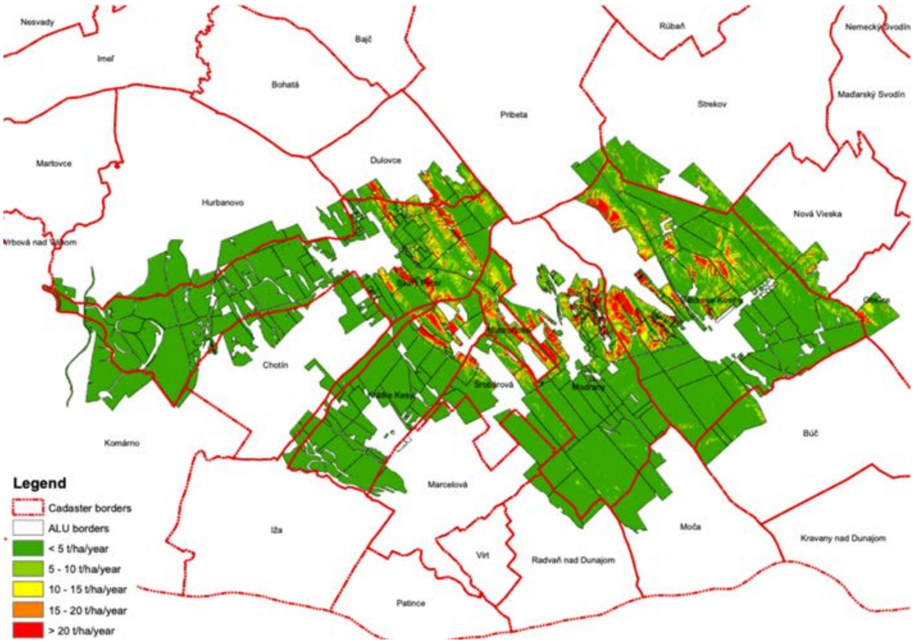

Figure 4. Soil erosion risk index calculated with USLE model for ALUs in the study area

Potential erosion risk values (t. ha^{-1}. $year^{-1}$) calculated for study area were classified according to the limits involved in the Annex No. 6 to the national legal act No. 508/2004 Coll.

Table 5

Limit values of soil runoff during water erosion (according to Annex 6 of the legal act No. 508/2004 Coll.)

Soil depth	t.ha^{-1}.$year^{-1}$
Shallow soils (to 0.3 m)	5
Medium deep soils (0.3 – 0.6 m)	10
Deep soils (0.6 – 0.9 m)	15
Very deep soils (more than 0.9 m)	20

Index of soil erosion risk degree (SEOP Index) is defined as a ratio of the calculated soil loss and the allowed values of soil loss according to the legal Act No. 220/2004 Coll. With this index it was possible to allocate individual ALUs into classes (Alena 1991). Based on such classification, the percentage of

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individual SEOP classes in agricultural land can be evaluated (Tab. 6, Fig. 5) and thus assess whether the land is endangered by soil erosion or not, and then also decide whether it is necessary to recommend any anti-erosion measures.

Table 6
Soil erosion risk classes – SEOP Index (according to Alena 1991)

	Naming of the soil erosion risk degree (SEOP)				
	No risk to weak risk	Moderately risk	Extreme risk	Very extreme risk	Catastrophic risk
SEOP Class	1	2	3	4	5
SEOP Index	< 1.00	1.01 – 2.00	2.01 – 7.00	7.01 – 28.00	> 28.01

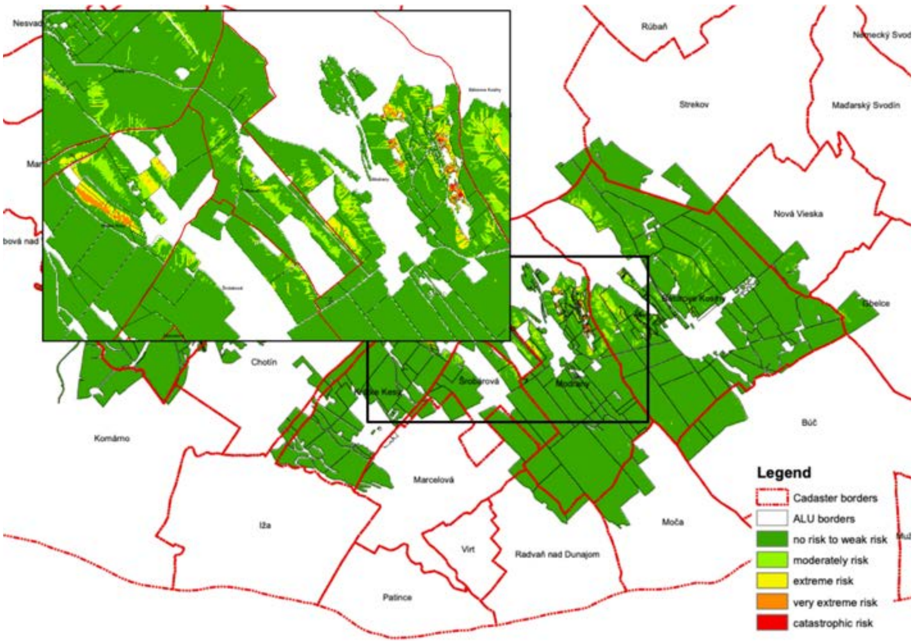

Figure 5 Soil erosion risk classes degree (SEOP) attributed to ALUs in the study area

Table 7
ALUs number of and acreage allocated into individual classes SEOP

	No risk to weak risk	Moderately risk	Extreme risk	Very extreme risk	Catastrophic risk
ALUs number	258	38	70	16	7
Acreage (ha)	12,946	350	135	23	2

The representation of individual classes of the soil erosion risk degree (SEOP) suggests that 96% of areas are of no risk or only weak risk according to the legal Act No. 508/2004 Coll. This can be explained by a large area share of deep soils with the limit value of soil runoff being 20 $t.ha^{-1}.year^{-1}$. The remaining 4% of the ALUs is affected mainly by moderate to extreme soil erosion risk. On approximately 1% of the ALU areas risk of very extreme erosion was observed.

Consolidation of soil erosion risk area

Area of 46 ALUs (corresponding to 2,201 ha or 16% of the total area) was divided based on slope class. Four ALUs with a total area of 135 ha (1%) were divided into smaller parcels with the total area of less than 20 h each. For one ALU, the part of slope steepness above 12% was set aside and allocated to grassland. Not any consolidation was required for ALUs in the remaining part of the study area (Tab. 8, Fig. 6).

Table 8

Final table showing ALUs consolidation number and related areas.

Anti-erosion measures	Number of ALUs	Acreage (ha)
No need consolidation	338	11,101
Division of the land into parts according to the slope	46	2,201
Division of land into parts with maximum area of 20 ha	4	135
Division of the land into parts according to the slope and grass the parts with a slope above 12°	1	18
Total	389	13,455

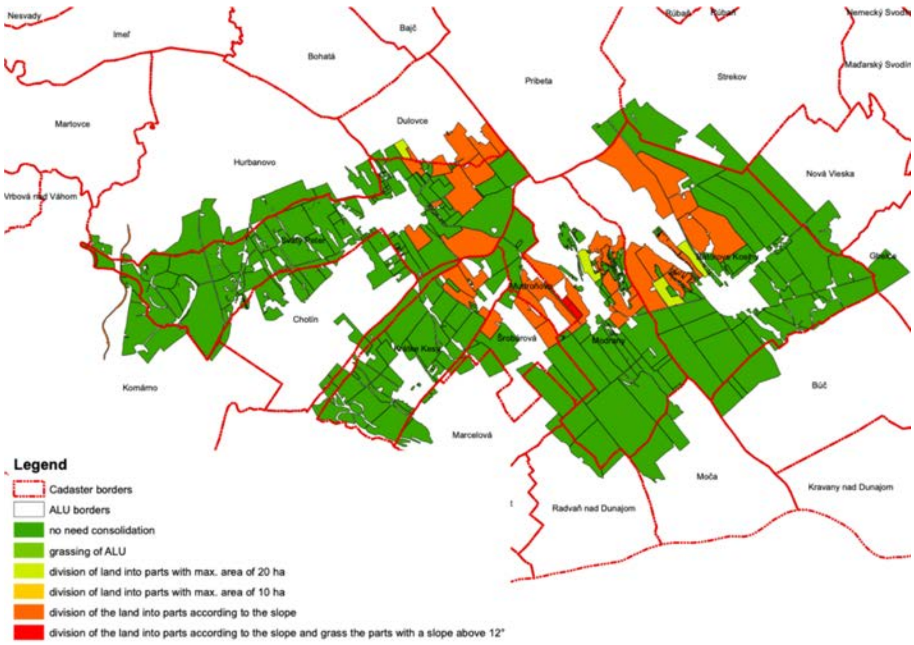

Figure 6 Differentiation of ALUs according to the anti-erosion measures recommended

Suitability of cultivated crops according to their anti-erosion effect

– Areas of soil erosion risk in agricultural land were identified by the SOEP index and anti-erosion measures proposed as a part of the consolidation algorithm. Next important step was to identify crop suitable for the given erosion risk conditions based on the anti-erosion effect of different agricultural crops.

Possible way is calculation of the maximum allowed value of the vegetation protection factor (Cp value), which is derived from the USLE equation (Wishmeier & Smith 1978). The Cp factor values for specific crops according to Alena (1991) were applied. Calculated Cp factor values allow for designing suitable composition of crops in the crop rotation which secures that actual soil erosion does not exceed the limit values (Tab. 9).

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Table 9

Maximum allowed values of the vegetation protection factor (Cp) and recommendations for crop rotations

Value Cp	Value Cp for individual crops	Description measure
< 0.005	0.005 – Permanent grassland	Grassing (use as permanent grassland)
0.005 – 0.02	0.015 – Clover	Cultivation of perennial forage
	0.020 – Lucerne	
0.02 – 0.1	0.09 – Oat	Exclusion of cultivation of broad-leaved crops, cultivation of narrow-leaved crops with the use of soil protection technologies
0.1 – 0.15	0.11 – Winter wheat	
	0,14 – Spring barley	
0.15 – 0.2	0.17 – Ray	
0.2 – 0.45	0.22 – Winter rape	Cultivation of narrow-row crops without restrictions and cultivation of wide row crops using soil protection technologies
	0.3 – Beans on grain	
	0.44 – Sugar beet	
	0.44 – Late potatoes	
0.45 – 0.6	0.6 – Early potatoes	
0.6 – 0.7	0.61 – Corn grain	Without restrictions
	0.72 – Silage corn	
> 0.7		

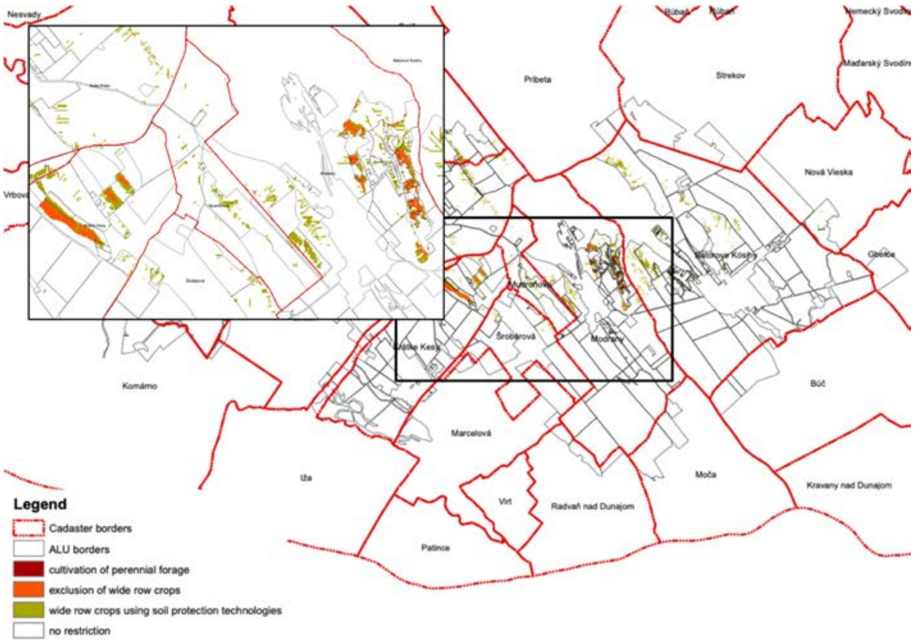

Figure 7 Maximum allowed Cp factor values calculated for ALUs in study area

Table 10

Area (ha) according to the suitability of crop production taking into account the anti-erosion effect of the crops

Without restriction	Cultivation of narrow row crops without restrictions and cultivation of wide row crops using soil protection technologies	Exclusion of cultivation of wide row crops, cultivation of narrow row crops using soil protection technologies	Cultivation of perennial forage
13,234	182	0.2	40

Setting priorities for handling erosion risk in land consolidation

All partial results obtained from previous calculations indicate factors (potential soil erosion risk, SEOP index), specific measures (consolidation of soil erosion risk areas) as well as recommendations (determination of suitability for cultivated crops taking into account their anti-erosion effect Table 10). They provide basis for professional and objective decision-making during the process of designing anti-erosion measures on agricultural land. Logical linking of this information was used to set the land consolidation priorities.

Areas with diverse land use, slope, parcel size, etc., can be found in the agricultural land which defines their different degree of potential threat from water erosion. For this reason, it was necessary to divide the agricultural areas in the study area into different categories according to the priorities. The basic area unit we evaluated was ALUs. Based on the overlap with the data on potential erosion risk and SEOP, we get the share of individual degrees of erosion risk within the ALU.

In the case of large agricultural parcels, it would be appropriate to divide them into smaller areas based on slope classes. Those ALUs with a large area and a high erosion rate were set the highest priority; in the second place, it was necessary to consolidate those ALUs with a smaller share of areas with high erosion rate. Tab. 11 shows example of the spatial differentiation of areas endangered by soil erosion as a prerequisite for land consolidation.

Table 11

Example of ALUs distribution according to the priorities for addressing soil erosion risk in consolidation process (cut-out table)

Description				**Areas endangered by soil erosion**	
Priority	**ALU**	**Acreage (ha)**	**Land use**	**Area endangered by potential soil erosion (ha)**	**Area endangered by SEOP (ha)**
1	Modrany 2001/1	216.85	Arable land	129.2	36.4
1	Modrany 2402/1	135.77	Arable land	93.4	33.8
1	Modrany 6403/1	87.02	Arable land	62.6	19.8
1	Modrany 4301/1	59	Arable land	41.2	18.7
1	Modrany 8401/1	35.45	Arable land	27.8	16.8
1	Modrany 0201/1	158.39	Arable land	91.0	16.6
1	Pribeta 9901/1	80.43	Arable land	36.8	14.2
1	Modrany 8301/1	132.66	Arable land	72.3	14.1
1	Modrany 9401/1	50.54	Arable land	30.9	13.9

Based on the total agricultural parcel area and the percentage of areas at risk of erosion according to the SEOP and the potential soil erosion risk, the following 6 groups were indicated which determine the priorities of the consolidation process (Tab. 12).

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Table 12
Priorities of addressing anti-erosion measures set for ALUs from the study area

Priority	Way of delineation	Description	Anti-erosion protection measure
1	SEOP area within ALU > 0.5ha	Agricultural land with area over 0.5 ha endangered by soil erosion	Division of the land into parts according to the slope, or into parts under 20 ha. Cultivation of broad-leaved crops using soil protection technologies.
2	SEOP area > 5% AND < 0.5 ha within ALU	Agricultural land with an area of less than 0.5 ha endangered by soil erosion	Division of land into parts according to the slope. Cultivation of broad-leaved crops using soil protection technologies.
3	ALU with VIN and SAD land use endangered by soil erosion	Agricultural land used as vineyards and orchards endangered by soil erosion	Ensuring year-round green soil cover by grassing, greening with herbaceous vegetation of abundant flowering plants, covering with straw, hay or other mulching material at least in every other aisle of the orchard / vineyard
4	Without risk, SEOP area < 5% AND > 0.5 ha within ALU	Agricultural land with a minimum area endangered by soil erosion	Areas in these groups do not exceed the limit values given by Decree no. 508/2004 Coll. as amended, subject to standard precipitation. In the event of more extreme rainfall, these areas may also be endangered to some extent by water erosion.
5	Potential soil erosion risk SEOP area > 5% AND > 0.5 ha within ALU	Agricultural land without soil erosion threat according to SEOP, but with an area over 5% resp. above 0.5 ha potentially endangered by soil erosion	
6	Without risk	–	–
Explanation: SEOP – soil erosion risk degree, ALUs – agricultural land-use units, VIN – vineyards, SAD – orchards			

The results in tabular form as well as their spatial identification (Fig. 8) allows the owner or user of the land to get an overview of the necessary anti-erosion measures and also help them to determine critical areas that need to be addressed first.

Recommendation of soil protection (anti-erosion) measures in the area threatened by water erosion is not straightforward process and it is necessary to evaluate first important factors that affect the erosion process itself. Also, each of the resulting anti-erosion measures consists of several partial measures, which together reduce the risk of erosion and enable via their combination to achieve a land use that will minimize possible crop cultivation constraints.

Compared to other case studies the level of analyses showed in this work is more detailed (not regional but cadaster level) and directly applicable at farm level. Many authors used USLE / RUSLE based GIS modelling (Shi *et al.* 2004, Nearing *et al.* 2005, Amore *et al.* 2004, Millward & Mersey 2001, Afshar, Yarnia, Bagherzadeh *et al.* 2016) for assessment of soil erosion risk or runoff on hilly slopes. Wishmeier & Smith (1978) equation based GIS toolbox was used in this study to determine the spatial pattern of soil erosion risk in the study area. Several simulation models were developed to estimate suitability of land for farming or selected management practices (Kovář, Janeček, Vaššová 2012, Simota *et al.* 2005). Chartin *et al.* 2014, Ledermann (2010) and assessed impacts of land consolidation on soil condition status.

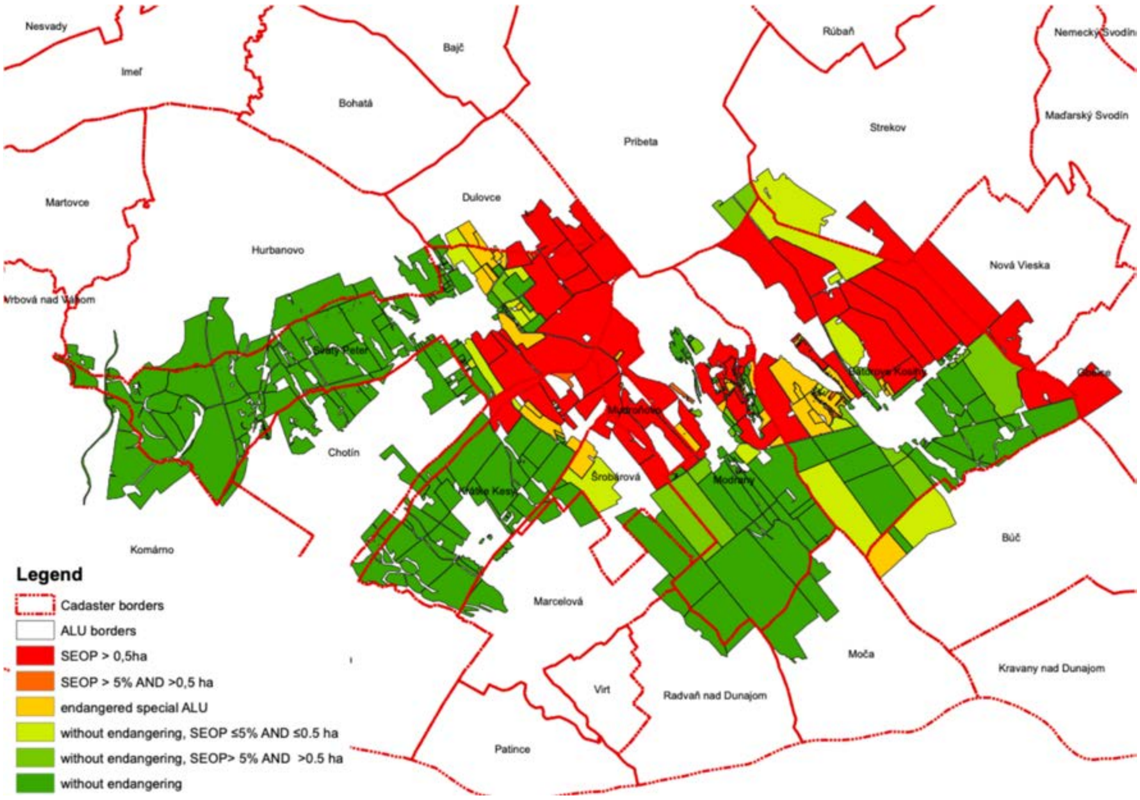

Figure 8 Distribution of ALUs according to the priorities of applying anti-erosion measures in the process of land consolidation.

Consolidation algorithm presented in this study follows the approach presented also by other authors (Nearing *et al.* 1990, Shi *et al.* 2004, Giles, Franklin 1998, Fu & Chen 2000. Baja, Chapman, Dragowich 2002) and fully respects the basic framework:

(i) Identification of erosion risk areas and their rate of risk (calculation of potential of soil erosion risk and SEOP);

(ii) Creating of the optimized spatial design of areas using the defined rate of risk (ALUs consolidation using STN technical norm)

(iii) Recommendation of the soil erosion control measures, in our case recommendation of optimal cropping system based on value of the soil protection factor by vegetation/crop (Cp).

CONCLUSIONS

Application of the land consolidation algorithm in the study area suggested that the most ALUs had a very small proportion of areas endangered by erosion, or that soil erosion risk did not exceed the limit values according to legal Act No. 508/2004 Coll. as amended. At the same time, some proportion of all ALUs are endangered in terms of potential soil erosion risk. These may represent a certain risk in the case of the rainfall events exceeding the average total or the rain intensity. This potential risk needs to be taken into account and, if necessary, can be additionally included in the system of recommended anti-erosion measures. Minor ALUs from the study area were not at risk of erosion, either in terms of potential erosion risk or because they were already used as grasslands.

This study attempts to address issues of elimination or partial mitigation of erosion-accumulation processes in the agricultural landscape. Properly implemented erosion control measures consist of recommended spatial design of the agricultural landscape, i.e. new spatial differentiation of agricultural land threatened by erosion, list of measures which might reduce the intensity of these undesirable processes and secure adequate agricultural production in a sustainable way. Web application is available for farmers on SOIL PORTAL (http://www.podnemapy.sk/portal/verejnost/konsolidacia/konsolidacia.aspx) which is based on the consolidation algorithm presented, can help farmers or other users of agricultural land to create a solid basis for a re-arrangement of agricultural land helping to eliminate water erosion.

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