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SMALL WOODLANDS AND TREES IN TRADITIONAL AGRICULTURAL LANDSCAPES OF SLOVAKIA

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ABSTRACT

The studies focused on distribution and characteristic of small woodlands and trees as a typical feature of traditional agricultural landscapes (TAL) in Slovakia are missing or are rather local. The source data for this study was obtained from the national inventory of TAL performed in 2010-2012 in Slovakia, where woody vegetation was considered as one of the landscape elements creating mosaic of TAL. Based on the types of woodland present, which endow the landscape with a distinctive character and structure, we have divided TAL into five subtypes: 1) TAL with low occurrence of woodland – not more than 10 % of the site covered by woods, 2) TAL with spatial woodland formation, 3) TAL with solitaire trees dominant, 4) TAL with lines of trees or shrubs dominant, and 5) TAL with small woodland dominant.

The proportion of woodland was relatively low, as TAL with low occurrence of woodland (36 %) was the most extended subtype of TAL. The most common dominant woodland structure was lines of trees and shrubs, with significant occurrence in TAL of arable-land and grassland and TAL with dispersed settlement. They tended to occur on typical agrarian relief forms. Our evaluation was supported by statistical analyses focused on the relationships between woodland type on agrarian relief forms (mostly balks) and their biotic and abiotic characteristics (type of agrarian relief form, content of skeleton, width, height, its continuity, as well as continuity of wood cover)

Keywords: solitaire trees, lines of trees or shrubs, small woodlands, typology of traditional agricultural landscape, agrarian relief form

INTRODUCTION

Traditional agricultural landscape (TAL) is a form of original agricultural landscape, which developed over centuries as a result of settlement, deforestation and colonization, and which has not lost the form of cultural-historical countryside (Špulerová *et al.*, 2016a). TAL in Slovakia consists of mosaics of small-scale arable field plots or permanent agricultural cultivations such as grasslands, vineyards and high-trunk orchards, or recently-abandoned plots in the early stages of succession, including small woodlands or trees. Unproductive plots on the bounds or between fields often create typical agrarian relief forms like terraces, heaps, mounds or unconsolidated walls. TAL plots preserve something of the history of woody vegetation in the agricultural landscape over the centuries. Woody vegetation was considered as one of the characteristic landscape elements contributing to mosaics of TAL in the initial identification of TAL, which was carried out by visual interpretation of aerial photos (Dobrovodská *et al*., 2010).

The three typical woody vegetation features at the landscape level are hedgerows, riparian strips, and small remnants of prior woodlands (Welsch *et al*., 2014). The hedgerows or hedges are created by lines of shrubs or trees that were considered essential for marking ownership boundaries, and for keeping livestock in or out of fields in the past not only in Europe but also across the world (Harvey *et al*., 2005). The farming landscape is dotted with three main types of hedgerows: (1) natural woody, (2) planted woody and (3) herbaceous (Boutin *et al*., 2002). Some margins are wide, often referred to as buffer strips or headlands, which are managed differently from arable fields or grass crops. Thoughtful management of these different components – shrub layer, mature trees, base/bank, ditch and margins – is important. The managed hedgerow is a line of woody vegetation that has been so managed that trees no longer take their natural shape. This type of hedgerows define the landscape character of much of the UK (Rackham, 2001). In other cases, where the vegetation on the field margins has not been regularly mowed or cut, the hedges have developed spontaneously by succession; in some areas such hedges have become dominant (Barančok & Barančoková, 2016; Cook *et al*., 2005).

Small woodlands and scattered trees are a common feature of the rural European landscape (Centeri *et al*., 2016) and provide important ecosystem services to populations and human society. For example, the smaller-scale structural features of plant communities can modify microclimates, and so may produce distinctive spatial patterns in decomposition rates (Hastwell & Morris, 2013). The structure of the vegetation impacts ecosystem services such as ground water allocation, carbon and nutrient content of soils, aboveground and belowground biodiversity, and soil structure (Creamer *et al*., 2016). Despite their small size, scattered trees and forest patches support high levels of farmland biodiversity and they often act as refuges for biodiversity (Kalda *et al*., 2015; Plieninger *et al*., 2015). Diverse dispersed communities in heterogeneous landscape mosaics ecosystems play a key role in ecosystem recovery (Escribano-Avila *et al*., 2014). Within these scattered patches the structural complexity of the vegetation was a better predictor of woodland bird richness than remnant width. In the fields, there was also a positive correlation of number of species with the number of scattered trees retained (Lentini *et al*., 2011). Hedgerows are an attractive foraging habitat for native bees and support high densities of woodland-characteristic shrubs. These flowering shrubs are important in attracting bees that are otherwise uncommon in the landscape, including some species that are potentially valuable pollinators of agricultural crops (Hannon & Sisk, 2009). Hedgerows in agricultural landscapes can increase the connectivity between otherwise isolated plant and pollinator populations (corridor function), but can have additional, and so far unknown barrier effects for other species (Klaus *et al*., 2015). Positive associations were observed between good health and general wellbeing and the density of the green space types "broadleaf woodland", "arable and horticulture", and "improved grassland" (Wheeler *et al*., 2015). As a form of green infrastructure they contribute to ecological networks and increase the overall ecological stability of the agricultural landscapes (Reháčková & Pauditšová, 2003). Different categories of small woodlands and trees (small remnant plots, lines of trees, and solitaire trees) vary in their structure and the functions they serve in the local ecosystem (Supuka & Stepankova, 2004)

Although there are various approaches to small woodlands and trees classification and many studies point out to their significance, studies on their distribution in agricultural landscape are rather local (Demková & Mida, 2014; Supuka *et al*., 2013). Similarly, the studies focused on distribution and characteristic of small woodlands and trees as a typical feature of TAL in Slovakia, are missing.

The main objectives of our study were:

1. to evaluate proportion of small woodlands and trees types within TAL classes
2. to evaluate relation of particular variables of agrarian relief forms to categories of woody coverage and habitats.

METHODS

The source data for this study was obtained from the national traditional agricultural landscapes (TAL) inventory performed in 2010-2012 in Slovakia. The TAL sites were delineated by interpretation of aerial photos using 1 km^2 network created in Google Earth and historical maps from the pre-collectivization era in combination with field research. 3,010 TAL plots were mapped in total, with a total area of 44,464 ha (Špulerová *et al*., 2011). 20 % sites from all identified localities with presence of TAL was randomly selected by statistical sampling and visited in the field.

Based on the presence of certain typical land-use elements (dispersed settlement, arable land, grassland, vineyard, orchard) TAL were classified into four classes (Špulerová *et al*., 2011): (I.) TAL with Dispersed Settlement (21,097 ha), (II.) TAL of Vineyards (7,702 ha), (III.) TAL of Arable-Land, Grasslands and Orchards (1,831 ha) and (IV.) TAL of Arable-Land and Grasslands (13,782 ha).

For woody vegetation elements we recorded (as a percentage) the total woodland coverage of the mapped sites, and the woodland types we labelled as "D" if dominant (> 50 %), "X" if present 5-50 %, and "O" if rare (<5 %). Depending on the shape, size, and morphometric and genetic characteristics we have distinguished three main types of woodland structure:

- Solitaire trees – 1-3 individual trees or shrubs close together without connections.
- Lines of trees or shrubs – one or more rows of vegetation, or a strip of woody vegetation with no distinct lines but width of more than 30 % of the length. It may be continuous or intermittent, single or multilayer, consisting of tree, shrub or mixed species.
- Small woodlands – these have varying geometric shapes (as viewed from above), and can be regular or irregular. Our criterion for this structure is a minimum wooded area of 50 m^2 up to 1 ha. It may be single- or multi-layer, of the same or different age, formed by monocultures or by various tree or shrub species.

Based on the occurrence of woodland types, which give the landscape a distinctive character and structure, we divided TAL into five subtypes (Fig. 1-5):

1) TAL with low occurrence of woodland – coverage by woods is not more than 10 % of the site.

2) TAL with spatial woodland formation – coverage by woods is more than 10 %, but no one woodland type (solitaire trees, lines, or small woodland) is dominant.

3) TAL with solitaire trees dominant – woodland coverage of the site is more than 10 %, groves and solitaire trees are the dominant woodland type.

4) TAL with lines of trees or shrubs dominant – woodland coverage of the site is more than 10 %, lines of trees or shrubs are the dominant woodland type.

5) TAL with small woodlands dominant – woodland coverage of the site is more than 10 %, small woodlands are the dominant woodland type.

The package Statistica 7 was used for statistical analyses of data (StatSoft, Inc., 2004). The output of our analysis is a histogram of abundance of woodland coverage and the various statistical parameters: mean, standard error, median, mode, standard deviation, sample variance, kurtosis, skewness, range, minimum, maximum and sum were all computed at a confidence level of 0.05.

The species composition of woody vegetation growing on field margins and bounds, which represent typical agrarian relief forms was recorded in the field. Moreover, differences in their spatial structure were analysed. Because of the nominal-categorical nature of the parameters the Cramer´s V test was used for calculation of correlation between particular variables (type of agrarian relief form, content of skeleton, width, height, its continuity, as well as continuity of wood cover) and habitat and shrub and tree abundance. The percentage cross-tables were used for testing relationships between them. The data were tested using the Monte Carlo method with 9999 iterations and a 99 % confidence interval. The sample size, N=3010, represents all TAL areas with presence of woodland.

Fig. 1: Traditional agricultural landscape with low occurence of woodland, in a photo (Liptovská Teplička) and orthophoto (Vráble) – Orthophoto © Geodis Slovakia 2010, Aerial photography and digital orthophoto © Eurosense, s.r.o., Slovakia, 2010)

Fig. 2: Traditional agricultural landscape with spatial woodland formation in a photo (Oščadnica) and orthophoto (Krupina)

Fig. 3: Traditional agricultural landscape with solitaire trees dominant in a photo (Hriňová) and orthophoto (Nová Baňa - Štále)

Fig. 4: Traditional agricultural landscape with lines of trees or shrubs dominant in a photo (Haligovce) and orthophoto (Podhradie)

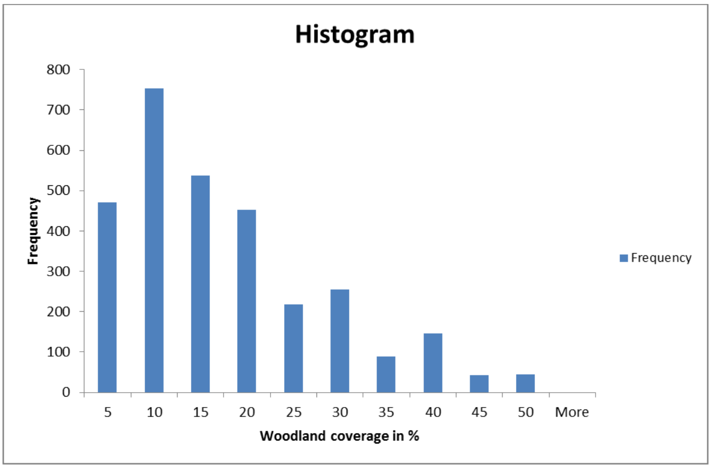
Fig. 5: Traditional agricultural landscape with small woodland dominant in a photo (Veľká Tŕňa) and orthophoto (Nová Bystrica)

RESULTS

Proportion of small woodlands and trees types in TAL

The average woodland cover was about 17 % (Tab. 1) with the most frequent interval from 5 to 10 % of woodland (Fig. 6). The overall proportion of woodland was relatively low, as TAL with low occurrence of woodland (36 %) was the most extended subtype when classifying TAL by predominant woodland type (Fig. 7).

Fig. 6: Distribution of woodland coverage in traditional agricultural landscapes in Slovakia based on the records of national TAL inventory

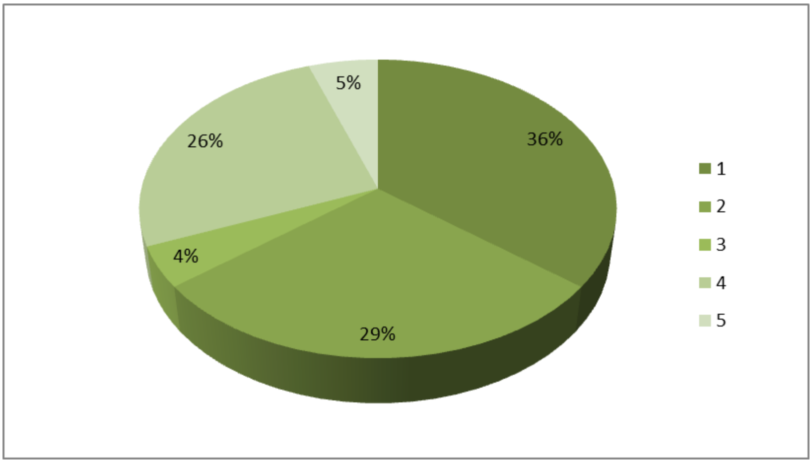


Overall, the average (mean) woodland coverage of TAL sites was 8 %. The second most widespread subtype was TAL with spatial woodland formation (29 % of TAL sites), characterized by 23 % average woodland coverage, followed by TAL with lines of trees or shrubs dominant (26 %). The two other subtypes were at low proportions. The highest average woodland coverage (28 %) was recorded for TAL with small woodlands dominant.

Table 1: Statistical characteristics of woodland coverage in traditional agricultural landscape

Statistical characteristic	Over all	1. TAL with low occurrence of woodland	2. TAL with spatial woodland formation	3. TAL with solitaire trees dominant	4. TAL with lines of trees or shrubs dominant	5. TAL with small woodland dominant
Mean	17.13	7.25	21.81	19.79	26.82	26.98
Standard Error	0.20	0.08	0.29	0.71	0.37	1.03
Median	15	8	20	20	25	25
Mode	10	10	15	15	30	20
Standard Deviation	11.11	2.75	8.90	5.99	9.42	10.79
Skewness	0.90	-0.49	1.3	1.21	0.47	0.74
Range	50	10	38	28	39	38
Minimum	0	0	12	12	11	12
Maximum	50	10	50	40	50	50
N	3010	1225	939	71	665	110
Confidence Level (95.0 %)	0.397	0.154	0.570	1.417	0.717	2.038

Fig. 7: Proportion of individual TAL subtypes in Slovakia

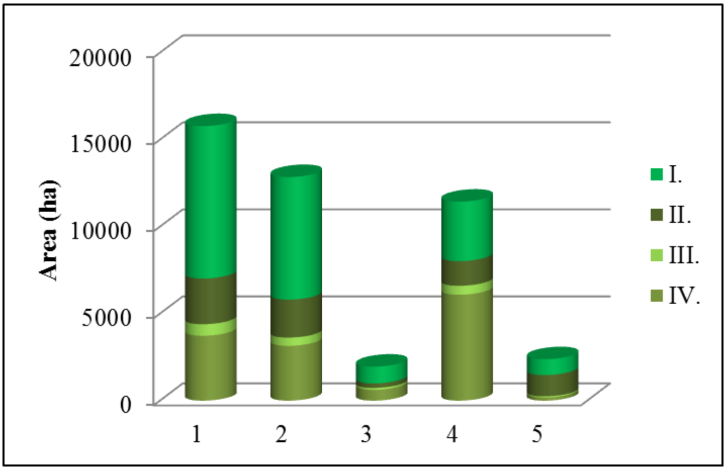


Legend: 1. TAL with low occurrence of woodland, 2. TAL with spatial woodland formation, 3. TAL with solitaire trees dominant, 4. TAL with lines of trees or shrubs dominant, 5. TAL with small woodland dominant

Regarding the occurrence of woodland subtypes in the various TAL classes, we observed the following (Fig. 8):

1. **TAL with low occurrence of woodland** predominates markedly in TAL with dispersed settlement, mainly within mosaics of arable land and permanent grasslands. The lowest share was recorded in TAL of arable-land, grasslands and orchards, but this was generally the least widespread TAL class. This subtype occurs mostly in mosaics with presence of arable land or vineyards, which indicate continuous regular management of mosaics.
2. **TAL with spatial woodland formation** has a similar representation in the various TAL types as the subtype of low woodland occurrence. Additionally, such TAL has been found most prominently in territories with a predominance of permanent grassland and orchards.
3. **TAL with solitaire trees dominant** is most frequent in TAL with dispersed settlements, which tends to consist of mosaics containing a variety of land uses – orchards, grassland and arable lands. Next to that, this subtype is mostly found in TAL of arable-land and grasslands. It usually occurs in connection with stone heaps and shorter mounds.
4. **TAL with lines of trees or shrubs dominant** was recorded mainly in TAL of arable-land and grasslands; and it particularly tends to occur in territories with a predominance of permanent grassland and dense systems of lengthwise terraces and mounds.
5. **TAL with small woodlands dominant** is mostly found in TAL of vineyards (and, within that category, mostly in mosaics with orchards and arable lands present). A notably low amount of this subtype was observed in TAL of arable-land, grasslands and orchards and TAL of arable-land and grasslands.

Fig. 8: Proportion of TAL woodland subtypes in TAL classess



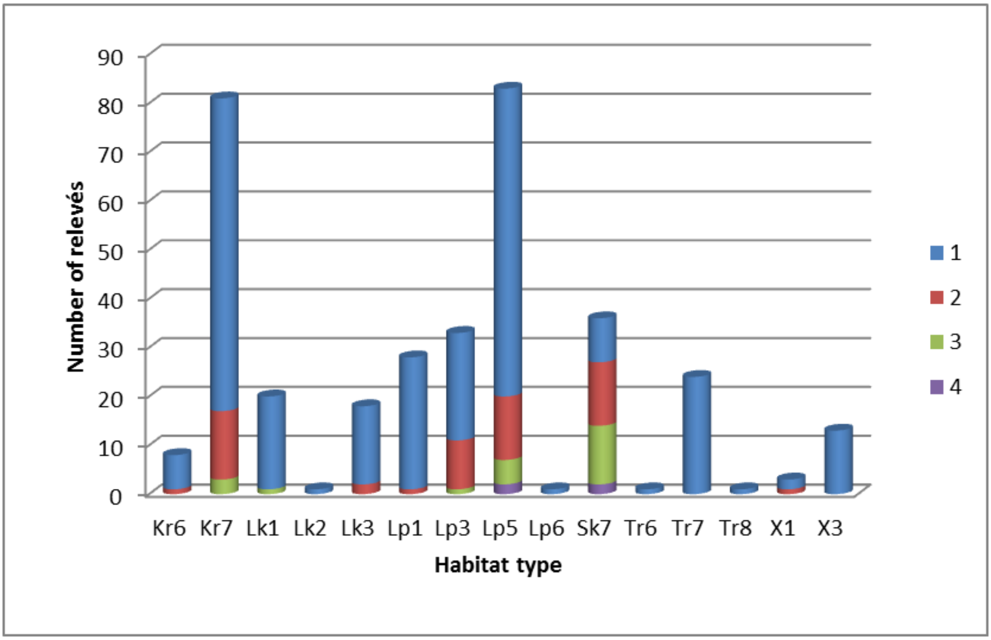
Legend: *TAL subtypes:* 1. TAL with low occurrence of woodland, 2. TAL with spatial woodland formation, 3. TAL with solitaire trees dominant, 4. TAL with lines of trees or shrubs dominant, 5. TAL with small woodlands dominant, *TAL classes*: I. TAL with Dispersed Settlements, II. TAL of Vineyards, III. TAL of Arable-Land, Grasslands and Orchards, IV. TAL of Arable-Land and Grasslands.

Variability of small woodlands and trees

Productive agricultural lands are often complemented by unproductive areas on the borders of fields where typical agrarian relief forms often appear, leading to mosaic-structured landscapes and the creation of absolutely new habitats for vegetation and animals. Agrarian relief forms arise as a result of improving the soil and relief quality or removal of the soil skeleton (Dobrovodská, 2006). The most common agrarian relief forms are terraces, followed by lengthwise mounds and solitary heaps. Unconsolidated walls, by their nature, are usually not covered by woody vegetation, although we have recorded a few exceptions where trees have successfully taken root on them. Where agrarian relief forms have not been cultivated, or were once cultivated but later abandoned, they are usually covered by wooded vegetation. The wooded vegetation studied on agrarian relief forms belongs to several groups: herbaceous habitats with scattered trees, or groups of trees, where tree layer cover was more than 10 %; shrub layer with cover of over 20 %; and shrub and tree habitats with continuous wood cover.

Woodland vegetation was recorded on 353 relevés (60 % of all mapped relevés), sometimes in groups of only one species, sometimes in mixed groups. Medio-European rich-soil thickets (Kr7) and lines/small woodlands of mixed successional trees (Lp5) were the most widespread communities. These communities were characterized by a high species richness (Fig. 9).

Fig. 9: Habitat of woody vegetation tied to agrarian relief forms



Legend: *Type of agrarian relief forms:* 1 – terraces, 2 – lengthwise mounds, 3 – solitary heaps, 4 – unconsolidated walls, *Habitat type: Kr – Shrub habitats*: Kr6 – Continental deciduous thickets, Kr7 – Rich-soil thickets, *Lk - Grassland*: Lk1 – Lowland hay meadows, Lk2 – Mountain hay meadows, Lk3 – Mesophile pastures, *Lp – lines of trees/small woodland*: Lp1 – Lines of fruit trees, Lp3 – Lines of deciduous trees, Lp5 – Lines/Small woodland of mixed successional trees, Lp6 – Lines/Small woodland of invasive trees. *SK7 Secondary scree and rocky habitats, Tr – Dry grassland:* Tr6 – Xero-thermophile fringes, Tr7 – Mesophile fringes, Tr8 – Species-rich Nardus grasslands on siliceous sutstrates in mountain areas, *X – Ruderal communities*: X1 - Herbaceous clearings, X3 – Ruderal communities.

Dominant trees and shrubs increase spatial diversity in the landscape. The most frequent species were *Prunus spinosa*, *Rosa canina*, *Viburnum opulus*, *Sambucus nigra*, *Corylus avellana*, *Tilia platyphyllos*, *Quercus petraea*, *Carpinus betulus*, *Acer pseudoplatanus*, *Acer campestre* and *Fraxinus excelsior*.

Correlation of particular variables with woody coverage (E2 shrubs or E3 trees) gave highest results for terraces, of muddy skeleton content, with a width of 1.1 to 3 m and a height of 1.1 to 3 m. The bounds with presence of woods were mostly continuous, not interrupted. Continuous wood cover dominated. An interrupted or disconnected woodland coverage was correlated with shrub cover being in the 20-40 % range.

The statistical analysis showed shrubs and woodland habitat (Kr and Lp group) to have the strongest connection to agrarian relief forms, mostly terraces.

Grassland and ruderal communities showed very low, or no significance, as they formed only a small proportion of the territories under study.

DISCUSSION

A two-stage approach to mapping distribution of small woodland and trees in TAL was applied for this study: interpretation of aerial photos and analysis of environmental variables from field survey. Similar mapping methodology and analysis framework has been applicable to regional and global scales (Aksoy *et al.*, 2010; Clark & Kilham, 2016; Hill *et al.*, 2017) and could be essential for many ecological applications ranging from species conservation to landscape planning.

The presence of shrub and tree habitats correlates strongly with agrarian relief forms, and is particularly associated with terraces of muddy skeleton content, reflecting the origin of both the muddy terraces and relief forms by gradual ploughing and skeleton removal. Terraced landscapes arose mainly on steep slopes and skeletal soils of low productivity (Lieskovský *et al*., 2015; Pazúr *et al*., 2014). The lack of management of agrarian relief forms allowed succession by trees and vegetation, resulting in communities of shrubs and pioneer tree species.

A similar study in the Czech republic has confirmed a close relationship between the distribution of non-forest woody vegetation and environmental conditions such as elevation, slope, distance from settlements, and – less strongly correlated – with soil and landscape type (Demková & Lipský, 2015; Demková & Mida, 2014).

Average cover by woody vegetation was relatively low in regularly managed TAL, since vegetation on the bounds was regularly mowed, and young trees or shrubs were managed so as not to extend to production plots. Succession of woods on the bounds was eliminated by cutting shrubs or trees or by fire management; farmers are also using herbicides (Hanušin & Štefunková, 2015). Such practices are applied for crops which require direct light and cannot thrive if overshadowed by trees – e. g. grapevines need a lot of light, so growers try to remove woody seedlings around their land parcels in order to grow high-quality grapes.

Our results confirm the close correlation between increasing woody vegetation coverage and management intensity. The lower the management intensity, the higher the coverage by woody vegetation. This trend is seen in many regions of Europe, where large-scale socio-economic changes have led to the abandonment of rural activities and gradual overgrowth by natural vegetation (Regos *et al.*, 2016; Skalos *et al*., 2015). It is important to assess the relative positive and negative effects of land abandonment on particular areas where low-intensity farming is no longer socially or economically viable in order to quantify the potential conservation costs and benefits of rewilding as a land-use management policy. The spontaneous succession of vegetation resulting from agricultural extensification helps to recover woodland; on the other hand, extensification, continuing landscape abandonment, and social changes since the mid-20th century threaten the maintenance of TAL (Baumann *et al.*, 2011; Keenleyside & Tucker, 2010; Kuemmerle *et al*., 2008; Mojses & Petrovič, 2013). Land use change is one of the main drivers of species extinction. A study in an abandoned mountain landscape (Galicia, NW Spain) discovered that rewilding had a positive effect on biodiversity overall, but did have significant negative effects on ecotone and open-habitat species (Regos *et al*., 2016). Analyses of biodiversity and provision of selected ecosystem services in England found significantly lower biodiversity in woodland than in open patch habitats, but the timber, carbon storage and aesthetic values were highest in woodland (Cordingley *et a*l., 2016).

Managing and maintaining habitats at field margins in a way that preserves, and preferably enhances, their value for biodiversity is therefore important at the landscape scale (Street *et al*., 2015). Understanding the magnitude and drivers of background vegetation change at the landscape scale is an essential step towards improving management strategies and policy with attempts to increase the extent and quality of native vegetation in the landscape (Kyle & Duncan, 2012). While extensive agricultural landscape is facing abandonment, intensively used agricultural landscape simply lack these habitats. The matter is addressed in new EU regulations, mandating that farmers must set aside 5 % of their land as an Ecological Focus Area (EFA), instead of being used for farming; this is known as “greening”. Ecological Focus Areas include solitaires, lines of trees, groups of trees, balks or hedges that can improve the quality of the environment.

Tab. 2: Relation of particular variables to categories of woody coverage (E2 shrub and E3 tree layer) and habitats expressed in percentage crosstables

		Type of agrarian relief form				Skeleton content				Width			Height				Continuity of agrarian relief form			Continuity of wood cover		
		1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	1.	2.	3.	4.	1.	2.	3.	1.	2.	3.
E2	20-40	34.1	4.9	4.3	0.3	19.7	12.5	8.5	3.0	5.9	23.6	14.1	3.9	11.1	26.6	2.0	33.4	8.5	1.6	15.1	17.0	11.5
	41-60	14.4	4.9	1.0	0	9.2	4.6	4.6	2.0	2.3	10.8	7.2	1.6	4.9	12.8	1.0	15.1	4.9	0.3	11.1	5.6	3.6
	61-80	18.1	4.3	0.7	0	9.8	6.9	4.9	1.3	3.6	14.1	5.2	3.3	6.2	12.8	0.7	19.0	3.6	0.3	14.8	7.5	0.7
	81-100	11.2	1.6	0.3	0	6.6	3.6	3.0	0	0.3	9.5	3.3	0.7	3.9	7.2	1.3	12.1	1.0	0	12.5	0.7	0
E3	0-10	26.2	2.3	0.7	0	16.1	9.2	3.6	0.3	4.9	19.3	4.9	2.0	9.5	16.7	1.0	23.9	3.9	1.3	11.8	8.9	8.5
	10-20	19.3	2.3	1.0	0.3	10.5	8.9	2.6	1.0	3.9	13.1	5.9	2.0	6.6	13.1	1.3	19.3	3.6	0	9.5	8.5	4.9
	21-40	16.3	3.6	1.3	0	10.5	4.9	3.9	2.0	1.6	14.1	5.6	3.9	3.6	13.4	0.3	15.7	5.2	0.3	12.1	7.5	1.6
	41-60	7.2	2.0	1.0	0	4.9	1.6	3.0	0.7	1.6	4.6	3.9	0.7	2.6	5.9	1.0	8.9	1.3	0	6.6	3.6	0
	61-80	5.3	4.6	1.0	0	2.3	2.6	5.6	0.3	0	4.3	6.6	1.0	2.3	6.2	1.3	7.9	2.6	0.3	9.2	1.3	0.3
	81-100	3.3	1.0	1.3	0	1.0	0.3	2.3	2.0	0	2.6	3.0	0	1.6	3.9	0	3.9	1.3	0.3	4.3	1.0	0.3
Habitat	Kr	20.2	4.3	0.9	0	10.8	8.8	4.8	0.9	2.0	16.8	6.5	2.0	6.8	15.1	1.4	19.9	4.8	0.6	17.9	6.0	1.4
	Lk	10.5	0.6	0.3	0	6.0	5.1	0.3	0	2.6	7.1	1.7	0.6	3.7	6.8	0.3	8.5	2.0	0.9	1.4	5.1	4.8
	Lp	32	6.8	1.7	0.6	19.6	10.8	7.7	3.1	5.1	23.0	13.1	4.3	10.2	25.6	1.1	32.4	8.2	0.6	21.6	15.9	3.7
	Sk	2.6	3.7	3.4	0.6	0	0.3	6.5	3.4	0.9	3.7	5.7	0.9	2.8	4.8	1.7	9.1	1.1	0	7.7	1.7	0.9
	Tr	7.5	0	0	0	4.5	2.0	0.9	0	1.4	4.3	1.7	0.6	2.0	4.5	0.3	6.8	0.3	0.3	1.4	2.3	3.7
	X	4.3	0.3	0	0	2.6	1.1	0.9	0	0.9	3.1	0.6	0.9	1.4	2.0	0.3	3.7	0.9	0	1.1	0.9	2.6

Legend: *Type of agrarian relief form:* 1. Terraces, 2. Heaps, 3. Mounds, 4. Unconsolidated walls. *Skeleton content:* 1. muddy, 2. muddy-rocky, 3. loamificated rocky, 4. rocky. *Width:* 1. < 1 m, 2. 1.1-3 m, 3. > 3 m. *Height:* 1. < 0.5 m, 2. 0.51-1m, 3. 1.1-3 m, 4. > 3 m. *Continuity of agrarian relief form:* 1. Continuous, 2. Interrupted – interruptions are shorter than fragments of bound, 3. Disconnected – interruptions are longer than fragments of bound. *Continuity of wood cover:* 1. Continuous, 2. Interrupted, 3. Disconnected. *Habitat type:* Kr – Shrub habitats, Lk - Grassland, Lp – lines of trees/small woodlands, SK7 Secondary scree and rocky habitats, Tr – Dry grassland, X – Ruderal communities.

CONCLUSION

Traditional agricultural landscapes in Slovakia are located mainly in the higher mountainous areas with unfavourable natural conditions for intensive farming and the cultivation of fruit and vegetables (Špulerová *et al*., 2016b). As a result of extreme conditions with respect to soil (high skeleton content) and relief (steeply sloping relief) they are characterized by the presence of typical agrarian relief forms or terraced landscapes which are often associated with hedges or other forms of woody vegetation. This woody vegetation is the focus of the current work, as it forms an important part of the landscape structure and is a determining feature of the landscape character.

The structure of small woodlands in TAL which had been managed in the past was examined with respect to the management intensity and pattern of land use elements. TAL with low occurrence of woodland accounted for 36 % of TAL sites. Their presence reflects relatively persistent land management. This subtype coincided with the presence of managed arable land, and surrounding grasslands and small woodlands also tended to be at least somewhat managed and maintained, by grazing or cutting respectively.

The highest average coverage by woodland (27 %) was recorded for TAL with small woodlands dominant, indicating threat to the TAL by abandonment and subsequent succession. This subtype dominated only on 5 % of TAL sites. The lack of management of unproductive plots in a mosaic landscape allowed succession to begin, creating scrubland and woodland communities, which are coupled with increased species richness and overall structural diversity. This phenomenon can be seen as positive as long as the character of a mosaic traditional agricultural landscape is preserved and offers habitats for other species. Total abandonment of agricultural landscape can result in conversion of mosaic landscape to forest and loss of its *genius loci*.

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