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ORIGINAL SCIENTIFIC PAPER

Jordana M. NINKOV[1*], *Klara L. SZABADOS*[2], *Snežana P. JAKŠIĆ*[1], *Branislava Z. BUTORAC*[2], *Slobodan N. PUZOVIĆ*[2], *Alen M. KIŠ*[2], *Ranko D. PERIĆ*[2]

[1] Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad 21000, Serbia
[2] Institute for Nature Conservation of Vojvodina Province, Radnička 20a, Novi Sad 21000, Serbia

ENVIRONMENTAL IMPACT ASSESSMENT OF LAND CONSOLIDATION

ABSTRACT: Land consolidation (LC) is an important tool for the improvement of agriculture and rural development, which also includes environmental issues in most of the countries in Europe. This paper presents the most important results of the environmental impact assessment (EIA) of land consolidation, conducted in the municipality of Vršac through a pilot project based on the EU methodology set within the project: "Strengthening Municipal Land Management in Serbia", supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. During the summer of 2018, field survey was carried out at 90 locations, documenting the natural, semi-natural and man-made landscape elements of ecological or cultural values, assessing their quality and estimating the potential harmful environmental impacts of the land consolidation. The already existing negative impacts of intensive agriculture were also registered, such as abandonment or overgrazing of pastures and meadows, converting grasslands into arable land, soil erosion and habitat fragmentation. Although the area of LC is without natural forest and extremely poor in semi-natural elements of rural landscape, the existing entities were revealed as refuges for protected species. Some of the grassland fragments belonged to protected habitat types. The final categorization of the landscape elements was conducted in three levels. Category I landscape elements had to remain undisturbed; Category II landscape elements could be removed with obligatory ecological compensation, while the Category III landscape elements could be removed without environmental compensation. Recommendations were given pointing out the possibilities for improving the environmental characters of the area by the land consolidation process.

KEYWORDS**:** land consolidation, environmental impact assessment, landscape elements, indicator species, Vršac

[*] Corresponding author. E-mail: jordana.ninkov@ifvcns.ns.ac.rs

INTRODUCTION

Land consolidation (LC) is a legally regulated procedure implemented by the public authorities to redistribute and reallocate parcels of individual agricultural landowners (Veršinskas et al., 2020). In the past, the main goal of LC was an economic effect: increasing agriculture production by ownership defragmentation and improving infrastructure. The landscape changes derived from the agricultural intensification have led to multiple negative effects (Stoate et al., 2010), including soil erosion (Borrelli et al., 2023), pollution (Rodríguez-Eugenio et al., 2018) and decrease of natural pest control (Perrot et al., 2021; Rusch et al., 2016). Hereupon, the rural development component was recognized in LC planning documents (Thomas, 2006) and, according to international initiatives of sustainable development, a set of measures for environment improvement have been included in LC process (Gečaite and Jankava, 2017; Moravcová et al., 2017; Muchová et al., 2016). According to the Veršinskas et al. (2020) definition, the contemporary land consolidation is used to adjust the property structure in rural areas and to achieve a number of other public objectives, including nature restoration and construction of infrastructure. The economic benefits of land consolidation are widely documented through cost-benefit analysis. However, the benefits of environment protection and nature conservation are difficult to calculate and their effects are not immediately visible (De Groot et al., 2010). For these reasons, the environmental component has not been strongly involved in land consolidation so far (Elvestad and Sky, 2019).

Land consolidation changes the landscape structure, providing a great tool to plan environmental issues, climate change adaptation and mitigation, including water management, habitat restoration and creation of nature reserves (Veršinskas et al., 2020). According to Gečaite and Jankava (2017), LC is a mechanism for reducing soil erosion, arranging reclamation facilities, preserving biodiversity, reducing air pollution and improving the landscape structure. This process requires multidisciplinary approach: in addition to professionals in the fields of geodesy, law, economics, agriculture, etc. it is obligatory to consult specialists in environmental sciences.

According to Vasiljević (2019), land consolidation in the Republic of Serbia covered 1.4 million hectares between 1955 and 1990, when the process was discontinued, primarily due to lack of funding. Since 2006, new LC projects have been implemented, predominantly through international cooperation. However, a full legislative framework is still pending and projects are implemented on small areas according to the real needs (Vasiljević et al., 2018).

There is no single umbrella law of land consolidation. Different countries apply different models and follow non-identical objectives (Veršinskas et al., 2020). Serbia lacks a modern legislative framework governing land consolidation (Vasiljević, 2019). According to the existing legislation (*Sl. gl. RS* 62/2006 in version 95/2018), environmental impact assessment is not a mandatory part of the LC documentation in the Republic of Serbia as it is in most of the EU countries (Veršinskas et al., 2020). This paper presents the most important results of the EIA for land consolidation conducted in the municipality of Vršac

(Szabados and Ninkov, 2018), through a pilot project within the project "Strengthening Municipal Land Management, Rural Development: Effective Land Management", supported and coordinated by GIZ (GIZ, 2017).

MATERIALS AND METHODS

General characteristics of the land consolidation area

The investigated land consolidation area includes three cadastral municipalities (CMs) of the municipality Vršac, R. Serbia: CM Vlajkovac (4,962 ha), CM Uljma (6,114 ha) and CM Izbište (4,501 ha). This area, according to Bugarski et al. (1995), includes three geomorphological units. The southern part belongs to the South Banat Loess Plateau with the Dumače hill at the southwestern border of the area. The elevation divergence between the hilltop and the plateau margin contributes to the formation of several loess valleys. The north-eastern parts are located on the lake-loess terrace, while the northern part belongs to the Alibunar Depression (Vršački rit).

According to Nejgebauer et al. (1971), in the northern part of the area, Hydromorphic soils, primarily Humoglay – Hydromorphic black soil, were formed. These soils in the northern and north-western part are permeated by halomorphic Solonetz and Solonchakas saline soils along the margin of the Alibunar depression, while the largest part of the land consolidation area is occupied by Chernozem – automorphic soil. Soils with a higher sand content are found at the south of the area, on the highest terrain towards the Deliblato Sands.

Municipality of Vršac has a moderate continental climate ([*]Lokalni ekološki akcioni plan grada Vršca, 2016). The average air temperature is 11.5 °C, by 0.5 °C higher than the Serbian Autonomous Province of Vojvodina average and the average annual rainfall is 644.1 mm. The municipality is known by its intense winds. The number of days with winds of 6 Beaufort (strong winds) is 167 days and the most common winds are directed from the southeast.

Natural watercourses have been canalized or drained and the groundwater levels of the wider area have been lowered (Bugarski et al., 1995). The first aquifer is quite alkalized, with a high content of dissolved sodium (Bogdanović and Marković, 2005). The investigated area includes one section of the Basic Canal Network and several lower order canals of Danube-Tisa-Danube hydro system. The artificial lakes of the fishpond "Vršački ritovi", with the 712 ha water surface, were formed on the low terrain of Alibunar depression. Surface waters also include the abandoned pits of the brickyard in Uljma, filled with groundwater. Groundwater is the main source of water supply for the residents and the economy, no sanitary sewage system has been built in any of the settlements within the LC area (Lokalni ekološki akcioni plan grada Vršca, 2016).

The potential vegetation, according to Jovanović et al. (1986) on the southern part of the LC area is forest-steppe (communities from the alliances *Festucion*

[*] Local ecological action plan by the Vršac town, 2016

rupicolae and *Aceri tatarici-Quercion*). The northern part is a mosaic made from patches of saline meadow-steppe (*Festuco-Puccinellietea*), forest of oak and tatarian maple (*Aceri tatarici-Quercetum s. lat.*), as well as hygrophilous forest of pedunculate oak and broom (*Genisto-Quercetum roboris s. lat.*). From the natural habitats the salt meadows and salt steppes are most noteworthy (Knežević, 1994; Slavnić, 1948).

The main land use type of the investigated area is agriculture with the domination of arable crops. Meadows and pastures cover 5.6–11.6% of the CMs, vineyards located on the Vinogradarski breg occupy below 2% of total area, while orchards are found on negligible areas (* *Službeni list*, VR 92/2012). The forests cover of LC area is below 0.5%.

Field work

The main objectives of the field work were set by GIZ. In the phase of planning, the input data (landscape history, geographical features, recent and planned land use, etc.) were collected and the localities foreseen for survey were selected: habitat fragments, semi-natural and man-made landscape elements, environmentally sensitive areas and large units of homogenous arable land. The field work was carried out by the use of printed orthophotos and cadastral maps of land use, in June and July of 2018, at 90 locations of observation. List of detected plant species and photo-documentation were prepared at each site, while the threats to natural resources were estimated visually. Unless otherwise stated, nomenclature follows the Euro+Med Plant Base (2006+). At the observed locations under field crops, the condition of crop cover was also assessed. All the surveyed locations were georeferenced by Trimble GPS receiver, as point and/or shape and transferred on the cadastral map. The software used for the mapping was ESRI ArcGIS Geostatistical Analyst 10. The presence of birds was detected by transects in 6 selected areas containing natural or semi-natural landscape elements.

Landscape and habitat assessment

Landscape and habitat assessment, by descriptive method set by GIZ (Thomas, 2017), was performed in relation to the following criteria:

- Endangerment of soil quality by erosion, pollution or inadequate use;
- Presence of indicator plant species of natural habitat types;
- Presence of strictly protected and protected species or protected habitat types;
- The habitat quality was assessed by floristic diversity and abundance of invasive plant species. At selected localities the presence and abundance of rare/threatened bird species were also used as indicators;

* The Official Paper.

– Evaluation of habitat fragments from the aspect of long-term preservation possibilities was based on the next characteristics: size and shape of the spatial unit, influences of neighbouring plots (land use type, presence of invasive species or human disturbances), as well as possibilities of sustainable use;
– Rarity – elements within a given space which have a higher value.

RESULTS AND DISCUSSION

Landscape elements with natural or cultural values

Natural habitats were presented by heavily fragmented grasslands, in the form of pastures, meadows and grass strips along the roads and canals. Based on the presence of characteristic species (Blaženčić et al., 2005), two habitat types listed as priorities for protection in Serbia (*Službeni glasnik RS*, 35/2010) were revealed. Pannonic loess steppic grasslands were identified by 42 indicator species, such as *Andropogon ischaemum*, *Festuca stricta* subsp. *sulcata*, *Poa angustifolia*, *Asparagus officinalis*, *Centaurea scabiosa*, *Euphorbia nicaeensis* subsp. *glareosa*, *Fragaria viridis*, *Linum austriacum*, *Orlaya grandiflora*, *Salvia nemorosa* and *Thymus pulegioides* subsp. *pannonicus.* Steppe fragments were detected on the slopes of valleys near Uljma and Izbište and along the road between Uljma and Dumača hill, as well as in the grass strips along the hedges and dirt roads of the loess plateau. The fragments of Pannonic salt steppes and marshes, identified by 15 indicator species, such as *Agrostis stolonifera*, *Alopecurus pratensis*, *Festuca pseudovina*, *Puccinellia distans* subsp. *limosa*, *Galatella cana*, *Camphorosma annua*, *Hordeum hystrix*, *Plantago maritima*, including the protected *Tripolium pannonicum* and *Limonium gmelini*, were revealed in the surroundings of Vlajkovac. Non-saline meadows and pastures represented the most fragmented and degraded habitat type, hardly identifiable by national classification, detected on the pastures, in the road verges and canal banks. However, some fragments still preserved some floristic rarities: the population of strictly protected *Iris spuria* was detected in the abandoned meadow near Vlajkovac, while specimens of *Iris spuria* and the protected *Senecio doria* were found on the edge of the dirt road leading from Uljma toward Nikolinci.

The semi-natural landscape elements of the investigated area were deficient in woody vegetation. Only one small, planted forest (named as Memorial Park) and several very small woodlots, dominated by young trees and shrubs were present in the LC area. Tree lines were restricted on the edges of the asphalted roads connecting the settlements (Figure 3), and a few solitary trees were found near the settlements. Field margins were detected only on the steep slopes of the Dumača hill, in the form of narrow grass strips more or less overgrown by bushes. A few detected hedges were scattered in the area, containing 5–7 autochthonous species such as *Acer tataricum*, *Cornus sanguinea*, *Crataegus monogyna*, *Euonymus europaeus*, *Ligustrum vulgare*, *Rhamnus catharticus*,

Rosa sp. The network of field roads was dominated with narrow dirt roads unfavourable for hosting tree lines or hedges, therefore the grass strips of road verges and canal banks were the most frequent semi-natural landscape elements of the area. Their floristic composition indicated that most of them were remains of natural grasslands.

The most important anthropogenic landscape element with considerable natural values was the network of ameliorative canals. The secondary vegetation of canal beds and banks contained the species natural habitats, in the main canal the protected *Trapa natans* agg. was abundant. The floristic diversity and the large number of observed animal species (dragonflies, butterflies, bugs, beetles, etc.) suggested that they represent an important secondary habitat, in accordance with the literature data from the wider region (Krizmanić et al., 2015; Stojanović et al., 2007; Tölgyesi et al., 2022). The abandoned clay-pits of the brickyard near Uljma represented a habitat mosaic containing wetlands, used as a feeding place for wildlife and a breeding habitat for the strictly protected *Merops apiaster*.

The artificial mounds, noted as archaeological sites (*Prostorni plan Opštine Vršac, 2015; Vršac EIA, 2015), were the only remarkable anthropogenic landscape elements with cultural values.

Detected threats to natural resources

Soil degradation by erosion was observed in the loess valleys in the CM Uljma and CM Izbište. These valleys were covered by grasslands in the past (Arcanum, 2018), but are currently used as arable land. Due to the ploughing, water erosion has washed down the black Chernozem topsoil from the slopes and the yellow loess substratum become clearly visible even on the orthophoto (Figure 1). The ongoing erosion process generated fissures in the soil between the crop rows (Figure 2). Earlier, the precipitation was retained by the stretch of grasslands. In recent years, the high intensity rainfalls form flood waves. The floods damaged the lower parts of the village Uljma in the years 2009, 2014 and 2017. In order to prevent further floods, construction of a retention basin is planned near the settlement (**Hidroprojekt, 2018), without even considering erosion control based on the sustainable use of the valley.

Despite the threat of wind erosion (Lokalni ekološki akcioni plan grada Vršca, 2016), there were no windbreaks in the area. Ploughing the grass strips along the road edges by the users of neighbouring plots has proved to be a widespread practice in all three CMs. Destruction of road edges resulted in the lack of hedges and the scarcity of floristically diverse grass strips. The extremely low number of semi-natural landscape elements refers to the poor quality of the connected ecosystem services. Grass verges provide habitats for pollinators and arthropods (Kütt et al., 2016), including species important for

* Spatial plan of the Vršac town
** Hydroproject

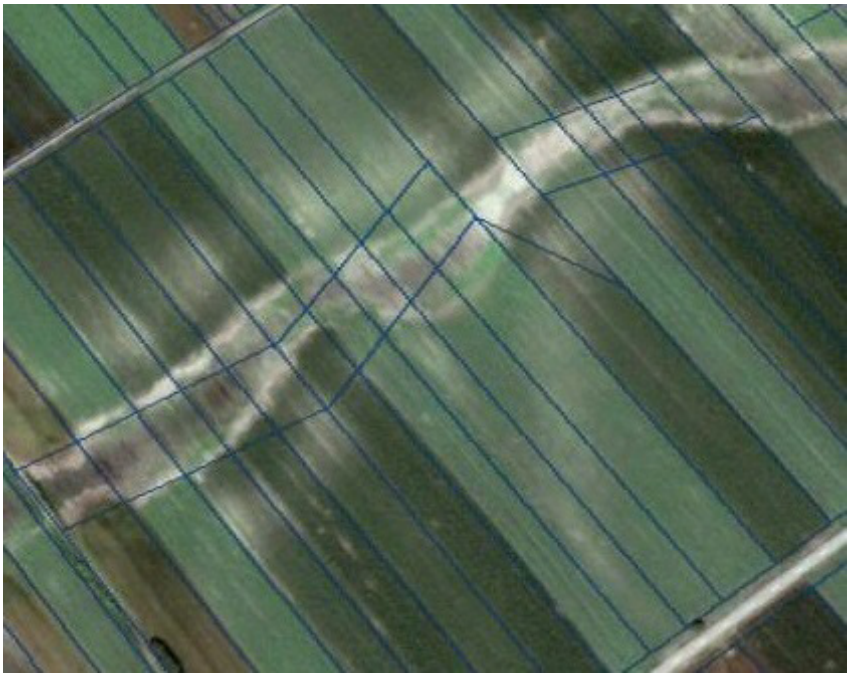

Figure 1. The satellite image shows the erosion on the slopes and the appearance of a light parent loess substrate

Figure 2. Traces of water erosion in the loess valley south of Uljma

the biological pest control (Rusch et al., 2016) and feeding areas for bird and game species (Graham et al., 2018). Hedges perform as windbreaks modifying microclimate and controlling erosion, also representing important habitats for wildlife and pollinators (Graham et al., 2018; Vanneste et al., 2020). Converting grass strips along the banks of ameliorative canals into arable land was also revealed at several localities, decreasing the buffer capacity of the vegetation (Dorioz et al., 2006).

The investigated common pastures near the settlements were mostly overgrazed, while the grasslands located at large distances of the settlement were abandoned, and some of them were even overgrown with woody vegetation. Invasive plant species were detected both at abandoned and overgrazed grasslands. Only small parts of the grasslands were used as hay fields that had been mowed in the period of the fieldwork. Almost at every grassland patch units converted into arable land were detected, or segments showing traces of previous cultivation and abandonment. Communal and construction waste was deposited on the common pastures near the settlements. The improper use has led to degradation of the grasslands, threatening not only their biodiversity (De Groot et al., 2010), but reducing ecosystem services provided by them, such as natural pest control (Perrot et al., 2021) or habitat for wildlife and game species (Stoate et al., 2009).

Invasive plants (a total of 14 species) were detected in all types of the surveyed landscape elements, except the grasslands on the extremely saline soil. The most frequent species of canal network was *Amorpha fruticosa*. Some sections of the canal dikes were covered with *Lycium barbarum* and *Robinia pseudoacacia*, the later forming a dense thicket as a result of illegal coppice. *Ailanthus altissima* and *Asclepias syriaca* were spreading on the overgrazed pastures, while *Celtis occidentalis* was observed in all habitat types.

Evaluation and proposed compensation measures

Despite the low number of natural and semi-natural landscape elements, the surveyed area still preserved a remarkable biodiversity. During the field work a total of 266 plant species were determined, six of them protected by law (*Službeni glasnik RS*, 98/2016). Results of the habitat values assessment show that 23 bird species were detected, but the real number of rare and threatened species is probably higher since the field work was carried out at the end of the breeding period. According to Serbian law (*Službeni glasnik RS*, 98/2016), 16 species were strictly protected, three were protected and four were listed as game species under special condition. According to EU Birds Directive (2009), 11 species were of international importance, out of which six belonged to the category I (species subject of special conservation measures): *Egretta garzetta*, *Tringa glareola*, *Chlidonias hybrida*, *Circaetus gallicus*, *Lanius collurio* and *Anthus campestris*. The presence of some species, such as *Merops apiaster*, *Saxicola rubetra*, *Upupa epops* and *Falco subbuteo* indicated richness of biodiversity and importance of remaining steppic grasslands for their survival.

One of the possible explanations for high biodiversity is the fact that at its southern part the LC area borders with the Special Nature Reserve Deliblato Sands. The dispersing organisms from Nature Reserve can maintain species populations at sites that would not ensure their long-term viability (De Groot et al., 2010).

By processing all collected data, the landscape elements were categorized (Thomas, 2017) in three levels (Figure 3). Category I Landscape elements that remain undisturbed included the following spatial units:

- Grasslands registered as a habitats of protected and strictly protected species (INCVP, 2018) and the abandoned clay-pits as a habitat of strictly protected species proved by the observations during the survey,
- Memorial Park, as the only forest of the area and the mounds already foreseen for protection (Prostorni plan Opštine Vršac, 2015; Vršac EIA, 2015),
- Landscape elements with the role of habitat and/or ecological corridor, including the hedges with grass strips along three roads (Izbište – Ritiševo, at the foot of Dumača hill and near Vlajkovac) and also the grass strip along the road leading from Uljma toward Nikolinci.

Category II Landscape elements that could be destroyed with obligatory ecological compensation include the meadows, pastures and hedges not listed in Category I, as well as the woodlots. Category III Landscape elements, not listed in the previous categories, could be removed without environmental compensation.

Compensation of meadows and pastures destroyed in the process of land consolidation should be done by forming meadows or pastures of the same total area in areas unsuitable for cultivation (muddy soils, saline depressions, slopes endangered by erosion), primarily near isolated habitats or near ecological corridors. The site selection has to be in accordance with habitat conditions and opportunities for sustainable use by mowing or grazing.

The compensation of removed hedges and woodlots has to be carried out within planning the windbreak network and game management. Since the subject area is extremely poorly forested, it is necessary to ensure the necessary area for windbreaks during the land consolidation process, in accordance with the current legislation (*Službeni glasnik RS*, 62/2006 in version 95/2018).

CONCLUSION

Land consolidation (LC) is an excellent tool for the planned protection and improvement of nature through ensuring coexistence of agriculture and environmental protection. Negative consequences of intensive agriculture have been noticed in the Vršac area of LC, including abandonment or overgrazing of pastures and meadows, converting grasslands into arable land, soil erosion and habitat fragmentation. Although the area of LC is without natural forest and extremely poor in semi-natural elements of rural landscape, the existing entities were revealed as refuges for protected species. Some of the grassland

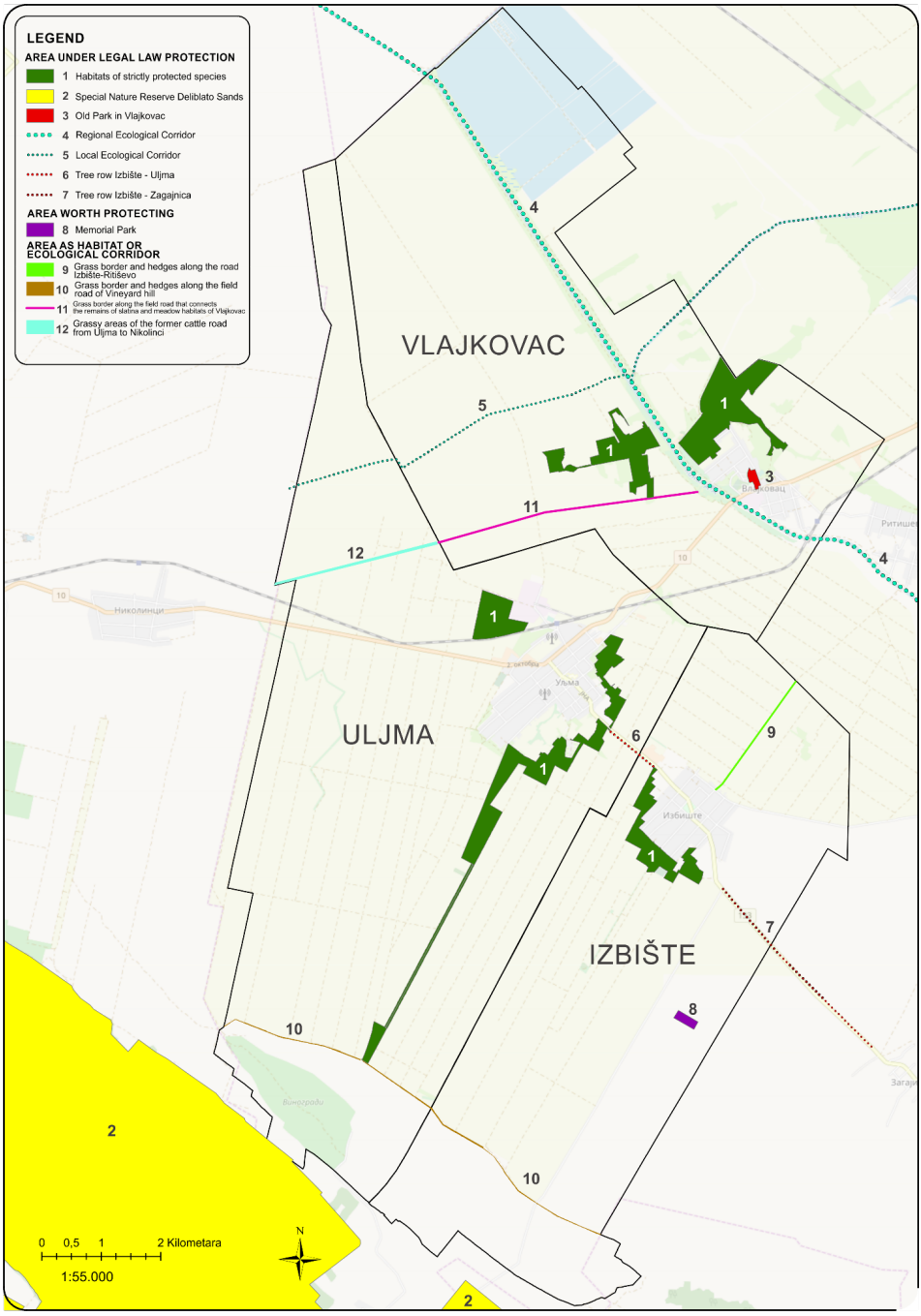

Figure 3. The categorization of the landscape elements

fragments belonged to protected habitat types. The final categorization of the landscape elements was conducted in three levels. Category I landscape elements had to remain undisturbed; Category II landscape elements could be removed with obligatory ecological compensation, while the Category III landscape elements could be removed without environmental compensation. Recommendations were given pointing out the possibilities for improving the environmental characters of the area by the land consolidation process.

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ОРИГИНАЛНИ НАУЧНИ РАД

ПРОЦЕНА УТИЦАЈА НА ЖИВОТНУ СРЕДИНУ У ОКВИРУ КОМАСАЦИЈЕ ЗЕМЉИШТА

Јордана М. НИНКОВ[1], Клара Л. САБАДОШ[2], Снежана П. ЈАКШИЋ[1], Бранислава З. БУТОРАЦ[2], Слободан Н. ПУЗОВИЋ[2], Ален М. КИШ[2], Ранко Д. ПЕРИЋ[2]

[1] Институт за ратарство и повртарство
Максима Горког 30, Нови Сад 21000, Србија
[2] Покрајински завод за заштиту природе Војводине
Радничка 20а, Нови Сад 21000, Србија

РЕЗИМЕ: У већини земаља у Европи комасација земљишта (КЗ) представља важну меру за унапређење пољопривреде и руралног развоја, укључујући питања животне средине,. У овом раду представљени су најважнији резултати процене утицаја комасације на животну средину (EIA) у Општини Вршац кроз пилот пројекат заснован на методологији ЕУ постављеној у оквиру пројекта: "Strengthening Municipal Land Management in Serbia", уз подршку Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Током лета 2018. године спроведено је теренско истраживање природних, полуприродних и вештачких елемената предела, еколошких и културних вредности на 90 локација. Урађена је процена стања ових вредности и процена потенцијалних штетних утицаја комасације на животну средину. Осмотрени су негативни утицаји интензивне пољопривреде, као што су: напуштање или прекомерна испаша пашњака и ливада, њихово претварање у обрадиво земљиште, ерозија земљишта и фрагментација природних станишта. Иако је подручје КЗ без природне шуме и изузетно сиромашно природним елементима руралног пејзажа, постојеће целине су откривене као уточишта за заштићене врсте. Неки од фрагмената травне вегетације припадали су заштићеним типовима станишта. Коначна категоризација елемената пејзажа спроведена је у три нивоа. Елементи предела I категорије – који остају ненарушени (не смеју се уклањати); II категорија – елементи пејзажа неутралног карактера са обавезном еколошком компензацијом; III категорија – елементи пејзажа који се уклањају без еколошке накнаде. Дате су препоруке којима се указује на могућности за побољшање еколошких карактеристика подручја процесом комасације.

КЉУЧНЕ РЕЧИ: комасација, процена утицаја на животну средину, елементи предела, индикаторске врсте, Вршац