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Comments on some evaluation criteria for the official prioritization of land consolidation projects in Slovakia

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ABSTRACT

Due to stalling land consolidation process and limited resources, Slovak administration needs to prioritize new projects. 120 cadastral areas are currently selected annually based on weights and different point-scales for the criteria. It can be argued that the evaluation of the official governmental special non-departmental criteria (6) for 2023, targeted to social, environmental, landscape, and development issues, is flawed and should be modified. Normalized relative magnitudes (particularly where the areal extent of the phenomenon represented by a given criterion is measurable and data is available) are suggested. Only 4 areas from the 2023 official selection would place in the first 120 (13 in the first 500) by the simple average ranking with modified criteria values. The criteria (M1, least developed districts; M2, transport infrastructure; M3, protected natural areas; M4, protected water management areas; M5, natural disasters; M6, risk of erosion) could be complemented by 4 new ones, namely: M7, critical profiles and integrated area protection; M8, marginalized population groups; M9, strategic projects and industrial parks; M10, agro-forestry systems. Using severity of risk for a cadastral area (i.e. percentages of appropriately measured and subsequently normalized criteria) could contribute to improved selection by removing unnecessary distortion by a point scheme.

Keywords: land consolidation, prioritization of projects, special criteria, cadastral areas, relative magnitudes.

INTRODUCTION

Jiang et al. (2022) state that land consolidation (LC) projects are a policy and technology tool widely used to mitigate land fragmentation (e.g. Kupidura, 2019) and other rural problems such as ecological hazards and inappropriate development. Land reclamation is carried out worldwide, for example, in China, Thailand, India, Morocco, Australia (Demetriou, 2014). Central and Eastern European countries introduced comprehensive LC in the above stated meaning after 1990. Some authors (Peng et al., 2020; Hartvigsen, 2005) argue that LC projects are an important platform and means of supporting revitalization of rural areas playing an important role in achieving the prosperity of rural economy, ecological stability, effective management and improving the quality of life. Comprehensive approach to LC projects can stimulate an increase of effectively cultivated land, optimize the structure and arrangement of land use, support better management of agricultural crops, set up modern agriculture and the development of rural tourism.

Socio-economic and environmental effects of LC should not be underestimated (Lisec et al., 2005; Dudzinska and Kocur-Bera, 2014; de Vries, 2022; Leń and Król, 2018; Vinge, 2018). Stakeholders and participants request and expect e.g. transparency and openness, reciprocal respect, societal embedding, and spatial equity (de Vries, 2022). A significant improvement of living and work conditions as well as enhancement of the quality of the environment and the cultural values of a community can be achieved by a LC (Leń and Król, 2018). At least to a certain extent, LC, inadequate LC projects, unfinished LC projects (unimplemented LC facilities and measures), as well as missing LC; all of them can also have adverse effects (Dudzinska and Kocur-Bera, 2014) or be misused (Vinge, 2018).

Land consolidation projects in Slovakia started on a proposal by a would-be participant or the state authority until 2019. The urgency and justification of LC had to be proven. Verification was the responsibility of the state authority, on internal criteria. 421 cadastral areas have been selected (Table 1) after the Act on Land Development (1991) came into the force. 417 LC projects are recorded in the Cadastre of Real Estates (Table 1) as completed (1991–2019). That does not mean that proposed measures and facilities have been actually implemented.

Since 2020, the selection of cadastral areas for land consolidation projects in Slovakia is based on the non-legislative material "Proposal of measures for accelerated implementation of land consolidations in the Slovak Republic", approved by Government Resolution no. 358 (2019). According to the proposal, LC should be carried out in all remaining cadastral areas within 30 years. Every year, 120 cadastral areas shall be selected for new LC projects. The list of selected cadastral areas is drawn up by the governmental interdepartmental "Commission for the evaluation of criteria for determining the urgency of carrying out land consolidations and the selection of cadastral areas".

Prioritization of new projects is consequently needed (Janus and Taszakowski, 2018; Strek et al., 2019; Muchová and Petrovič, 2019; Pašakarnisa et al., 2021). The commission uses its own point-based scheme and publishes point scales, weights and the final selection (with weights included in points). Descriptions, justifications and full classification of all cadastral areas are not disseminated, to the knowledge of authors of this contribution. The commission has so far selected 120 projects for the years 2020, 2021, 2022 and 2023. In 2022, the commission administratively postponed the projects for planned territories from the years 2020 and 2021 to start in 2022, which, despite the move, have not yet been commissioned. It is assumed that they will be moved to start by 2024; perhaps, the first drawing of financial resources in 2025, maybe.

This article focuses on the (special) criteria aimed at resolving social, environmental, landscape, and development issues (official governmental resources are referenced in the Material and Methods section). Modified evaluation of the criteria and the new criteria proposed and discussed in this contribution are aimed at overcoming design flaws of the current official ones that do not directly consider the size of a phenomenon, even if it is directly measurable and the data is available. Main goals of the article are as follows:

Proposing a new valuation of the existing special criteria based on direct measurement (area percentage) or occurrence of the phenomenon (binary classification) in the cadastral area using normalized values (<0.1> i.e. 0–100%)

Compiling the extent of areas for whole territory of Slovakia meeting the criteria and compare the new and the official classification, given the published information

MATERIALS AND METHODS

All the web-based datasets and resources used in this study are listed in the Table 1.

Administrative division of Slovakia (49,036 km², 5,459,000 inhabitants) is as follows: 8 regions, 79 districts, 3559 cadastral areas (Fig. 1). A cadastral area (CA) is a mapping unit that is dealt with by a one land consolidation project (LC). 3103 Cadastral areas, with no LC yet, have to be prioritized. Data is based on the borders of territorial units and cadastral areas of Slovakia on basic level. Areas (polygons) have name and code attributes. Data have been obtained as of January 2024 from ZBGIS (see also Table 1).

Description of official governmental special non-departmental criteria (M1–M6) for 2023

M1 – least developed districts (LDD) are territories that are technologically and innovatively lagging behind, have insufficient infrastructure of high-speed roads, a high proportion of long-term unemployed residents, a high proportion of the population with basic education and with the departure of labour forces abroad. 20 districts containing 1233 cadastral areas are defined by the legislation (Law no. 336/2015 Coll.); the listing (Table 1) is managed by the Ministry of Investments, Regional Development and Informatization of the Slovak Republic. From the 2023 listing, 39 territories were selected (assigned 20 points, zero for others).

M2 – the transport infrastructure (TI) is under the responsibility of the Ministry of Transport and Construction of the Slovak Republic and the data is published on the portal INEKO (Table 1). For the year 2023, 19 cadastral areas were selected (assigned 8 or 16 points, zero for others).

Table 1. URLs of the web-based datasets and resources used in this study

Dataset	URL
Numbers of complex land consolidation projects commissioned by the years in the period 1991–2019	https://data.slovensko.sk/datasety/e13b4f51-834c-4210-b697-b10e8635ba54
Numbers of complex land consolidation projects recorded as finished by the years in the period from 1991–2019	https://data.slovensko.sk/datasety/3d348c35-569b-49d9-ad78-9908d58cab86
ZBGIS	https://www.geoportal.sk/sk/zbgis/na-stiahnutie/
Legislative material	https://www.slov-lex.sk/legislativne-procesy/-/SK/LP/2019/847
Legislative material	https://www.slov-lex.sk/legislativne-procesy/-/SK/LP/2021/325
Governmental material	https://rokovania.gov.sk/RVL/Material/29186/1
Least Developed Districts	https://www.upsvr.gov.sk
INEKO	https://doprava.ineko.sk/mapa/cesty
Protected (including Natura 2000) Areas	http://maps.sopsr.sk/, http://webgis.biomonitoring.sk/
Protected Water Management Areas	https://www.minzp.sk/voda/chvo/
Data Slovensko	https://data.slovensko.sk/
ESRI ArcGIS Pro	https://www.esri.com
R software environment	https://www.r-project.org
URANOS project, ZBGIS	https://zbgis.skgeodesy.sk/mapka/en, https://www.geoportal.sk/sk/aplikacie/mapka/kriticke-profily.html
Office of the Plenipotentiary of the Government of the Slovak Republic for Roma communities	https://www.romovia.vlada.gov.sk/atlas-romskych-komunit/atlas-romskych-komunit-2019/?csrt=2803070811164149725

M3 – Protected bird areas (PBA) and Areas of European Importance (AEI) are included in Natura 2000 and are defined by Act No. 543/2002 Coll. on Nature and Landscape Protection, as amended. The records are kept by the State Nature Protection of the Slovak Republic (Table 1). 9 territories (2023) were selected (assigned 5, 10 or 15 points, zero for others).

M4 – Protected water management areas (PWMA) are defined by Act no. 305/2018 Coll. on Protected Areas of Natural Water Accumulation and on amendments to certain laws. The data are under the responsibility of the Ministry of the Environment of the Slovak Republic (Table 1). Protected water management areas cover 582 cadastral areas covering 6,842,453,044 m^2.

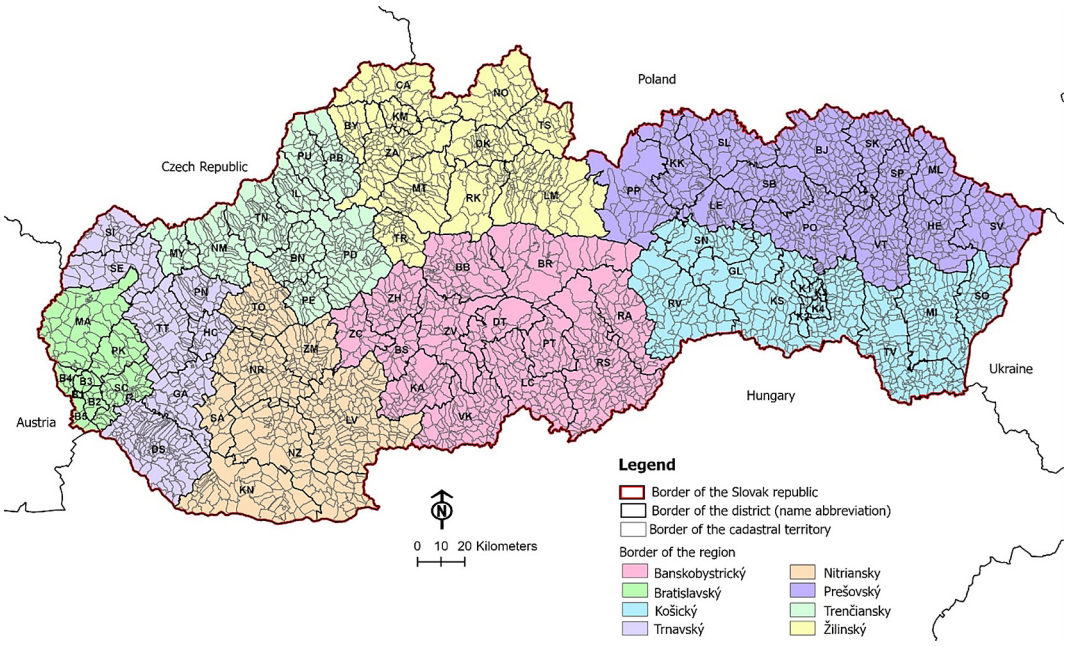

Figure 1. Administrative division of Slovakia; Source: original adaptation by authors based on the boundaries of the administrative division of the territory freely available on: https://www.geoportal.sk/sk/zbgis/na-stiahnutie/

22 territories (2023) were selected (assigned 10 points, zero for others).

M5 – a natural disaster area is a territory where an extraordinary event that threatens life, health, property or the environment happened or might happen, floods in particular. For the year 2023, the governmental authorities selected 56 cadastral areas (assigned 15, 20, 25, 30, 35 points, zero for others).

M6 – the risk of erosion is determined on the basis of the documents of the National Agricultural and Food Centre for identifying agricultural areas threatened by the effects of erosion and the most sensitive areas, including defining the method of cultivation and coverage for the purpose of finalizing the Strategic Plan SPP 2021–2027. The layers of soils at risk of erosion due to water and wind erosion are available at Data Slovensko portal (Table 1). Authorities (2023) selected 118 cadastral areas (assigned 8, 16, 24, 32, 40 points, zero for others).

Modifications and new criteria definition

Task 1: Reviewing the official non-departmental criteria and highlighting situations where the application of the criteria significantly distorts the selection of cadastral areas.

Task 2: Modification of existing criteria aimed at increasing the landscape adaptive capacity.

Task 3: Introduction of new "permanent" criteria considered necessary for proper selection of cadastral areas.

Task 4: Proposing new "temporal" criteria that could be introduced according to current needs, e.g. related to agricultural subsidies, forestry issues, development of bicycle routes, viticulture, restoration of the historical potential of the landscape, etc.

New criteria valuation

Binary criteria (e.g. M1) are given point according to whether the criterion condition is met (1) in the cadastral area or not (0), due to a lack of publicly available data for areal or equivalent costs/damages evaluation.

Size criteria, where the areal extent of the phenomenon represented by the criterion is measurable and the data is available, are evaluated as the percentage of the cadastral area (e.g. 0.75, i.e. 75% of the area is affected).

All criteria columns were subsequently normalized by their respective column maxima. Maps (layers identifying areas at risk according to the criteria; i.e. shape, colouring) in Figure 2 were created in the ESRI ArcGIS Pro software. R software environment was used for preliminary data processing and error control (standard descriptive statistics, correlation analysis and clustering) and preparing datasets for subsequent overlaps by standard UNIX tools (awk, grep, sed, sort, cat, wc).

The overview of modified / new criteria for land consolidation projects prioritization is presented in Table 2.

The official (weights are included in points) valuation of the criteria uses simple sum to produce the composite index for ranking the cadastral areas. The new valuation of the criteria uses simple average to produce the composite index for ranking the cadastral areas. Which is essentially the same approach.

Limits of this research known to the authors are as follows:

1. Lack of information on official selection process used by the authorities (descriptions, justifications, full classification of all cadastral areas of Slovakia).
2. Partial comparison of the official and the new valuation due to irreproducibility of the authorities' selection (see the first point).
3. Narrow focus of the study (alert to differences and quick fix approach).

RESULTS AND DISCUSSION

Cadastral areas at a risk as measured by the new criteria (highlighted) with the current official selection (marked by closed violet boundaries) are depicted on the panels of the Figure 2.

The least developed districts (Fig. 2, M1 panel) should be treated equally for all 1233 legislatively defined locations on 15,601 km^2 of the Slovak territory. A better way would be to value it by costs / loses (there is a lack of information to do that right now, unfortunately).

Territories that connect to each other and thereby functionally organize the country in the same period considering the prepared transport infrastructure (Fig. 2, M2 panel) shall be prioritized. The planned 77 sections (highways and expressways with a total length of 1031 km) cross 372 cadastral areas with a total area of 5735 km^2.

It seems reasonable to assess the protected natural areas (Fig. 2, M3 panel) according to the percentage representation in a cadastral area.

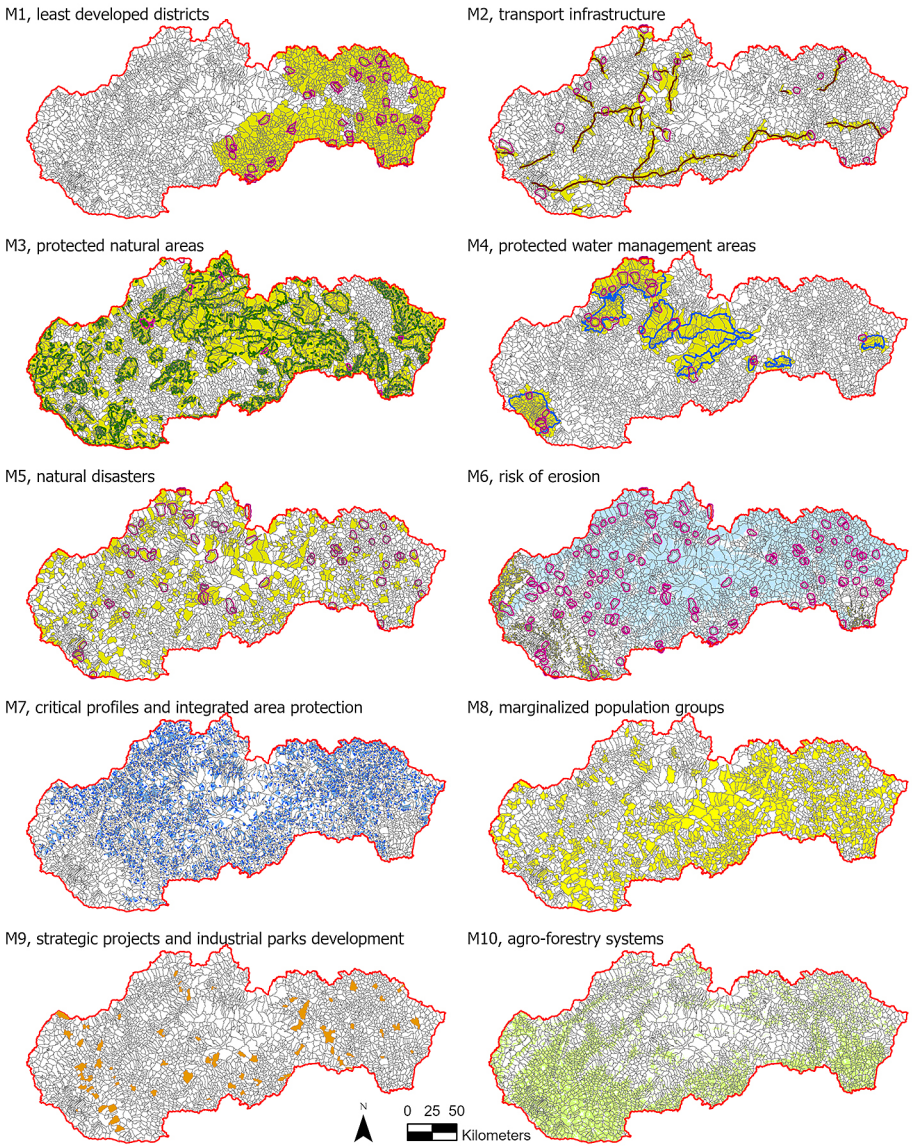

Figure 2. Cadastral areas that need to be addressed by modified / new criteria (highlighted) in the context of the current official ones (marked by closed violet boundaries). M1, least developed districts; M2, transport infrastructure; M3, protected natural areas; M4, protected water management areas; M5, natural disasters; M6, risk of erosion; M7, critical profiles and integrated area protection; M8, marginalized population groups; M9, strategic projects and industrial parks development; M10, agro-forestry systems; Source: original adaptation by authors based on the boundaries of the administrative division of the territory (freely available on https://www.geoportal.sk/sk/zbgis/na-stiahnutie/) and the input databases described in the Table 1.

Currently, the same number of points were assigned in locations where the percentage of the protected area was even less than a 1%. Natura 2000 sites in 1726 cadastral areas cover 14,510 km^2. The point-assessment by the entire cadastral territory affected up to 31,165 km^2, which is more than twice as much. The protected large-scale and small-scale territories in accordance with Act no. 543/2002 Coll. on nature and landscape protection, as amended, and subsequently also sites defined by other conventions (Table 1) shall be included as they do not fully overlap with the Natura 2000 locations to overcome a bias.

Protected water management areas (Fig. 2, M4 panel, 6842 km^2) should be evaluated according to their relative representation in a cadastral area as well.

Natural disasters evaluation (Fig. 2, M5 panel) shall not be reduced to floods (49% of recorded events, Slovak Ministry of Interior, 2018) just because of an “easy” availability of the data.

Table 2. Overview of old and modified / new criteria for land consolidation prioritization

Selection criteria		Proposal	
2020 criteria	2021 and 2022 criteria	2023 criteria	Modified / new criteria
Points M1 least developed districts max. 50 points	Points M1 least developed districts max. 20 points	Points M1 least developed districts max. 20 points	Points M1, least developed districts Binary classification (not present 0 xor present 1)
	Points M2 transport infrastructure max. 40 points	Points M2 transport infrastructure max. 40 points	Points M2, transport infrastructure Binary classification (not present 0 xor present 1)
	Points M3 protected natural areas max. 20 points	Points M3 protected natural areas max. 20 points	Points → Area fraction M3, protected natural areas (including those not counted yet)
	Points obsolete M4 Unsettled water structures and streams max. 20 points		Not to be used
Points M4 protected water management areas max. 50 points		Points M4 protected water management areas max. 20 points	Points → Area fraction M4, protected water management areas
	Points M5 Natural disasters max. 60 points	Points M5 Natural disasters max. 60 points	Points M5, natural disasters Binary classification (not present 0 xor present 1)
	Points M6 risk of erosion max. 40 points	Points M6 risk of erosion max. 40 points	Points → Area fraction M6, risk of erosion
			Area fraction M7 critical profiles (CPs) and integrated area protection (extent of contributing area of the CPs)

A longer timeline (min. 10 years) is necessary; during 2013–2023, as much as 455 municipalities needed help of the Slovak Fire and Rescue Service in cases that have to be included. Equivalent costs / loses are quantifiable in principle, i.e. this parameter is transformable to a percentage criterion, given enough reliable information (that is collected by various entities, but not available to scholars / public).

Erosion risk (Fig. 2, M6 panel) is derived from the layers of soil at risk of erosion by water and wind compiled for SPP 2021–2027, regarding the good agricultural and environmental condition of the soil (DPEP 5). It should be evaluated according to the fraction of the endangered area in a cadastral area as well. Erosion risks extend to 3468 cadastral areas (36,580 km^2 in total). This was distorted to 48,539 km^2 by the point-based assessment.

Presence of critical profiles (CPs), a new proposed criterion, identifies possible danger of concentrated surface runoff entering municipalities, (Fig. 2, M7 panel). It is evaluated according to the percentage representation of contributing areas (catchments of CPs) in the cadastral area. 3661 critical profiles have been identified in Slovakia with contributing areas of 8896 km^2 (Table 1).

Presence of Marginalized Population Groups (MPG / Roma settlements, M8, Fig. 2), Sites for Strategic Projects and Industrial Parks Development (SPIPD, M9, Fig. 2) or implementation of Agro-Forestry Systems (AFS, M10, Fig. 2) might be considered as examples of the temporal criteria to address pressing needs.

Roma settlements (825) are located in 1104 cadastral areas (8036 km^2); vast majority of the sites illegally built without permission from the land owners. Floods occurred in 41 of them

(Office of the Plenipotentiary of the Government of the Slovak Republic for Roma communities 2019, Table 1). 80 industrial parks are located in 70 cadastral areas on 2021 km^2. Waterlogging- or drought- or erosion-endangered locations or successively overgrown sites suitable for agro-forestry systems cover 17,895 km^2 in 3358 cadastral areas.

To get an idea what a ranking by the modified M1 – 6 criteria might be, the simple average has been used for each cadastral area, depicting fraction of risk for particular area compared to others (theoretical maximum being exactly one, worst case value of 0.6055 or 60.55% has been calculated for one location). Subsequently all cadastral areas have been sorted by the result (max. to min.). Only 4 officially 2023 selected cadastral areas would place into the first 120 (only 13 into the first 500) by the modified system. Selections of 2020–22 ranked not better. Land consolidation projects have been postponed in the selected cadastral areas, none of them is commissioned yet, as of finishing writing this article (July 2024).

Authors of this study proposed simple modifications to the currently official approach hoping to better the decision making and prevent further damage to land consolidation in Slovakia once it has been virtually restarted. It should be understood as an alert a possibly temporal quick fix ready to adopt if necessary, although not intended as such.

Proposed evaluation of the criteria is crucially dependent on proper definition and measurement. It reduces the possibility of overestimating but it is prone to underestimating (minor representation with large influence). The second case can be understood as an instance of bad definition or wrong measurement (gross mistake, fundamental error), in ideal conditions. In reality, it can be dealt with e.g. by introducing new criterion measured differently (as the circumstances allow) to account for anomalies and grouping the supplement with the existing criterion (e.g. by averaging) thus pushing the extreme up. This is equivalent to introducing individual weights for individual locations, but by calculation.

There are many less-or-more sophisticated approaches based on multivariate methods (e.g. Pitel, 1990; Harasimowicz et al., 2021; Muchová, 2019; Choubin et al., 2019; Marinković et al., 2022; Ertunç et al., 2023; Janus and Taszakowski, 2018; Leń, 2018; Strek et al. 2019; Muchová and Petrovič, 2019; Pašakarnisa et al. 2021) that could be used for prioritization directly or to justify a reasonable accuracy of a simplified "panel" evaluation prior to its deployment by the authorities.

Selected criteria and composite indices are being introduced prior to the analysis based on the relevant knowledge and even using surveys on experts' opinion (Pašakarnisa et al., 2021); the decision variables are further revised/refined and/or modified during the processing (Janus and Taszakowski, 2018; Leń, 2018; Strek at al., 2019; Muchová and Petrovič, 2019).

The example of continuing land consolidation (LC) in the neighbouring Czech Republic (CZ) shows that even without explicit prioritization by the authorities, it is possible to implement a large number of projects given enough resources and interest from involved stakeholders (Sklenička, 2006). Cadastral areas for LC are still selected in the CZ based on interest of the potential participants (including the state administration itself, which means an implicit prioritization of a kind) and verification of need and feasibility (Karásek et al., 2018).

CONCLUSIONS

Slovak authorities are forced to prioritize new land consolidation projects due to prior stalling and very limited resources. Cadastral areas are selected using a system of weights and different point-scales for individual criteria. Based on official governmental special non-departmental criteria (6) for 2023, targeted to social, environmental, landscape, and development issues, authors argue that a fix is needed to overcome that they do not directly consider the size effect of a phenomenon, even if it is directly measurable and data is available. This gives cadastral areas with small manifestations of a criterion equal position as those affected much more. Criteria should be evaluated by using normalized relative magnitudes to avoid bias, whenever possible. Just 4 areas from the 2023 governmental selection would place in the first 120 (13 in first 500) by the average of the modified criteria. Modified criteria are as follows: M1, least developed districts; M2, transport infrastructure; M3, protected natural areas; M4, protected water management areas; M5, natural disasters; M6, risk of erosion. Introduction of 4 new ones is proposed in this article, namely: M7, critical profiles and integrated area protection; M8,

marginalized population groups; M9, strategic projects and industrial parks development; M10, agro-forestry systems. Using relative normalized magnitudes of criteria (i.e. a severity of risk for a cadastral area), based on measured values where possible, and properly defined (sub)groups could contribute to removing deformation of selection by a point scheme.

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