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Management and Land Cover Changes in the Western Carpathian Traditional Orchard Landscape in the Period after 1948

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Abstract: In Slovakia, traditional orchards, like other European rural landscapes and their agricultural systems, are at long-term risk from changes in land use and management. We focused on this issue in the Nová Baňa dispersed settlement region (central Slovakia), which contains numerous traditional orchards. Management changes over the period 1949–2017 were evaluated on the basis of structured interviews conducted with the owners of 63 traditional orchards. Management measures were evaluated separately for 1949, 1970, 1991, 2000, 2007 and 2017. These data were supplemented by data on land cover over time, with an emphasis on orchards, evaluated for the years 1949, 1976, 1991 and 2017 using historical orthophoto maps. Traditional orchard management included mowing, grazing, plowing, fertilizing, and litter raking. By 2017, the management regime had changed in 92% of orchards. The use of plowing and grazing in orchards decreased, and the use of mulching has increased since 2000. From 1949 to 2017, the number of identifiable management regimes doubled; regimes consisting of a single management measure appeared, while regimes of multiple management measures decreased in frequency. Between 1949 and 2017, there was a total decrease of 38.36% in the area of traditional orchards; 31.62% of orchards remained unchanged. The largest decrease was caused by orchard conversion into grasslands (18.93%), forests (13.81%), shrubs (9.42%) and urbanized areas (8.87%).

Keywords: traditional orchards; management; land use; agroforestry; dispersed settlement; Slovakia

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1. Introduction

The structure of the landscape has long been influenced by human activities. In Europe, land use is mainly determined by agriculture, and the extent of this impact varies from region to region [1,2]. The most valuable elements of the cultural landscape of Europe include traditional vineyards and orchards, and their biological and cultural values [3,4]. Traditional orchards are one of the systems of agroforestry [5] which are considered a sustainable form of land management, optimizing the use of natural resources such as nutrients, radiation, and water [6]. Traditional orchards vary in their habitat conditions, species composition and management methods [7]. They are composed of fruit trees (e.g., *Malus domestica* Borkh., *Prunus domestica* L., *Pyrus communis* L. emend. Burgsd., *Juglans regia* L., etc.), and their understory consists of cultivated plants or seminatural grasslands [8]. In an agricultural landscape, they play an important role in maintaining diversity

of plants [7], including old fruit tree species and varieties [9] as well as various invertebrates and vertebrates [10–14]. This latter group also includes bees, the biggest group of pollinators in temperate climate zones [15]. Additionally, they are important for protecting soil against erosion [16], retaining water [17,18], and preserving landscape context and scenery [19]. In conditions of agricultural intensification and abandonment [20–22], they have a particular importance for preserving agricultural landscape diversity, providing ecosystem services [23,24], and supporting environmentally sustainable tourism [25]. The preservation of traditional orchards and their understories is dependent on regular management, which helps ensure their high biological value [7,26]. However, abandoned orchards are also ecologically important. They provide convenient conditions for birds [11,14,27], and old fruit trees are important for secondary cavity users [28]. Their dead wood provides the proper environment for food specialists such as saproxylic beetles, fungi and epiphytic lichens [12,29–32]. Any type of management regime that has been applied for a long time is referred to as traditional [33–37]. In traditional orchards, this includes mowing, grazing, plowing, fertilizing, litter raking, and combinations thereof [38]. Traditional management of seminatural habitats has changed throughout Europe in recent decades [33,39,40], including traditional orchards in Slovakia [38].

The area of agroforestry systems has declined in many regions of Europe [41]. Nowadays, agroforestry systems cover approximately 8.8% of the utilized agricultural area in the European Union 27 [2]. Studies of land cover and landscape changes focus mainly on analysis of spatial patterns [42–44]. The databases of Corine Land Cover and LUCAS (Land Use/Cover Area frame Survey), along with the output of scientific projects [45], are often used in evaluating the distribution of traditional orchards. Researchers examine the distribution or area of traditional orchards in individual European countries (e.g., Herzog [3]) or the regions thereof [46,47], and study selected types of landscapes, such as traditional agricultural landscapes (TAL) [19,48] or land use systems, e.g., agroforestry systems [2]. However, understanding of landscape changes requires a sound understanding of the underlying processes, which can be triggered by different driving forces [49]. Both the area and management regimes of orchards have been influenced by major political changes over the past century. In central and eastern Europe, the most important of these were collectivization after 1948 and restoration of the market economy after 1989. Collectivization was a politically driven process, based on the socialist idea of common property [50]. As a result, small fields were merged into large blocks with unified management, and the grasslands, shrubs and trees (including traditional orchards) which bounded the fields disappeared. Restoration of the market economy after 1989 triggered a huge crisis in the agricultural sector linked to restitution, privatization of the property of agricultural cooperatives, and even their ruin [51,52]. The last major event in the development of Slovakia's agriculture was the adoption of the common agricultural policy (CAP) after Slovakia's accession to the EU in 2004 [53]. These major transformations have been reflected in many aspects of society. They have had a great impact on agricultural production, due to changes in ownership and the structure and intensity of the land use. In recent times, we have observed a trend of loss of agricultural land, including orchards, especially in less productive regions [54]. This is reflected in changes in the landscape appearance—so it is detectable in research on land cover changes.

Land use and management changes have resulted in loss of biodiversity and the disappearance of traditional orchards [47,55]. The complete loss of this type of land use might lead to the loss of traditional management proficiency [56]. Due to their significance in the European agricultural landscape, traditional orchards have come to the attention of researchers in recent decades [3,7,19,45,47,57]. Research confirms that land cover and land use changes have taken place in the traditional agricultural landscape of Europe [20,58,59], and that traditional management strongly affects—and is important for—biodiversity [60]. Most of these studies focused on grasslands [61–64]. Data on traditional orchards is much poorer [65,66], and little is known about how their management has changed over the years or about the influence of land use changes on their decline [45,47]. This article therefore

aims to contribute to this issue by studying the area of the Nová Baňa dispersed settlement region.

2. Materials and Methods

2.1. Study Area

The study area consists of the cadastre of Nová Baňa town, which has an area of 6125.52 ha and is situated in central Slovakia (Figure 1). This region is characterized by dispersed settlements established by German mining colonization dating back to the 11th–12th centuries. For centuries, the main occupation of the population was the mining of precious metals, but the gradual decline of that industry since the beginning of the 18th century forced them to seek an alternative livelihood [67,68]. As the region provided only limited opportunities for growing grain due to the extreme relief and skeletal soils, the favorable climatic conditions for fruit trees encouraged the development of fruit growing. Fruit was also a commodity, grown to exchange for grain or to sell [69]. In addition, understory grassland was used for haymaking or as pasture. In the first half of the 19th century, orchards covered most of the territory [70]. In 1895, a total of 47,515 fruit trees were recorded in Nová Baňa and the surrounding settlements—mainly plums (61%), apple trees (16%), and pears (12%), but also cherries, nuts, mulberries, peaches, apricots, and chestnuts. Fruit trees were severely damaged by frost in the winter of 1929/1930 [71].

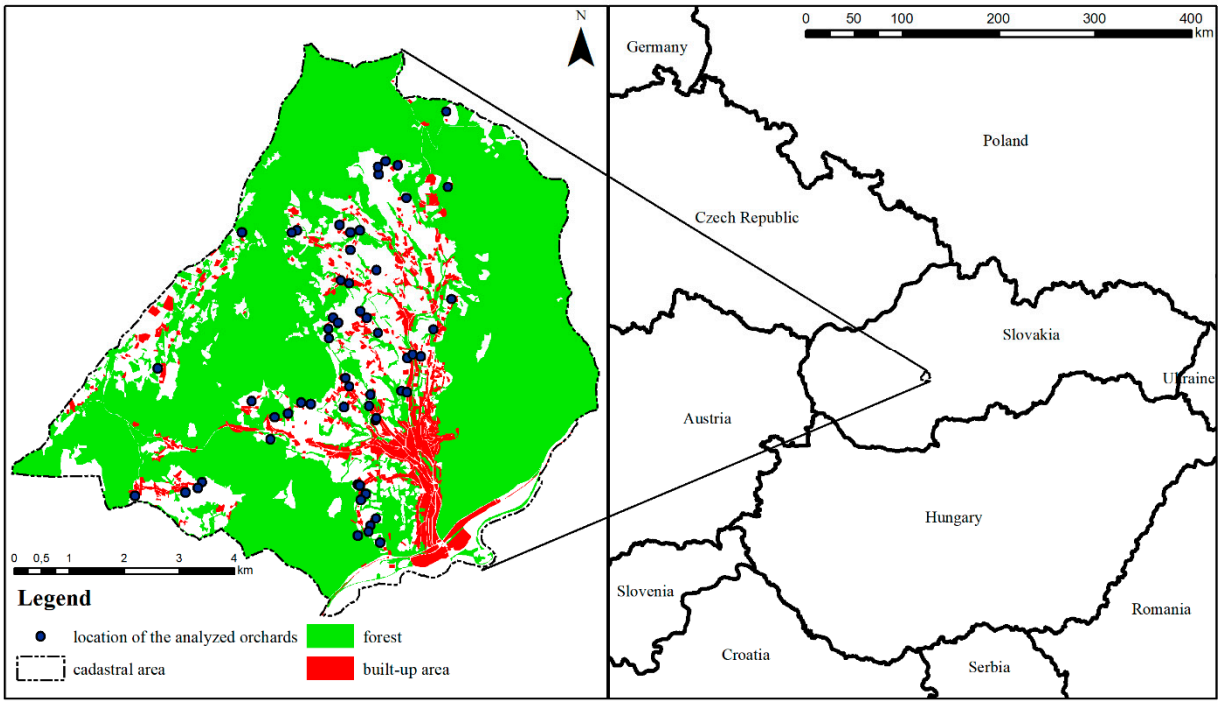

Figure 1. Study area and location of the analyzed orchards.

In this location, collectivization started in 1949, but its most intensive phase took place in the mid-1970s [71]. Traditional orchards and fruit trees on land boundaries were eradicated to enable mechanized utilization of large blocks of land. Wolf [72] reported eradication of more than 8000 fruit trees. In addition, in the 1980s, traditional orchards were affected by the establishment of large intensive orchard on the terraced relief, with a planned area of 400 ha. The planting mainly consisted of dwarf varieties of apple trees (90%), with pears, plums, cherries, and walnuts planted in smaller quantities [69].

The area lies between the volcanic mountains of Vtáčnik and Pohronský Inovec [73]. The soils are mostly Cambisols. The climate is moderately warm, with an average July temperature of at least 16 °C [74]. Annual precipitation is 700–800 mm [75]. Potential

vegetation in the area include Carpathian oak-hornbeam forest (*Carici pilosae-Carpinenion*) and submontane beech forest (*Eu-Fagenion*) in the western and northern parts [76].

The most common grassland vegetation in the orchards are mesophilous grasslands of alliance *Arrhenatherion elatioris* Luquet 1926. The warm southern and southwestern slopes are also covered by thermophilous grasslands of alliance *Bromion erecti* Th. Müller 1966, while grazed orchards are occupied by pastures of alliance *Cynosurion cristati* R. Tx. 1947 [77].

2.2. Structured Interviews

Data on management of the chosen orchards were gathered using structured interviews [78]. We conducted a total of 63 interviews (Figure 1) with local residents over 50 years of age between spring and autumn in the years 2016–2017. The interviewees were current orchard owners. Although some interviewees were younger than the beginning of the studied period, they were descendants of earlier owners, and thus inheritors of long-lasting and persisting traditions in management. This allowed us to evaluate the evolution of management over all periods. Respondents answered questions on management procedures, e.g., their intensity and frequency. Since the respondents were not able to provide sufficiently detailed information on litter raking, fertilizing, use of chemical protection, cultivated plants or the impact of collectivization, these were only evaluated verbally and are not included in tables and figures. Management measures were evaluated separately for 1949, 1970, 1991, 2000, 2007 and 2017 for the following reasons: in 1949, traditional orchard management would have still been in place; 1970 represents the period before intensive collectivization; 1991 represents the status of orchard management at the end of the socialist period; 2000 reflects orchard management status after the transition to capitalism; 2007 represents the situation after the accession of Slovakia to the EU; 2017 represents current orchard management. Land cover changes between 1949 and 1970 (i.e., over the twenty years or so before intensive collectivization) were not evaluated, since there were no available orthophoto maps for 1970. Detailed information on the structured interviews was provided by Žarnovičan et al. [38].

2.3. Land Cover Changes

In studying the land cover, we used orthorectified panchromatic aerial survey images from the Military Topographic Institute of Banská Bystrica from 1949, 1976 and 1991. The land cover in 2017 was mapped using orthophoto mosaics [79]. The historical images were selected mainly on the basis of the availability of data, but also with a view to capturing all significant changes in the landscape as faithfully as possible. The year 1949 shows traditional land use before the collectivization of agriculture. The year 1976 documents the state of land after collectivization. The year 1991 provides information on changes in land use after the fall of socialism and the onset of the market economy. The year 2017 serves to capture the current state of land use, which is affected by the common agricultural policy of the European Union.

The methodology of the 4th hierarchical level of CORINE Land Cover (CLC) was used for the identification and tracking of land cover changes at a scale of 1:50,000 [80,81]. It was based on the concepts or procedures applied to hierarchically higher classes [82]. The land cover areas typical of the Nová Baňa region were classified, with an emphasis on greater detail. For these, we used the methodology of land cover classification at the 5th hierarchical level of CLC [83]. These areas included, in particular, orchard areas, which we divided into two categories: traditional orchards and intensively-used orchards. Other types of land cover could also be generalized in the processed maps. We included all homogeneous areas with more than 20 fruit trees per ha and a minimum mapping area of 0.1 ha in the category of traditional fruit orchards [47]. In the category of intensively-used orchards, we included orchards with a high density of dwarf fruit trees planted in dense lines. In addition to the orchards, we also placed emphasis on the areas of traditional dispersed settlements typical for this area, and on the areas of mosaics of fields, meadows

and permanent cultures. On detailed investigation, the size of the minimum mapped area of traditional orchards, settlements and mosaics of field, meadow and permanent cultures agreed with the study of Plieninger et al. [47], who gave it as 0.1 ha. The minimum change polygon was calculated, by analogy to the generally-applied CLC methodology of the third level, as a fifth of the minimum identified area; the result was 0.02 ha [84]. The proposed nomenclature respects the following principal groups of criteria:

- Size of identified and recorded objects by minimum area and spatial relationship.
- Morphostructural and physiognomic attributes of objects which differentiate classes on the 4th and 5th hierarchical levels.
- Attributes of objects associated with differentiation of classes according to their spatial relationship [83].

2.4. Landscape Metrics Analysis

We applied several metrics for the quantitative analysis of the landscape structure dynamics of the whole study area level, as well as chosen relevant land cover classes. The patch is considered the basic object of analysis. The analysis of landscape patterns has specific ecological significance [85]. Metrics were calculated using the extension "Patch Analyst 5.2" in ArcGIS 10.1 environment (ESRI).

The following variables were entered into our analysis, as retrieved by the GIS tools [85–87]: P–Surface area of all patches of a selected class of land cover; NP–number of patches; TLA–size of the area; E–edge of a particular land cover patch; TE–edge of all land cover patches. We considered changes in number of land cover patches and the following relevant land cover metrics: mean patch size (MPS = $\sum$ P/NP), median patch size (MEPS), total edge (TE = $\sum$ E), edge density (ED = TE/TLA), mean patch edge (MPE = TE/NP), mean shape index (MSI = ($\sum$ TE/$\sqrt{}$PS)/(NP), Shannon's diversity index (SDI), and Shannon's evenness index (SEI).

3. Results

3.1. Age of Orchards

Of the 63 evaluated orchards, 60 were over 50 years old; and of these, 37 were over 100 years old. Three orchards were younger than 50 years old.

3.2. Management of Traditional Orchards in the First Half of Socialist Period (1949–1970)

Before the socialist period and at its beginning, orchards were traditionally managed by mowing, grazing, plowing, fertilizing and litter raking. As regards management regimes, prevailing methods included, grazing, partial plowing, and a combination of two mowings (49%). Mowing was mostly done twice a year (89%), more rarely only once (6%). The first mowing was in May–June, the second in August–September. Mowing was done exclusively by scythe. The mown phytomass was dried and used as animal feed. After the second mowing (or after the first, in orchards mown only once a year), understory grassland was grazed by livestock until winter (Figure 2). In plowed orchards, five years of crop production was regularly alternated with five years of cultivation of *Trifolium pratense* L. and *Medicago sativa* L. Alternately, the fields were allowed to change naturally into meadows. The duration of individual cycles varied by individual owner. The plowed parts were regularly fertilized (81%), mainly with manure, sometimes with urea, more rarely with industrial fertilizers (Thomas slag, NPK). Every year, litter raking was done in all researched orchards during spring or autumn, and the litter was used for livestock breeding. Generally, only dead branches were cut. Chemical protection of trees was not used.

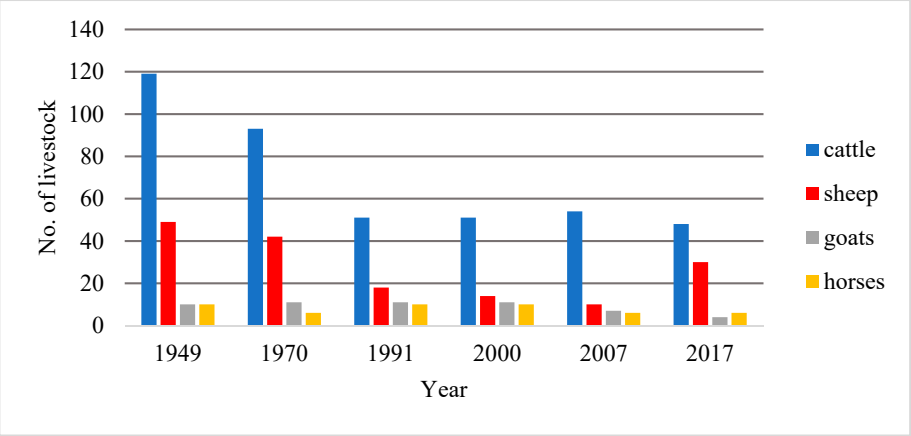

Figure 2. Number of livestock grazed in the orchards over the period 1949–2017 (not including livestock kept on the cooperatives and farms).

3.3. Management of Traditional Orchards at the End of Socialism (1991)

In this period, various combinations of twice-yearly mowings, grazing and partial plowing prevailed (51%). The number of orchards mown once a year increased (to 24%), and mowing was shifted to June and July. The numbers of both grazing livestock and grazed orchards decreased (Table 1, Figure 2). Dried phytomass was used mainly for animal feeding, or was sold (phytomass from 14% of orchards). Mechanized mowing predominated (78%). In most orchards, litter raking (83%) and fertilization were applied (39%). With the exception of one orchard, only organic fertilizers were used. As many as 50% of respondents stated that their orchards were affected by collectivization (annexation of part or all of the orchard, chopping down of fruit trees, etc.). Three of the evaluated orchards were established during the socialist period.

Table 1. Changes in the occurrence of the main management measures used in traditional orchards over the period 1949–2017.

Management Measure	1949	1970	1991	2000	2007	2017
Mowing	60	60	59	59	57	49
Grazing	38	38	28	26	26	22
Plowing	52	46	29	24	14	9
Mulching	0	0	1	1	3	9
No management	0	0	1	2	1	2
Orchard does not exist	3	0	0	0	0	0

3.4. Management of Traditional Orchards in 2017, 12 Years after the Accession to the EU

The most frequently used management regime was twice-yearly mowing (24%). Mowing was mechanized in all but four orchards. We observed an increase in the number of sheep (Figure 2). Phytomass was used for animal feeding (51% of orchards, including those leased to a local cooperative) or sold (21%). The original utilization of phytomass ceased in 27% of orchards, and these were mulched (Table 1); phytomass was gathered in heaps, composted, or left in situ (two abandoned orchards). Fertilization was used in 13% of orchards, and only organic fertilizers were applied. Litter raking was conducted in 75% of orchards.

3.5. Changes in the Management of Traditional Orchards over the Years 1949–2017

When considering mowing, grazing, plowing and mulching, methods of management changed in 92% of evaluated orchards over this period. At the same time, the number of orchards managed by a combination of three management measures decreased and the number of orchards managed by a single management measure increased. Moreover, the

number of different management regimes doubled (Table 2). Over the monitored period, we recorded a reduction in the frequency of mowing from two to one (23% of orchards), and mowing by scythe was replaced by mechanized mowing (by a single-axle motorized mower in 35 orchards, by tractor in 10). Grazing of orchards persisted to the present, but the number of grazing animals and grazed orchards decreased (Figure 2, Table 1). The research found a decrease in the use of plowing, fertilizing (from 81% to 13%), and, to a lesser degree, litter raking in orchards (from 100% to 75%). Mulching was established as a new management measure during this period. Chemical protection of trees was found in only one orchard in 2017. Until 1991, gradual mowing (i.e., individual orchards were mown in several stages) prevailed, being found in 75% of orchards, but till 2017 this has decreased to 41% of orchards.

Table 2. Changes in orchard management over the period 1949–2017.

	1949	1970	1991	2000	2007	2017
No. of traditional orchards managed by 3 management measures	34	28	13	12	6	3
No. of traditional orchards managed by 2 management measures	22	25	29	25	26	22
No. of traditional orchards managed by 1 management measures	4	10	20	24	30	36
No. of management regimes	6	9	11	11	12	12

3.6. Changes in Traditional Orchard Area and Land Cover

Significant changes took place in the land cover of the cadastral area of Nová Baňa between 1949–2017, including the area of traditional orchards (Figure 3, Table 3, Table S1). The dominant type of land cover was deciduous forests; for the whole of the monitored period they occupied more than half of the cadastral area. In 1949, mosaics of fields, meadows and permanent cultures were the second most widespread element in the landscape of the cadastral area of Nová Baňa (Table 3). Due to the collectivization of agriculture in the area, narrow fields were merged into large blocks of arable land. Some of the fruit trees originally growing on the boundaries separating the fields were removed so that the land could be managed mechanically. However, due to the sloping relief and low soil fertility, the land was changed into grassland with scattered fruit trees. As a result, by 1976, the land cover category of traditional orchards had increased. At the same time, the category of mosaic of fields, meadows and permanent cultures had decreased (Figure 4, Table 3). Some traditional orchards did not change in area over the period 1949–1976 (55.43%) (Table S1).

Over the period 1976–1991, 62.66% of the area of traditional orchards remained unchanged, and the total area of orchards decreased by 337.73 ha (Table 3). There was a very small increase in the area of traditional orchards over this period (4.77%). As dead fruit trees were not replaced by new ones, their number decreased, and this continued up to the present day. In 1980, an intensive orchard was established, which occupied 1.28% of the area by 1991 (Table 3). After the end of socialism, this orchard ceased to be managed as a single entity; the restoration of property to the original owners caused its area to decrease by more than 60% between 1990 and 2017 (Table 3). In the period 1991–2017, the decline of traditional orchards continued. Almost 40% of traditional orchards remained unchanged, with minimal establishment of new ones, which in all cases were established on the sites of grasslands (2.83%). Between 1949 and 2017, there was a total decrease of 53.37% in the area of traditional orchards, with only 31.62% of orchards remaining unchanged in area. The largest decrease occurred through tree removal and conversion to grasslands (18.93%), successional processes which led to the formation of forests (13.81%) and shrubs (9.42%), and urbanization (8.87%) (Table S1). We also recorded the emergence of new traditional orchards by 2017 (15.01%); this happened mainly as a result of the transformation of the mosaic of fields, meadows and permanent cultures into traditional orchards.

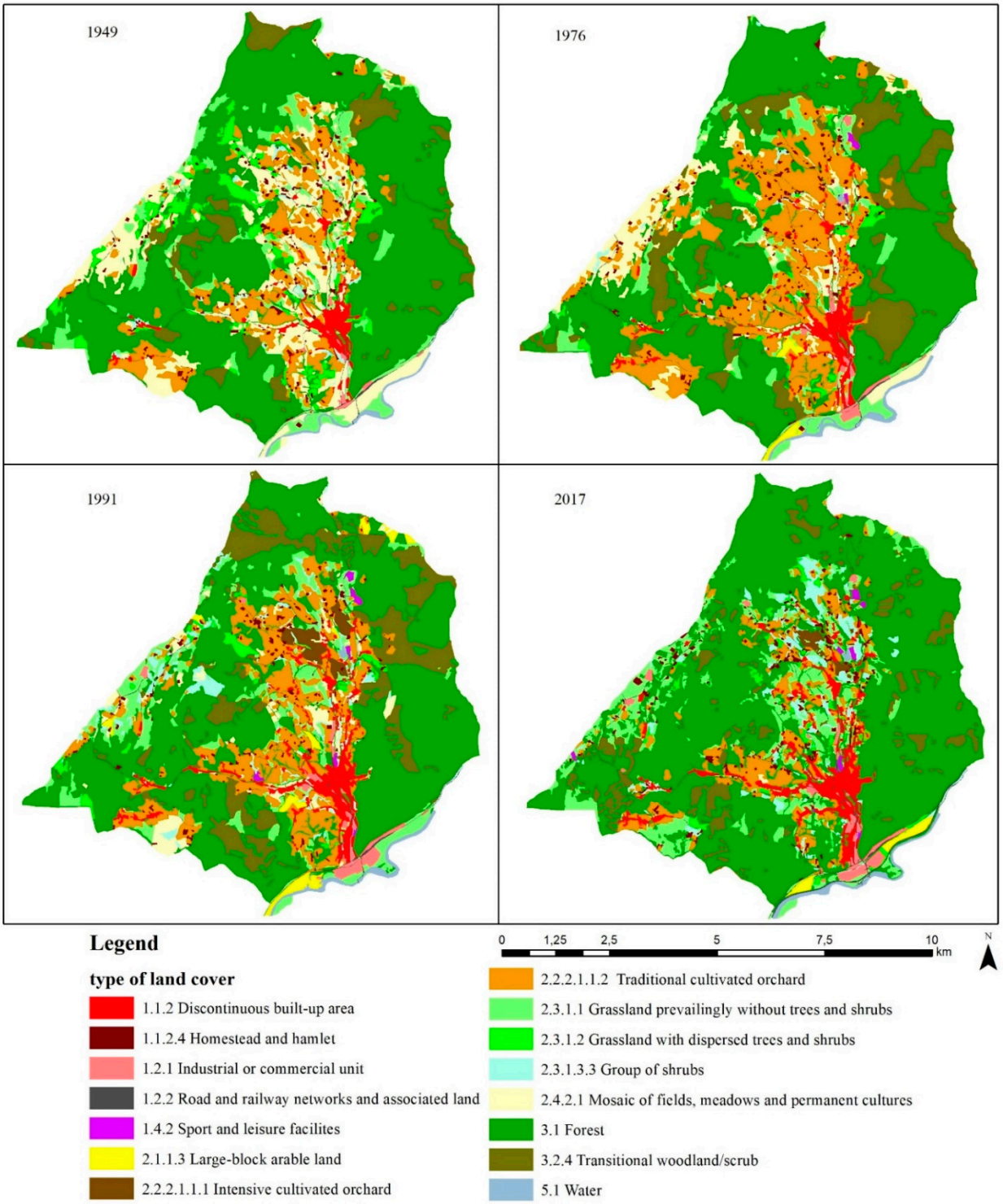

Figure 3. Changes in areas of land cover classes in the cadastral area of Nová Baňa over the period 1949–2017.

Table 3. Changes in land cover in the cadastral area of Nová Baňa over the period 1949–2017. CLC (CORINE Land Cover).

CLC	1949		1976		1991		2017	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
1.1.2 Discontinuous built-up area	116.38	1.90	166.58	2.72	221.56	3.62	249.55	4.08
1.1.2.4 Homestead and hamlet	86.18	1.41	88.51	1.44	72.26	1.18	99.94	1.63
1.2.1 Industrial or commercial unit	14.37	0.23	40.54	0.66	70.43	1.15	71.56	1.17
1.2.2 Road and railway networks and associated land	56.28	0.92	57.61	0.94	63.31	1.03	85.32	1.39
1.4.2 Sport and leisure facilities	-	-	6.77	0.11	18.07	0.29	16.73	0.27
2.1.1.3 Large-block arable land	-	-	29.83	0.49	74.48	1.22	35.13	0.57
2.2.2.1.1.1 Intensive cultivated orchard	-	-	-	-	78.34	1.28	30.28	0.50
2.2.2.1.1.2 Traditional cultivated orchard	702.04	11.46	1134.67	18.52	796.93	13.01	371.64	6.07
2.3.1.1 Grassland prevailingly without trees and shrubs	435.38	7.11	363.01	5.93	505.75	8.26	639.73	10.44
2.3.1.2 Grassland with dispersed trees and shrubs	256.92	4.19	83.40	1.36	79.01	1.29	84.43	1.38
2.3.1.3.3 Group of shrubs	54.68	0.89	43.28	0.71	152.40	2.49	194.82	3.18
2.4.2.1 Mosaic of fields, meadows and permanent cultures	787.47	12.86	404.76	6.61	176.80	2.89	2.61	0.04
3.1 Forest	3179.36	51.90	2913.88	47.57	2996.24	48.91	3783.55	61.77
3.2.4 Transitional woodland/scrub	400.25	6.53	743.98	12.15	767.97	12.54	412.89	6.74
5.1 Water	36.21	0.59	48.71	0.80	51.97	0.85	47.34	0.77
Sum	6125.52	100	6125.52	100	6125.52	100	6125.52	100

3.7. Landscape Metrics Evaluation

The fragmentation of the land cover structure increased between 1976 and 2017, and the extent of individual patches slightly decreased (Table S2). The increasing length of the edge of the patches reflect the greater fragmentation of the individual types of land cover, while the heterogeneity of the contact areas of neighboring land cover patches increased significantly—especially at the beginning of this century—and the shape of the patches became more regular. At the same time, the diversity of the landscape was largest in the period up to the 1970s (which was also related to the development of orchards in this period), and then began to gradually decline. The most even distribution of land cover patches was recorded in 1991.

The significant decrease in the area of orchards went hand in hand with their fragmentation. The two factors contributed to a gradual reduction of the impact of these valuable permanent crops on the appearance and function of the agricultural landscape of the area under study. Although the number of orchard patches increased by almost 30% during the period under study, their total area decreased by half. The average area of a traditional cultivated orchard decreased from about 4 ha to 2 ha, while over the second half of the overall study period (1991–2017), the average area of intensively-cultivated orchard decreased from about 15 ha to 5 ha (Table S3a–c). The edge density of orchard areas was naturally significantly higher in traditional orchards than in intensive orchard, due to ongoing secondary succession. The areas of the other types of land cover exhibited a more regular edge shape. The number of homesteads and hamlets doubled over the period under review, as did the number of meadow shrubs, due to ongoing succession. The increasing fragmentation of the cultural landscape of the area is also evidenced by the decreasing mean patch size of meadows over the last 70 years. However, the mean patch edge and the mean shape index of meadows did not change significantly. At the same time, the number of forest areas and transitional woodlands increased, the edge density increased slightly, and their mean patch edge decreased.

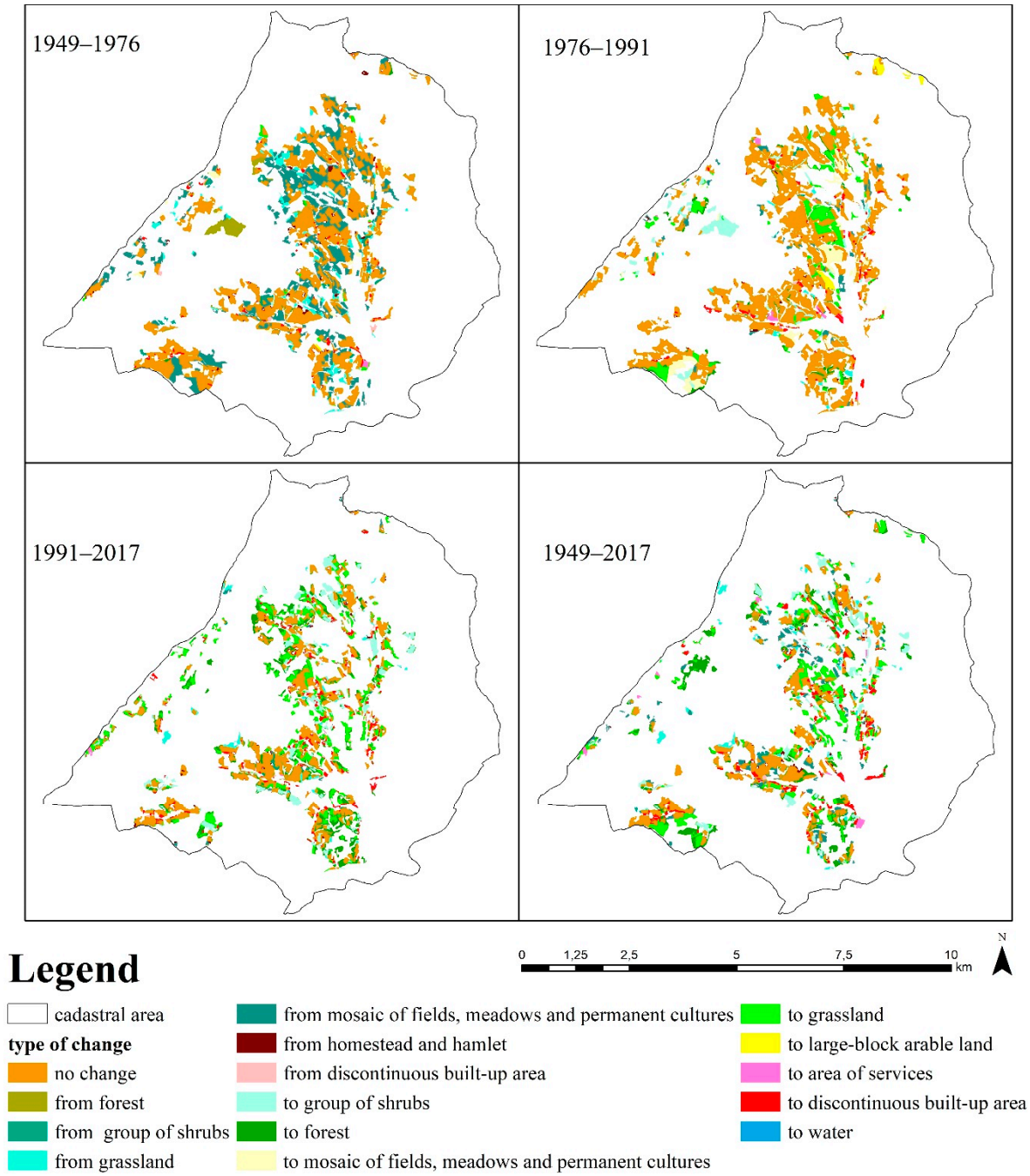

Figure 4. Land cover changes of traditional orchards in the cadastral area of Nová Baňa over the period 1949–2017.

4. Discussion

Our study has examined the changes in traditional orchard management and land cover in the region of Nová Baňa, which were linked to changes in the political system. The area and management regimes of the traditional orchards in the study region have undergone significant changes over the past 70 years. The observed land use and management changes, largely driven by political and socioeconomic transformations, threaten the preservation of the seminatural habitats of the traditional agricultural landscape [20,88]. Therefore, detailed research on orchards is important for ensuring the sustainability of the agricultural landscape.

Compared to the traditional management of orchards in the Myjava–White Carpathian region (Western Slovakia) [38], the studied orchards were more often managed by combinations of mowing, grazing and plowing (89% of orchards, vs. 39% in the Myjava-White Carpathian region). The combination of all three of those management measures was used in 54% of orchards in the Nová Baňa region and only in 10% of orchards in the Myjava-White Carpathian region. In addition, undergrowth grazing occurred in a larger proportion of Nová Baňa orchards, and the land of the orchards was more often used for growing crops. These differences were probably due to the larger area of traditional orchards in the Nová Baňa region, as well as geomorphological conditions. Orchards based on slopes were not plowed. Orchard plowing might also have been omitted in cases where the farmer had large plots of land to manage.

Significant changes in the management of the studied orchards occurred in the 1970s, which was a period of intensive socialistic agricultural collectivization (Table 1). When private, individually managed farmland was put under pressure, more remote and unproductive places were abandoned, and easily accessible areas were incorporated into the collectivized farming system [53,71]. This involved changes in management intensity and frequency and, in more extreme cases, changes in the management measures used. The preservation of private ownership was a key factor in maintaining traditional management during the socialist era [33]. Similar management changes were documented by Žarnovičan et al. [38] in the traditional orchards of the Myjava-White Carpathian region. Since collectivization did not take place in these regions at the same time or with the same intensity [71,89], the rate of changes in orchard management was not the same. Comparison over the past 70 years showed differences in the degree of plowing and grazing in particular. In the orchards of the Myjava-White Carpathian dispersed settlement region, plowing ceased by 1990, while it has survived to the present day in the Nová Baňa region. However, even in the Nová Baňa region, the area of the plowed land was significantly reduced, and traditional cyclic sowing systems were replaced by simple vegetable growing.

While grazing in the orchards of the Myjava-White Carpathian region had almost disappeared by 2015 [38], it was still used in the orchards studied in this paper. Although the extent of grazing was diminished, all species of livestock involved in orchard grazing continued to be involved during all observed periods. The decrease in the number of grazed animals and the decrease in the number of grazed private orchards in the Nová Baňa region occurred during a period of intensive socialization of agriculture and concentration of livestock production in large farms in the latter half of the 1970s. After 1989, this trend slowed down (Table 1, Figure 2). In the period 1991–2017, the number of cattle in Slovakia decreased by 68%, and sheep by 31% [90]. The global decline in livestock production after 1991 had no significant impact on orchard grazing. This development in animal production after 1989 was related to the political and socioeconomic changes in Slovakia after that time, which led to the demise of agricultural cooperatives and the reduction of animal production. This trend did not show any fundamental change after the accession of Slovakia to the EU in 2004 [90]. Since World War II, abandonment and land use change have taken place across almost all of the wood pastures in Slovakia [91], and have also been reported in other European countries [92–94].

The reduction of domestic livestock breeding has reduced the demand for hay. This has led to an increase in the number of mulched orchards, especially in the period after 2000. Mulching is a method used by farmers to solve problems with orchard mowing and phytomass processing. However, replacing traditional management with mulching has had a negative impact on biodiversity. According to Gaisler et al. [62], mulching once a year inhibits the development of tree species, but does not prevent the spread of weedy species. These expand in the vegetation much as they do in unmanaged areas. Regardless of the frequency of its use, mulching causes a reduction in the species richness of plants, with mulching once a year being considered the most unsuitable [65,95].

Scythe mowing is an element of traditional management of hay meadows, as in other countries such as Hungary [96] and the Czech Republic [61]. The negative impact

of mechanized mowing lies in how mowing large areas all at once homogenizes the habitat conditions. Conversely, traditional management, with its gradual hand mowing, ensures a heterogeneity of habitat conditions, which supports biodiversity [36]. The degree of parcel-scale diversity under traditional grassland management usually depends on weather, orchard size, sufficiency of the workforce, and the individual decisions and family traditions of the local farmers [36]. Even the temporary cessation of management in some of the orchards in the area is not considered to be an unambiguously negative phenomenon. Orchards with terminated or limited management still have an important role in the cultural landscape—although this should be only a transitory phase in land use [7]. These are of particular importance in the vicinity of commercial orchards for pollination services of fruit trees and the maintenance of biodiversity within the landscapes [97].

Data on the occurrence of traditional orchards within the TAL of Slovakia are given by Špulerová et al. [19]. The traditional orchard landscape (mosaics of arable land, grasslands, and the orchards) subset of TAL occupies 1883.44 ha. The latest data on the area covered by traditional orchards of central Europe, including Slovakia, are those published by Forejt and Syrbe [45]. According to them, the current area of traditional orchards is 35,600 ha in Slovakia, which is 0.73% of the area of the state. In the region of Nová Baňa, we found a decrease in the area of traditional fruit orchards and intensified orchard. This can be compared with the results of Némethová et al. [98], who reported a reduction in the area of all types of orchards in Slovakia by 4.9% over the period 2004–2010. Their study excluded orchards under 0.3 ha in area. The same general trend of decrease in traditional orchard area has been documented in the Baden–Württemberg region of Germany, where Plieninger et al. [47] recorded a 22% loss of traditional orchard area between 1968 and 2009; this loss was accompanied by a reduction in the number of orchards over 5 ha in area. In addition, Küpfer and Balko [99] reported a 50% decrease in the number of fruit trees in traditional orchards over the past 40 years in the same region.

Differences between published estimates of the areas of traditional orchards (and other agroforestry systems) result from different definitions of the mapped units and differences in database concepts, map resolution, and quality of historical images [2,45].

The socialist era was characterized by the intensification of agriculture, while in the post-socialist period, agricultural extensification prevailed [100], which has led to the cessation of management in many cases [101]. These processes, together with land use changes, have had a long-term impact on the traditional rural landscape and caused the disappearance of distinctive elements such as traditional vineyards, narrow fields [102], and traditional orchards. Arable land is more quickly and more severely influenced by those processes than are permanent grasslands and orchards [54]. In the study area, this has led especially to the almost complete disappearance of mosaics of fields, meadows, and permanent cultures. These findings correspond with those of Žarnovičan et al. [38], according to whom changes in traditional orchard management are gradual but continuous, and do not necessarily follow events of historical significance immediately. This can be ascribed to the strong involvement of local farmers in local traditions, which delays the effects of political change. Political regimes and related agricultural policies affect the landscape management, but in different regions to varying degrees and with varying intensity. According to Jepsen et al. [101], "land-system changes should not be conceived as unidirectional developments following predefined trajectories, but rather as path-dependent processes that may be affected by various drivers, including sudden events".

5. Conclusions

Traditional European rural landscapes and their agricultural systems, including the studied traditional orchards in the Nová Baňa region of Slovakia, are under long-term threat by changes in land use and management. We have focused on the management and land cover changes which have taken place since 1949. The most important drivers thereof were the major socioeconomic changes which central European countries faced during the

studied period, e.g., the socialist collectivization of agriculture, the collapse of socialism, and accession into the EU.

The management changes can be summarized as follows: (i) simplification of management (one of the main trends at present, with the combination of several management measures being replaced by one); (ii) a clear decrease in plowing and grazing in orchards; (iii) mulching as a new and common practice; (iv) the number of different management regimes, which has increased. Although current management regimes are able to maintain the orchard habitat, they are not equivalent to traditional management, due to the lower diversity of management techniques in use and lower temporospatial heterogeneity.

Deciduous forests dominate the landscape of the Nová Baňa cadastral area, and they increased in area by 9% over the period under study. In 1949, orchards occupied about 11% of the territory, and fruit trees also occurred in the mosaic of fields, meadow and permanent cultures. Nowadays, orchards occupy about 7% of the cadastral area, with extensively-managed areas being dominant. The principal changes in traditional orchard area and land cover were: (i) between 1949 and 2017, there was a total decrease in the area of traditional orchards by 38.36%; (ii) the landscape diversity decreased as a result of socialistic intensification of agriculture.

The results obtained in this paper are comparable with those from other post-socialistic regions. However, it turns out that every region has its own specific character, so it makes sense to continue with regional-level research in order to better understand and preserve the cultural and natural heritage which traditional orchards undoubtedly constitute.

Supplementary Materials: The following are available online at https://www.mdpi.com/2073-4395/11/2/366/s1, Table S1: Land cover changes in the traditional orchards in the cadastral area of Nová Baňa over the period 1949–2017, Table S2: Landscape metrics of the whole study area, Table S3a–c: Landscape metrics of chosen classes of land cover.

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