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STRUCTURAL CHANGES IN THE FARMSTEAD SETTLEMENT SYSTEM

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1. INTRODUCTION

1.1. Actuality of the topic, problem statement

The farmstead is a traditional element of the Hungarian settlement network with a specific development path. In our country, the farmstead number and their population reached their maximum in the middle of the 20th century, when more than one million people lived in the countryside. Since the 1950s, the rural areas' population has continuously decreased due to the transition to large-scale agriculture and the ban on farm construction. According to the 2011 census data, 306,000 people lived outside the country, two-thirds within the Great Plain. Nearly half of the latter in the Homokhátság, where the proportion of the outer part population reached 18%.

After the regime change, the privatization of land appeared as a new opportunity for farmstead people. Therefore, at the beginning of the 1990s, an approach began to develop that intended to rely on the private sector in agriculture by creating so-called "full-time" family farms. Nowadays, it can be seen that the idea did not realize. However, at the beginning of the 2000s, studies carried out by the Regional Research Center of the Hungarian Academy of Sciences pointed out the continuous transformation of farmstead areas.

In recent decades, some farmsteads have been set up for family farming and produce for self-sufficiency. At the same time, farms, typically founded for commodity production produce goods, gained ground. Some farms have become hobby and holiday farms, where most agricultural activities are carried out for fun. However, the concentrated agricultural production typical of today and the increase in expectations related to lifestyle and housing hinder the creation of new farms.

Even though many people recognized the values of the farm lifestyle, no measures were taken to support it until the years following the millennium. Among the organizations and institutions involved in rural development, the Institute for Rural Development, Training and, Consulting of the Ministry of Agriculture and Rural Development established the Program Office for Hungarian Farms in 2008. The office aimed to assist in maintaining and modernizing the farm lifestyle and increasing the standard of living of those living on the farm. To achieve these goals, the Ministry of Rural Development launched the first Farm Development Program in 2011, for which interest is growing yearly. Regarding the future of the farms, the Rural Development Program for 2014-2020 paid particular attention to the sustainable development of this settlement type. At the same time, the tenders supporting organic farming, which are available for farms with a traditional agricultural profile, protect and sustain the natural environment.

Between 2014 and 2017, as the head of the farmstead office operating as part of the Herman Ottó Institute, I could participate in evaluating the 2016 Great Plains farm survey. During the work, I could access other databases and perform comparative analyses. However, during the study of surveys at different times and areas, by various organizations using different terminology, the need arose to create a database based on geospatial information that is as uniform as possible.

A file containing data on the geographical location of the farms, the state of their natural environment, and the infrastructural supply could ensure an accurate assessment of the results of the tender grants. It could also provide a reference point for the designation of new grant targets.

Moreover, a time-dependent examination of the spatial arrangement of the farmsteads and the surface cover also emerged. The expected results allow the description of historical changes and are also suitable for predicting the near future. Answering these questions is supported by remote sensing methods getting better that provide better spatial and temporal resolution. During my investigations, drones, considered novel in farm research, expanded the scope of these possibilities.

1.2. The research area and period

In addition to the considerations related to the available databases, I considered several aspects regarding the geographical delimitation of the sample area. Located between the Danube and the Tisza, the unique situation of the Sand Ridge, with its special nature and history, still exists today. Living outside the country is much more decisive than in other areas of the country. Although many outlying settlements ceased to exist here in the previous decades, a significant part of them remains. With this in mind, within Bács-Kiskun County, I searched for settlements with different sizes and historical backgrounds that could be used as typical examples. It was also crucial that the database should contain a statistically evaluable number of answers for the affected settlements. The selected Felsőlajos is the smallest and youngest settlement of Bács-Kiskun County, founded in the thirties of the last century. However, the history of the town of Kiskunmajsa is written from the middle of the 18th century. This market town is an excellent example of those settlements in the vicinity of which many farms were established. While suburbanization processes are not noticeable in the case of Felsőlajos, the holiday part created in the ötfa settlement part of Kiskunmajsa has a significant appeal regionally.

I investigated the spatial changes of Kiskunmajsa's farm landscape and the evolution of its surface cover from the end of the 19th century to the present using time-series map files as well as GIS and remote sensing methods. Using a similar methodology, I analyzed in detail the farms and land cover of Felsőlajos, founded after World War I between 1960 and 2019, using satellite and drone images.

1.3. Research objectives

In my thesis, I used public databases, remote sensing, and geospatial information methods to examine the farmsteads in the Great Plains and two settlements highlighted as examples. I summarize my research aims below:

- Comparative analysis of farm surveys available at the beginning of 2017 for the entire Great Plain, Bács-Kiskun County, and the two sample areas.
- Development of a correction method for inaccurately recorded geographic coordinates in the 2016 farm survey.
- Identification and integration of farmsteads in Kiskunmajsa and Felsőlajos into a GIS database to analyze the changes that occurred from the end of the 19th century to 2016.
- Characterization of the settlement structure and land cover of Kiskunmajsa, in its inner area and five highlighted settlement parts, from the end of the 19th century to 2018.
- Detailed analysis of the change in surface cover of Felsőlajos from 1961 to 2019.

2. MATERIAL AND METHODS

The sample area of my research was the farmsteads of Kiskunmajsa and Felsőlajos settlements (Figure 1). Both settlements are located in Bács-Kiskun County within the Homokhátság region. Felsőlajos (N. 47° 04′, E. 19° 31′) is situated on the border of Bács-Kiskun and Pest counties, while Kiskunmajsa (N. 46° 29′ 32″, E. 19° 44′ 13″) is on the boundary of Bács-Kiskun and Csongrád-Csanád County. The town of Kiskunmajsa (222.3 km^2, 10,968 inhabitants) dates back to the 18th century, and today it has an extensive farm world. Felsőlajos (11.4 km^2, 883 people) current area used to be the outskirts of the neighboring Lajosmizse.

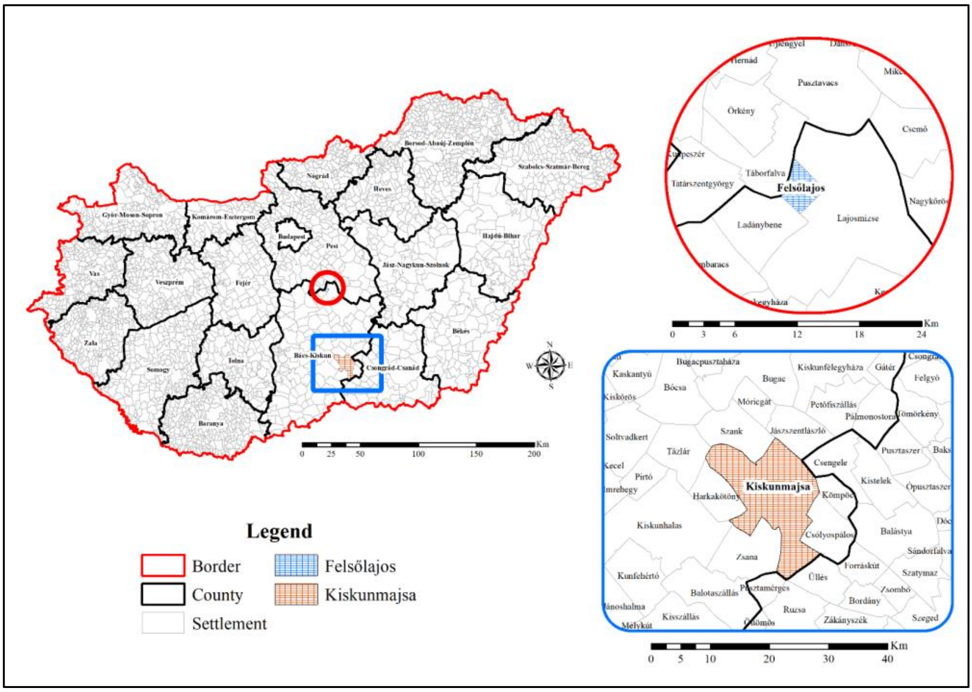

Figure 1: Location of Kiskunmajsa and Felsőlajos

I used primary and secondary data in the research, performing two types of examination. On the one hand, based on time-series maps and geospatial and remote sensing methods, I examined the spatial changes in the Kiskunmajsa farm landscape between 1785 and 2020. On the other hand, I analyzed the land cover changes in Felsőlajos (between 1961 and 2020) using historical and topographic maps, aerial photographs, and orthophotos.

2.1. Numerical databases

During the construction of the database that served as the basis of my analyses, I also used the results of the questionnaire farm survey for the entire area of the Great Plain, i.e., 724 settlements, organized centrally in the spring of 2016. As part of the survey, data were collected on eight thematic groups of questions: 1. The location of the homestead, 2. The state of the natural environment around the homestead, 3. Questions concerning residents, 4. The condition of the homestead buildings, 5. The infrastructural situation, 6. Wired electricity questions related to its provision, 7. Questions related to farming, 8. Involvement by the Farm Development Program and other subsidies.

I also examined the numerical databases that served as the basis of the questionnaire used during the 2016 survey, such as the real estate registry database, the vector topographic map database, and the data on farms of the Land Parcel Identification System (after this: LPIS-HU). To present the sample areas, I used the 2020 stock of the Hungarian locality directory for Kiskunmajsa and Felsőlajos. From the settlement-level data available in the National Regional Development and Spatial Planning Information System free-text metadata search module, I downloaded the population numbers living in the outskirts between 1960 and 2011. I supplemented this with the data on the distribution of employment provided by the Hungarian Central Statistical Office by the branch of the national economy (agriculture, industry, services). I used these time series data to present the change in the employment structure in farm areas.

2.2. Map databases

I examined the spatial arrangement of the farms partly based on literature data and various databases and partly using time-series map files.

I used the spatial data collected within the framework of the INSPIRE directive, selecting the squares of the grid network for Kiskunmajsa, with the population and housing number data belonging to each cell, to examine the spatial arrangement of the farms.

One of the bases of my land cover investigations was the 1:100,000 scale files of the CORINE land cover database for the reference years 1990, 2000, 2006, 2012, and 2018, aligned to the standard European 3-level classification. To produce the most accurate base map available, in the case of the Kiskunmajsa sample area, I also used the high-resolution – 1:50,000 scale – national CORINE land cover database, which contains level 4 and 5 land cover classes.

I also used the database of the National Ecological Network for the reference year 2014, which is available on a scale of 1:50,000 and distinguishes between core areas, ecological rivers, and buffer zones.

Among the freely usable maps of Open Street Map, I downloaded the shape files of the building stock and the linear road network for the sample areas to examine the farms' spatial arrangement and surface coverage. For my investigations in the sample areas, I used the outer area vector map files (after this: KÜVET) of the two settlements for the reference year 2011 as a base map. From the data stored in the database, I used the land plot boundaries and related topographic number entries and the elements of residential and commercial buildings. Since the KÜVET database does not include areas classified as closed gardens, I also used the files containing parcels of land in closed gardens when compiling the maps.

2.3. Aerial and satellite images

I applied black-and-white archived aerial photographs in GeoTIFF format for my research from the Lechner Knowledge Center's aerial film archive. In the case of Felsőlajos, I downloaded these recordings from 1961 and 1974 and for Kiskunmajsa from 1967, 1979, and 1989. If necessary, I improved the georeferencing accuracy of these aerial photographs with ground surface connection points. Moreover, I used 2000, 2005, 2015, and 2019 true color RGB orthophoto files with 40 and 50 cm/pixel resolution for spatial analysis.

In addition, I also used freely available multispectral Sentinel-2 satellite imagery within the framework of the European Space Agency's earth observation program. I downloaded atmospherically corrected "Level 2A" recordings for the land cover tests, then created an NDVI index using the ESA SNAP software. I also used the CORONA satellite images released in the 1960s with a resolution of 1.8-7.5 m to examine the spatial arrangement of the farms.

2.4. Raster map files

Topographic maps are also part of my time series files. To identify the farms of the Kiskunmajsa sample area and to present their spatial arrangement, I used the 1:10,000 EOV projection raster topographic maps made between 1989-1994. For the land cover analyses carried out in the sample area of Felsőlajos, I used 1:10,000 scale EOV projected maps made between 1976-1980, as well as 1:25,000 military topographic maps available in the WGS84 projection. Finally, I also used the 1:50,000 scale map sheets available in the Gauss-Krüger projection made in 1956. All files were available in a georeferenced version in digital format.

To examine the spatial arrangement of the farms in Kiskunmajsa and the changes in the surface cover of Felsőlajos, I used the second military survey georeferenced maps made between 1860 and 1864, scale 1:28,800. In the case of both surveys, I located the farmsteads that can be identified on the map based on the current administrative boundaries of the settlement.

2.5. Field data collection and drone survey

During the field surveys in the farmstead area of Felsőlajos in 2016-2017, I aimed to check the farms identified based on the 2015 orthophotos and surveyed as part of the 2016 farm survey. In the course of the field data collection, I created photo documentation and recorded the GPS coordinates of the surveyed farms. However, to describe the actual conditions, I repeated the previous field visits in 2020-2021.

In 2016 and 2017, 12 MP photos were taken from Kiskunmajsa and Felsőlajos applying a DJI Phantom 3 Advanced drone creating photo documentation. During the flights in 2018, I used a 20 MP resolution camera mounted on a DJI Phantom 4 Pro drone to fly over specific rural areas. First, I determined the flight parameters using the freely available DroneDeploy software with 60% and 80% lateral and longitudinal overlap. Then, I created georeferenced EOV projection orthomosaics with centimeter field resolution using photogrammetric methods.

2.6. Geospatial database construction

I compiled the relevant geospatial database in the ArcGIS for Desktop software for both sample areas. I used vector and large-scale raster files in my studies, so I created file geodatabase (.gdb) type databases, which adapted to the range of studies carried out in a given area unit. I built the databases from three basic elements, the element class data set (Feature Dataset), the element class (Feature class), and the raster data set (Raster Dataset).

The characteristics and structure of the map files and numerical databases serving as the basis of the geospatial databases were significantly different from each other. Thus, the first step in the database construction work was to resolve these differences. First, I sorted the collected vector layers, then transformed the raster files with different projections from different sources used during the compilation of the time series maps into the EOV projection (EPSG: 23700). Next, I re-geo-referenced the files with distortions and georeferencing errors (sections of military surveys and archived aerial photographs). Finally, I adjusted the raster files to the 1:10,000 scale EOV coordinate system topographic map used as a reference map with the help of specified adjustment points. I tried to achieve the highest possible accuracy during the work, so I marked permanent map elements (e.g., road intersections and church towers) as connection points. Then, based on at least six recorded points per section, I performed the georeferencing using the Global Mapper v15 program.

After processing the vector stocks and preparing the raster base maps, I created reference stocks to analyze the spatial arrangement of the farmsteads for farm density calculations and surface cover estimation. Finally, I performed data cleaning on the 2016 farm survey data before inserting them into the databases.

2.7. Digital imagine evaluation

To examine the surface cover changes in Felsőlajos, I digitized the predefined surface cover categories that also appear in the CORINE database at a scale of 1:4,000. After preparing the land cover maps, I examined the spatial changes in each category using attribute-based and spatial queries and then created a stability map using ArcGIS software. Finally, I digitized the farms by sample area during the evaluation based on the relevant map files. To examine the change in the spatial arrangement of the farms, I generated a 250x250-meter grid for the sample area and then assigned the farmsteads to the cells digitized from the maps of different times.

2.8. Statistical methods

I organized the data from different sources and calculated the basic statistics in an Excel environment. During the 2016 farm survey evaluation, I characterized the infrastructural condition of the Great Plan farms at the county level with an index value, considering the supply of electricity, gas, and drinking water. To classify the farms of Kiskunmajsa, I used a two-way cluster analysis, which enables the simultaneous inclusion of discrete and continuous variables. I standardized the continuous variables and checked the reliability of the classification with the Silhouette coefficient using the SPSS

20 software. I performed a supervised classification (ESA SNAP 8.0, decision tree method) based on Sentinel-2 satellite images during the land cover tests.

3. RESULTS

I summarized my results in four subsections. First, I analyzed the farm survey databases for the entire Great Plain. After that, I characterized the changes in Kiskunmajsa’s settlement structure and surface cover from the end of the 18th century to 2020. Finally, the last section contains the analysis results of the change in Felsőlajos, another sample settlement in Bács-Kiskun County.

3.1. The results of farm surveys with particular regard to the 2016 Great Plains farm survey

During the evaluation of homestead surveys based on county aggregators, I proved that the databases that register homesteads (Land registry database - INYA, Vector topographic map database - VTTA, LPIS-HU) are not uniform. Accordingly, their comparability is limited (Table 1).

Table 1: County summary for farmsteads, based on different databases

County	Farmstead settlement based on INYA (number)	Farmstead based on INYA (number)	Farmstead settlement based on VTTA (number)	Farmstead based on VTTA (number)	Farmstead settlement based on LPIS-HU (number)	Farmstead based on LPIS-HU (number)
Bács-Kiskun	119	18,809	116	68,160	108	22,479
Békés	75	6,568	73	20,944	71	12,136
Csongrád	66	9,050	65	45,429	61	27,319
Hajdú-Bihar	85	18,733	72	9,718	70	4,852
Jász-Nagykun-Szolnok	77	6,551	72	9,826	65	4,181
Pest	80	11,021	74	15,310	60	5,289
Szabolcs-Szatmár-Bereg	218	20,126	186	5,935	108	1,847
Sum	**720**	**90,858**	**658**	**175,322**	**543**	**78,103**

Source: own editing based on Budapest Capital Government Office data

The 2016 Great Plain farmstead survey is based on 95,000 questionnaires. It contains eight thematic units aimed primarily at correcting the geographical location of the farmsteads and describing their general condition in as much detail as possible. During the database analysis, I found that the fieldwork carried out for the vital goal was inaccurate in several ways (the GPS coordinates of approximately 3,000 farms were erroneous) or incomplete.

Therefore, after the possible corrections, I depicted the geographical appearance of the farms on a density map (Figure 2).

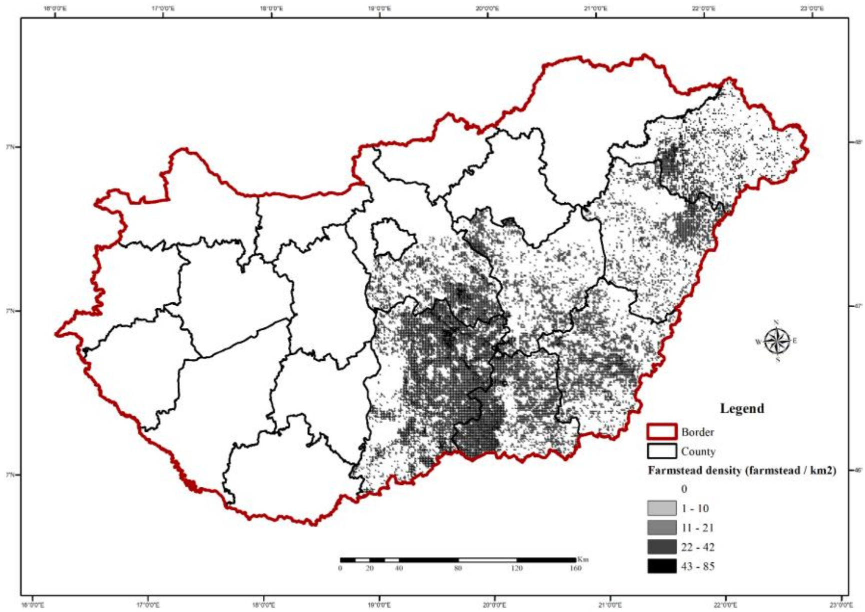

Figure 2: Geographical appearance of the surveyed farms

Aligned with the current Farm Development Program/Rural Development Program for 2014-2020 goals at the time of the survey, I examined the supply of electricity to the farmsteads with residential or economic functions, with a response rate of 41%. Furthermore, in the case of the nearly 5,000 unelectrified farms, based on the questionnaire responses and the data from the e-public utility system, I have given the distances of these farmsteads from the public network in tabular form, which may be necessary for terms of their future connection to the network.

The questionnaire also included the relationship between the farmstead and the natural environment. Based on the answers given to them, it became clear that many owners are not aware of whether their farm is affected by a protected area or not. In addition, the answers often confuse the concepts of a National Park and Nature Conservation Area, and two-thirds of those affected do not know that their farm is in contact with a Natura 2000 area.

According to the database, most farmsteads included in the survey (90%) were built before the regime change in 1989. According to the distribution of homesteads according to residential functions – based on the 49,000 evaluable responses – nearly 80% of the properties were permanently inhabited. The proportion of uninhabited farms is 12%, but a significant part has some economic function. The ratio of farms functioning as hobby farms is 8.5%. The majority of surveyed farms (based on 24,000 responses) (58%) produce exclusively for their consumption; that is, they do not sell their products on the market. However, 23% of the farms sell the surplus above their consumption, while 19% of the respondents produce primarily for sales purposes.

Regarding the infrastructural situation of the farms, they asked about the property's supply of electricity, gas, and drinking water. Based on the answers, I created indexes based on these, and the farms were sorted into groups with unfavorable, average, and favorable infrastructural conditions (Table 2).

Table 2: The infrastructural features of the farms surveyed

County	Farmstead (number)	Unfavorable		Average		Favorable	
		number	%	number	%	number	%
Bács-Kiskun	17,943	432	2.41	12,977	72.32	4,534	25.27
Békés	3,497	37	1.06	2,172	62.11	1,288	36.83
Csongrád	8,443	1,349	**15.98**	5,215	61.77	1,879	22.26
Hajdú-Bihar	2,323	61	2.63	1,626	70.00	636	27.38
Jász-Nagykun-Szolnok	1,526	59	3.87	1,066	69.86	401	26.28
Pest	4,900	65	1.33	3,751	76.55	1,084	22.12
Szabolcs-Szatmár-Bereg	4,384	23	0.52	1,269	**28.95**	3,092	**70.53**
Sum	**43,016**	**2,026**	**4.71**	**28,076**	**65.27**	**12,914**	**30.02**

While less than 5% of the total sample falls into the "unfavorable" category, 30% can be classified into the "favorable" category, emphasizing the significant differences in county-level distributions.

3.2. Analysis of changes in the settlement structure of Kiskunmajsa

I presented the historical changes in the center of the Kiskunmajsa settlement (inner area) and the settlement parts of its outskirts (Bodoglár, Ötfa, Kígyós, Tajó, and Gárgyán) with the help of maps, aerial photographs, and orthophotos. In addition, I briefly described the impact of environmental factors (sand dunes, wetlands, marshy areas) on the extent of the central part of the city and its changes, including the binding of sand with plantations and the result of sewerage. In addition, Figure 3 contains the five sample areas (Tajó, Aranyhegy, Kígyós, Bodoglár, and Ötfa) of the surface cover studies presented in chapter 3.3.

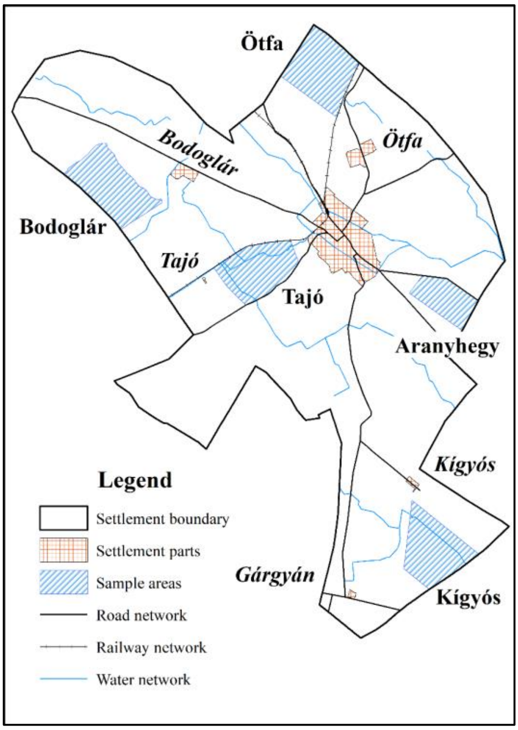

Figure 3: Settlement parts of Kiskunmajsa with the selected sample areas

I created a GIS database for change analysis to manage the used raster and vector files. Based on the time series density maps – from the end of the 18th century to 2016 – 131, 602, 1,554, and 1,353 farmsteads were identified based on the I., II. military survey, the 1950 military topographic map, and the 1989-1994 stock. Table 3 consists of the distribution of these by sample area.

Table 3: Evolution of the number of farms by sample area

	Kiskunmajsa	**Bodoglár**	**Ötfa**	**Tajó**	**Aranyhegy**	**Kígyós**
First Military Survey	131	0	0	0	0	0
Second Military Survey	602	7	14	15	0	0
Military Topography Map (1950)	1,554	42	72	19	18	55
Civilian Topography Map (1989-1994)	1,353	14	66	15	0	75
Farm Survey of the Great Plan (2016)	1,138	6	48	16	0	64

In the 2016 farmstead survey database, sorted according to the mother settlement, 1,453 farms belong to the Kiskunmajsa settlement. Due to the previously presented uncertainty of the database, I digitized the farms based on the 1989 topographic map – using the 2015 orthophoto as the base map – and identified 1,619 farmstead locations. Then, I applied Google Maps' "street view" function to make the database more reliable, interpreted the 2015 orthophoto imagery, and performed a site survey. As a result, I found 555 farms – from the 1,619 – which were uninhabited, ruined, or could not be identified.

For farmsteads that are not visible in the 2015 orthophoto but included in the database, I applied additional correction steps using the 1950 military map and the 1989-1994 topographic map, as well as the Kiskunmajsa micro-regional farm-development program data.

As a result of the correction process, I identified 1,138 farms in 2016 and subsequently considered this stock as a benchmark (Figure 4).

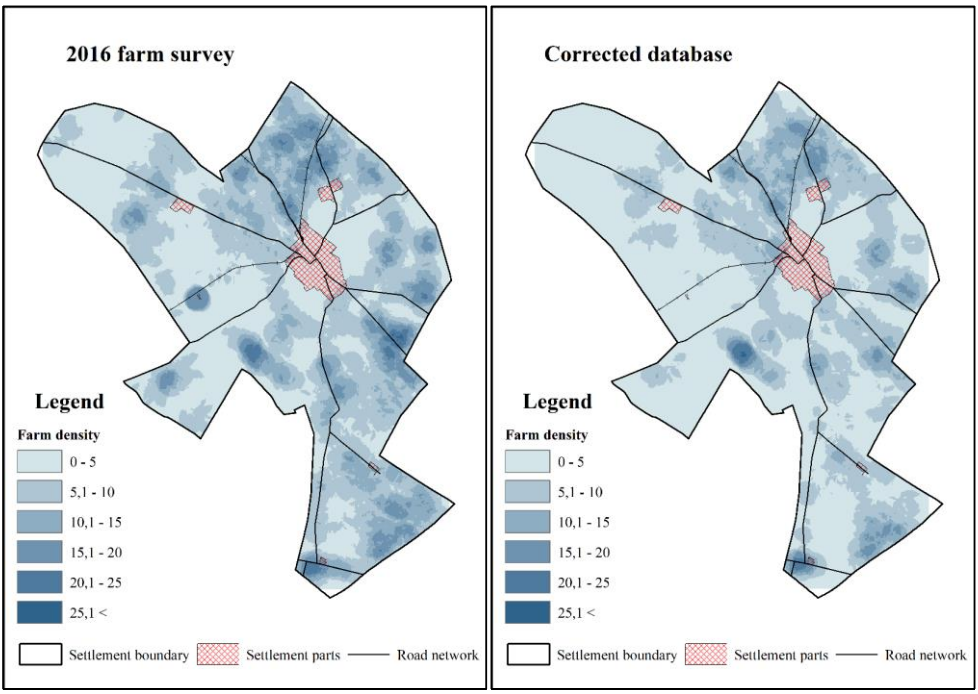

Figure 4: Density map of Kiskunmajsa' farmstead based on the 2016 survey and the corrected database

Based on the developed GIS database and the 2016 farm survey data for Kiskunmajsa, I graphically represented the buildings established before 1945, between 1945 and 1989, between 1990 and 2000, and after 2000. In addition, I highlighted the areas where no farmsteads have been built in the last 70 years. Moreover, I displayed the distribution of hobby (n=77) and deserted farms (n=26), using orthophotos to prove the inaccuracy of the farm survey. Finally, the distribution of farms according to economic function is also defined. Accordingly, the farms primarily producing for sale are typically located along road 5405, connecting Kiskunmajsa with Soltvadkert (Figure 5).

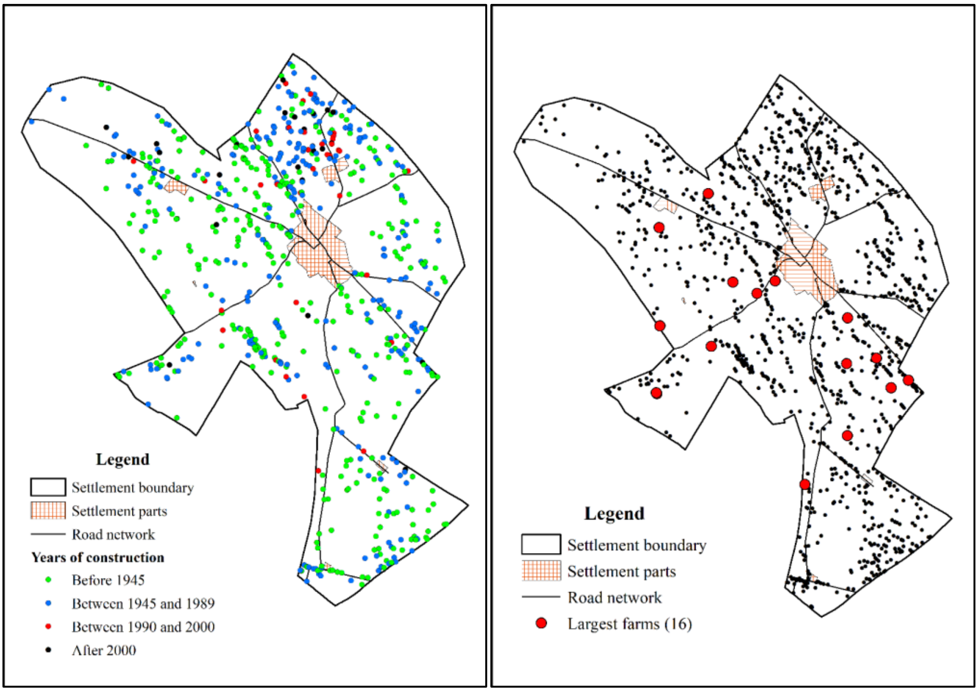

Figure 5: Distribution of farms in Kiskunmajsa according to years of construction and the location of the largest farms (3th cluster)

Classification of the farmsteads by two-way cluster analysis, the wired power supply, which characterizes the basic infrastructure well, is treated as a category variable. The percentage of cultivated areas around the farm, the total size of the farm, and the distance from the solid road were considered continuous variables (Table 4).

Table 4: Clustering results of Kiskunmajsa' farmsteads

Cluster number	4	1	5	2	3
Farmstead number (%)	231 (54.7%)	117 (27.7%)	38 (9%)	20 (4.7%)	16 (3.8%)
Cultivated areas around the farmstead (%)	95.7	16,1	98.2	68.3	68.4
Wired power supply (%)	100	100	100	0	93.8
The total size of the farmstead (ha)	6.02	4.37	9.16	2.85	90.94
Distance from the solid road (m)	785	1,050	5,058	1,604	781

Of the five clusters obtained from the analysis, the second (4.7%) includes homesteads without a wired power supply and the smallest floor area. The largest farmsteads (farms rather than homesteads) (cluster 3, 3.8%) are located near a paved road. Homesteads with wired power without exception (clusters 1, 4, and 5, 91.5% of the total sample) are around 5 hectares. While in the case of farms belonging to cluster 1, the ratio of cultivated areas is low, in the case of farms belonging to cluster 5, the percentage of cultivated areas is high; however, in the case of the latter, the approach distance is the largest.

It is worth noting that 3.8% of the farms (cluster 1) cultivate almost 39% (1,455 ha) of the total area of 3,757 ha of the examined farmsteads (involved in the cluster analysis), thus producing the majority of local agricultural products.

During the accessibility examination of the settlement's homesteads, travel time and distance data from the settlement center (Roman Catholic Church) are estimated by car. Besides the graphical presentation (Figure 6), the number of homesteads belonging to the given accessibility category is counted, registering significant differences between the outer parts of the settlement.

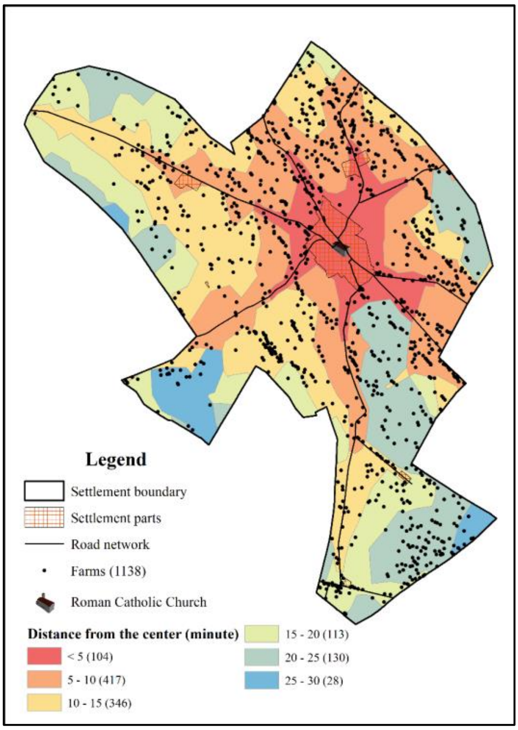

Figure 6: The time required to reach the farms in Kiskunmajsa from the center by car

The isochron diagram clearly shows the role of the main road network in the accessibility of farms. Almost 75% of the farms in the settlement are within 5-15 minutes of the city center. At the same time, there are two areas (the SE edge of Kígyós (11 farmsteads) and the SW edge of the settlement (17 farmsteads)) where the distance measured per minute exceeds 25.

3.3. The Land cover examination of Kiskunmajsa

In the first step, the change in the surface cover of Kiskunmajsa between 1990 and 2018 based on the available CORINE files is present. The landscape used kept its mosaic character, but at the same time, in addition to the 12% and 25% decrease in the arable and vineyard areas, the forest surface increased by 36% in the examined time interval. The 2018 situation is shown in Figure 7.

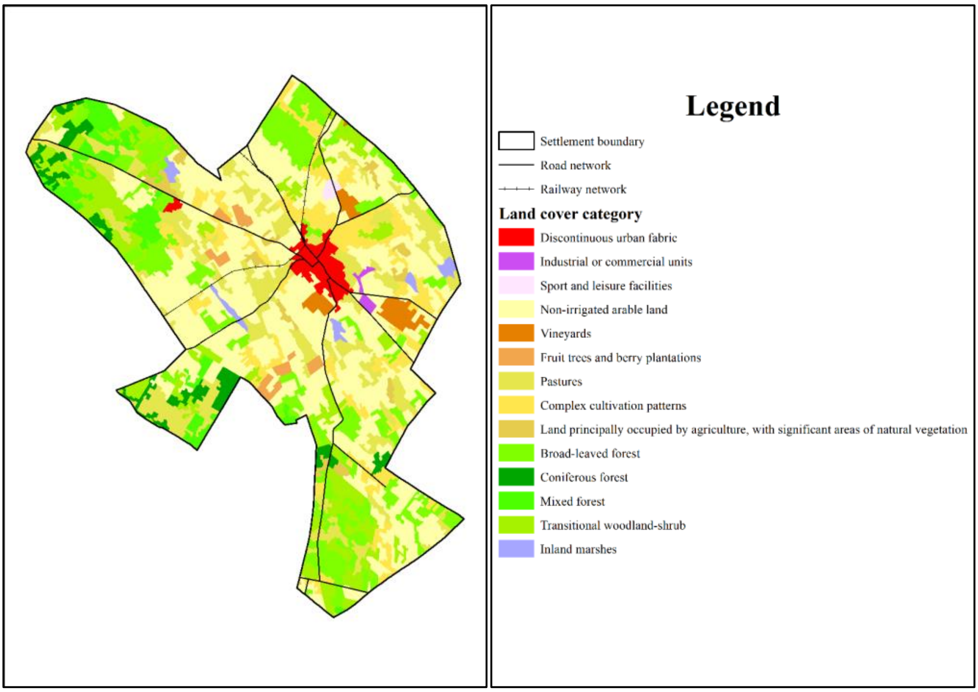

Figure 7: The landcover of Kiskunmajsa in 2018

The CORINE database is updated every six years, with the latest version being in 2018. However, based on orthophotos and satellite imagery, the land cover change is measurable in the years after 2008. The change in forest cover in the North-West area of Kiskunmajsa using five-day return time Sentinel-2 satellite images was presented as an example. The afforestation area changes are depicted on a hectare scale based on RGB and NDVI recordings. The areas marked in Figure 8 are parcels affected by logging.

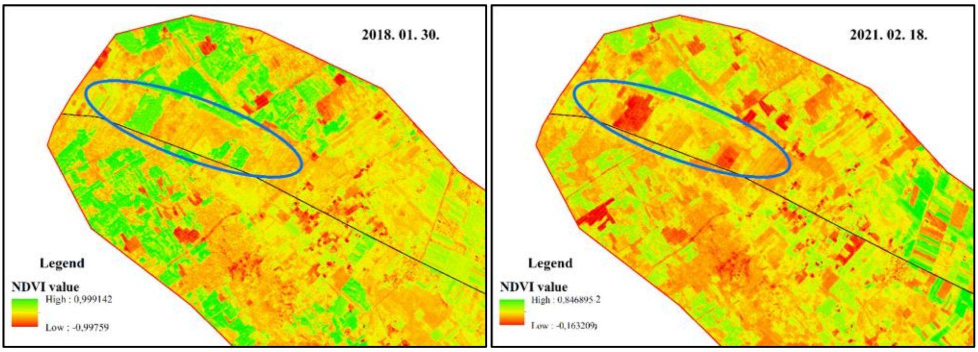

Figure 8: NDVI data from the North-Western edge of Kiskunmajsa

The growth of the forest surface is primarily due to the poor conditions of the given area. For this reason, the dysfunctional large-scale arable farming was replaced by afforestation, financed by the agricultural support system and the common agricultural policy subsidies.

Furthermore, I carried out a detailed investigation of the land cover in five rather heterogeneous sample areas, three of which are typically agricultural (Tajó, Aranyhegy, and Kígyós), and two are forested areas close to nature (Bodoglár and Ötfa). Among the agricultural regions, Tajó is a wetland, while Aranyhegy and Kígyós are arid areas. In terms of ecological network involvement, the area of Bodoglár and Tajó occupies an outstanding, Kígyós an intermediate position. At the same time, Ötfa and Aranyhegy are not affected.

For the five sample areas, I illustrated the spatial location of farms from the 1860s to 2016 with the help of map files. As a result of detailed data processing, I numerically provided each sample area's CLC2018 land cover values per category (Table 5).

Table 5: Surface coverage of sample areas in Kiskunmajsa based on CLC2018, in %

Standard 3. level	Bodoglár	Ötfa	Tajó	Aranyhegy	Kígyós
Non-irrigated arable land (2.1.1.)	0.5	6.1	59.6	27.0	60.8
Vineyard (2.2.1.)				60.6	
Pastures (2.3.1.)	12.2		30.1		5.9
Complex cultivation patterns (2.4.2.)		23.1	0.5	5.6	16.3
Broad-leaved forest (3.1.1.)	2.2	68.6	2.3		7.2
Cofireous forest (3.1.2.)	8.6			0.1	
Mixed forest (3.1.3.)	18.2				
Transitional woodland/shrub (3.2.4.)	58.3	2.2		6.7	9.8
Inland marshes (4.1.1.)			7.3		

Furthermore, applying the Land Parcel Identification System, I depicted the ecological corridors and core areas belonging to the sample areas. I also provided the involvement of the High Nature Value Land, and the degree of supportability. Almost 50% of the Tajo sample area is part of the Ecological Network, including the arable marsh already recorded on the cadastral map, as it is shown in Figure 9.

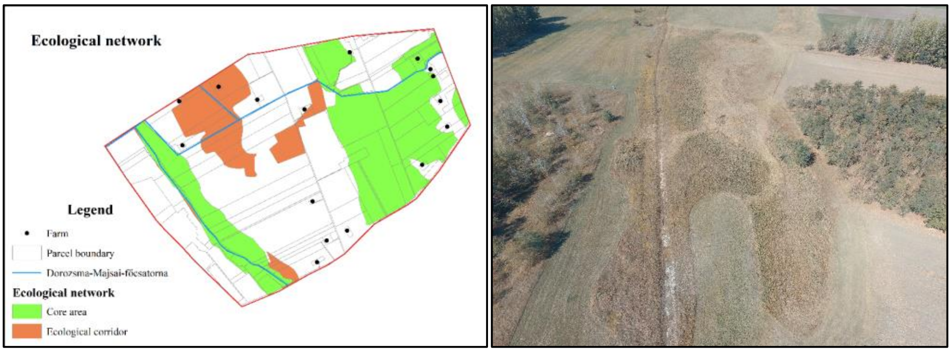

Figure 9: Ecological network involvement of the Tajo sample area, drone footage of the inland marsh

It should be emphasized that the (zoning) nature conservation programs related to the Rural Development Program for 2014-2020 prioritize areas of high natural value, encouraging local farmers to develop and maintain nature-friendly farming practices.

Examining the basic infrastructural situation of the farms in the sample area, I found that the supply of wired electricity is generally reasonable. Only three farms in Bodoglar do not have electricity, and four other farms are connected to the network by private wires. However, there is no piped drinking water network, and water quality problems have been reported in six drilled wells belonging to the homesteads. It is critical for the quality of water resources that wastewater enters the soil in an environmentally polluting way everywhere except one farm. Furthermore, while the road accessibility of Tajó and Aranyhegy is good, in the case of Kígyós, the travel time is over 30 minutes.

Homesteads stand alone with the smallest average economic area (25 ha) in the Bodoglár sample area. On the other hand, the proportion of regions cultivated around a given farm is the highest in Kígyós (66.6%), in connection with the high farm density. The homesteads with the largest farming area (58.3 ha) are around Tajó (Table 6).

Table 6: Some characteristics features of the farmsteads by sample area

Sample areas	Area ratio (%)	Floor area (m^2)	Farm area (ha)
Bodoglár	0	69.2	25
Ötfa	4.2	79.3	36.7
Tajó	24.7	75	58.3
Kígyós	66.6	73.3	37.1

Area ratio: cultivated areas around the farmstead, floor area: the floor area of the farms' residential building, farm area: the total area of farming.

Finally, the residential building distribution according to their construction time was tabulated. It is worth mentioning that, within the Ötfa area, 18% of the homesteads build after 1990, and every third of the existing 34 homesteads functions as a hobby farm.

3.4. Spatial arrangement and surface coverage of Felsőlajos farms

The spatial arrangement changes of the farms in Felsőlajos were presented with the help of maps, aerial photographs, and orthophotos between 1941 and 2019. The gradual incorporation of the inner area of the settlement was followed by aerial photos showing the elimination of the orchards and, in parallel, the designation of new streets.

In the first step, I determined the land cover of the settlement based on the CORINE stocks. According to Table 7. two opposing processes can be seen. On the one hand, during the nearly three decades studied – typically in the northern and southern areas of the settlement – the proportion of forests increased significantly by 177.3 ha. But conversely, at the same time, the size of diverse agricultural areas decreased by 147.5 ha.

Table 7: Changes in Felsőlajos land cover between 1990 and 2018

Artificial Surfaces	CLC1990		CLC2000		CLC2006		CLC2012		CLC2018	
	ha	*%*	*ha*	*%*	*ha*	*%*	*ha*	*%*	*ha*	*%*
Artificial surfaces	59.8	*5.2*	59.8	*5.2*	59.8	*5.2*	59.8	*5.2*	59.8	*5.2*
Arable land	452.5	*39.6*	506.2	*44.2*	467.3	*40.8*	467.3	*40.8*	374.5	*32.7*
Permanent crops	1.5	*0.1*	1.5	*0.1*	1.7	*0.1*	1.7	*0.1*	10.1	*0.9*
Grassland	118.5	*10.3*	106.2	*9.3*	96.5	*8.5*	96.5	*8.4*	158.1	*13.8*
Heterogenous agricultural areas	429.0	*37.4*	387.6	*33.8*	359.7	*31.4*	359.8	*31.4*	281.5	*24.6*
Forest	84.1	*7.3*	84.1	*7.3*	160.4	*14.0*	160.4	*14.0*	261.4	*22.8*
Sum	**1,145.4**	***100***	**1,145.4**	***100***	**1,145.4**	***100***	**1,145.4**	***100***	**1,145.4**	***100***

According to the stability map, 340 ha (a total of 1,147 ha) Felsőlajos area was affected by the land cover change between 1990 and 2018 (Figure 10).

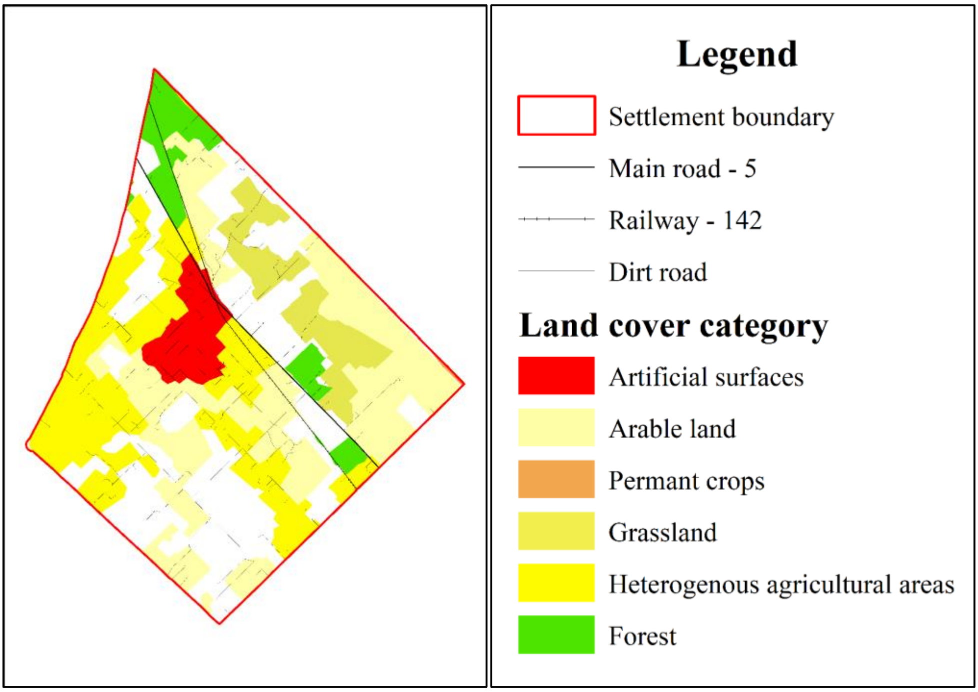

Figure 10: Stability map of Felsőlajos surface cover based on CLC100 databases

Considering that the CORINE databases are not suitable for detailed comparative land cover studies, the surface cover categories were digitized using visual interpretation in a 1:1,000 scale from 1961 aerial photographs and 2000 and 2019 orthophotos to achieve a more detailed surface cover change. In the case of uncategorizable areas on the 2019 orthophotos, a correction was made using the drone survey of 2016 and 2018. In addition, I determined the land cover categories using the digitization of a 1:10,000 scale civil topographic map made between 1976 and 1980.

According to results, in the six decades affected by processing, the proportion of artificial surfaces and forest areas has increased steadily (from 1.5 to 7.5% and 6.5% to 33%, respectively). The extent of orchards decreased from 419.5 ha to 19.7 ha. Examining the changes in the wetlands, the total 190 ha of permanent water surfaces and marshy parts depicted on the Second Military Survey to date has fallen to a third of its previous value (Figure 11). At the same time, the remaining wetlands show a good agreement with the core area and ecological corridor parts of the ecological network to be sampled.

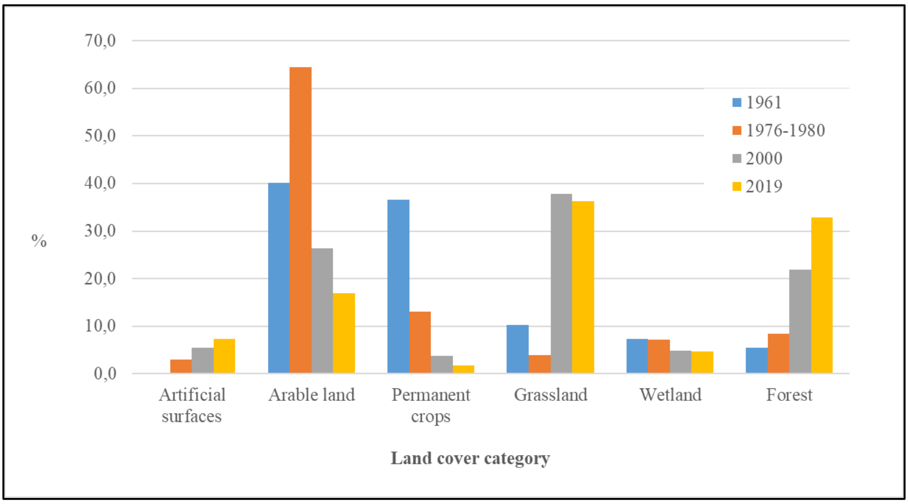

Figure 11: Change in Felsőlajos surface cover between 1961 and 2019, as a percentage of the total area

Finally, a comparative land cover study in the 38.7 ha area of SW Felsőlajos was performed. I investigated three farms using a 10 m resolution Sentinel-2 satellite image taken in August 2018, the 2019 state orthophoto stock with a resolution of 40 cm, and orthomosaics from drone images with a resolution of 4 cm/pixel.

On the orthomosaics of the drone survey – considered a benchmark – the wood-covered surface is 10.4 ha, determined by unsupervised classification. Compared to this, the relevant values of Sentinel-2 and 2019 orthophotos taken from the area are 12.18 and 13.08 ha, respectively. Compared to the standard orthomosaics with cm resolution, the prediction based on satellite imagery and orthophotos results in a larger woody surface due to the weaker geometric resolution (Figure 12).

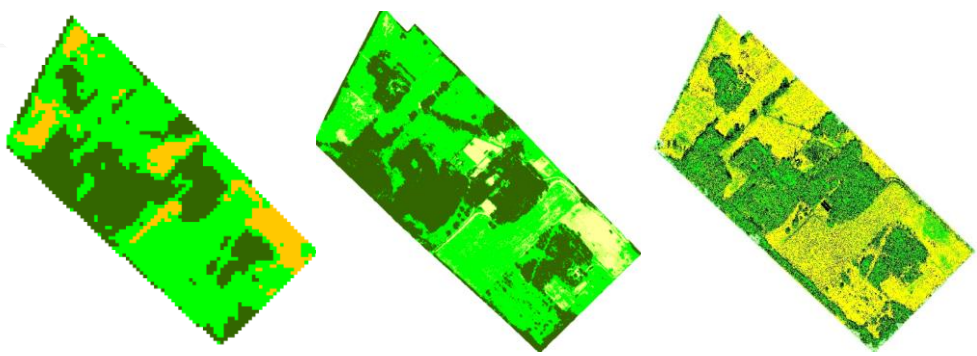

Figure 12: The forest coverage of the Felsőlajos sample area
(Sentinel-2, 2015 ortophoto, ortomosaics)

In summary, the available public databases for farms are inaccurate in several aspects, difficult to compare, and thus require correction. However, based on the developed geospatial databases, I illustrated through specific examples that the combined use of remote sensing and geospatial methods provides a new opportunity to study farmsteads' geographical layouts and temporal changes. The chosen methodology was suitable for characterizing the changes in the settlement structure and land use of the farmstead areas in the case of two sample areas of Homokhátság.

4. CONCLUSIONS AND RECOMMENDATIONS

Evaluating the research results related to farmsteads and their comparison is made significantly more difficult by the different definitions. The 2016 Farm Survey defines a farmstead as a plot of land on the outskirts of the settlement with a maximum size of 1 ha. However, it also considers those parcels of land which belong to this category in the real estate register. For this reason, even farms over 50 ha are listed as homesteads in the records. The further problem is that the available public databases contain significantly different data, even at the county level. The question of the population living on the farm is similarly problematic since the Hungarian Central Statistical Office has been publishing population numbers in rural areas since the 1990 census. The latter category includes, in addition to farmsteads, other inhabited places in the outskirts, so it is difficult to obtain accurate data on the homestead population.

As a first step, the concept of the homestead should be clearly defined. Then, to resolve uncertainties, it is justified to create an unified database for the entire Great Plain, with updates at specific intervals (5-10 years). In addition, it would be helpful to create sample areas and conduct surveys on them every 2-3 years using an uniform methodology. Successful completion of these surveys requires properly trained surveyors and an advanced IT background. On the other hand, well-structured and standardized databases, such as the 2013 model project in Gyula, can provide information that can be used in many areas (operating community service, determining support target areas, and assessing the effectiveness of tenders).

I think the content and structure of the geospatial database I compiled for Kiskunmajsa and Felsőlajos – two distinct farmstead areas of Bács-Kiskun County – are suitable for displaying short- and medium-term changes at farm and settlement levels.

The regularly repeated surveys are justifiable because, during the 2014-2020 programming period of the Farm Development Program, both individual farmsteads and local governments are among the supported with an amount of nearly 11 billion. As a result of the subsidies, significant infrastructural developments took place. At the same time, the expansion of the electricity network and piped water supply, as well as the maintenance of roads in the outlying areas, directly affect the operation of the farmsteads.

Simultaneously, frequent changes in the support type for the agricultural sector are a problem in the sample areas and, more broadly, in the whole of the Homokhátság. After the regime change, the cultivation of grape and fruit plantations typical of the area was first abandoned. Then in the 1990s, their restoration was supported through refundable, area-based, or direct subsidies. The latter sources ceased after the accession to the EU, resulting in forestation in place of the plantations. This constantly changing support system contradicts the sustainability aspects that are increasingly important nowadays.

The increase in the role of organic farming also deserves attention, along with the announcement of tenders for environmental protection, which are also beneficial for applicants engaged in agricultural activities.

The primary goal of the 2016 homestead survey was to determine the exact geographic coordinates of individual Great Plain homesteads. Unfortunately, due to the measurement inaccuracies of the surveyors, the proportion of incorrect coordinates in the database is approximately 3%. At the same time, the erroneous GPS positions are correctable later based on the available orthophotos and KÜVET files.

With the help of increasingly advanced image processing techniques, the identification process and the tracking of changes over time (appearance of a new building, closure of an existing one) can be progressively automated. At the same time, the available geospatial software makes it possible to display the economic area belonging to the given farmstead, to follow the utilization method or the change of ownership. These tools provide an excellent opportunity to follow land cover changes and describe related trends.

First, based on the evaluation of the 2016 farm survey, I recommend a thorough review of the question lists. Furthermore, it would be advisable to insert the publicly available data (electrical network, water utilities, paved roads) and the GPS coordinates of the farmsteads directly into the database before starting the current survey. According to my experience, the answers to these questions are error-laden in a significant proportion. For example, in the case of the distance between the land registry boundary of the homestead and the public electricity network, the respondents generally overestimated it. At the same time, doubts may also arise with other thematic groups of questions (state of the natural environment around the farm, data on farming), where it is difficult to solve without reliable databases to check the answers.

The interviewees gave uncertain answers to the questions regarding the nature conservation implications of the farm area, such as precious areas, as in the case of the Bodoglár bucks. In connection with this, the counter-interest that can be detected more and more often concerning nature and tourism aspects should be highlighted. As long as many ecotourists do not threaten the protected environment of Kiskunmajsa, some areas are already in danger.

From an environmental point of view, the whole Homokhátság, including the two sample areas, is classified as a semi-desert zone by the World Wildlife Fund. The quality of life of the area's population is directly affected by problems related to water management. In the sample areas affected by my investigations (Bodoglár, Ötfa, Kígyó, Tajó), the piped water supply is low, and the wastewater enters the soil in an environmentally polluting way. Mitigating the situation (slowing down unfavorable processes) can be imagined in the medium term with the help of targeted projects.

The government treats the complete electrification of farms – in addition to access by road – as a priority task. Accordingly, during the farm survey, they tried to assess the electricity supply in detail, asking about the electricity-generating equipment operating on the farm and the use of renewable energies. At the same time, only 41% of the questionnaires contained answers to these questions, presumably due to the highly detailed questions, which sometimes assumed technical knowledge. However, the missing information does not prevent the necessary network upgrades since Lechner Knowledge Center manages the EHK system containing up-to-date data.

The historical maps (especially military surveys), aerial photos from the 50s, satellite images from the 70s, and digital orthophoto files from the 2000s I use are suitable for settlement morphological studies. At the same time, the accuracy of map files can and should be improved using ground control points.

In my investigations, I used density maps to identify the areas with the most significant change in the number of farms between given dates. Then, with a similar logic, I represented the areas where the surface cover proved to be constant within a given period on a stability map. Both approximations are suitable for selecting the areas most affected by the change, the inclusion of which is particularly justified in the previously proposed periodical surveys by sample area.

My results pointed out that different forms of development in geographically similar areas can result in significantly different settlement patterns. These processes are easily monitored even after the regime change. In the example of Kiskunmajsa, the differences between the outer settlement parts can be explained by infrastructural differences, such as the quality of the road network - characterized by my accessibility test. The change in land use shown in the example of Ötfa, when the establishment of the thermal bath resulted in a significant increase in the number of hobbity farms, also had a considerable impact. It is also worth highlighting the change in the size of the estate (the termination of the Tajó State Farm) and its influence on agricultural activity. Typically, some effects reinforce each other. In an example of Kígyós, the active population migrates due to the road accessibility over 30 minutes from the center and the lack of public utilities and essential services. Parallel to this, the image of the outskirts changes significantly. Farms support the importance of a road network of adequate quality located not nearby the Ötfa thermal bath but along the roads established by Mol Group were turned into holiday farms. However, there is a close relationship between the availability and settlement development concerning road accessibility as a service level. Therefore, good traffic conditions are reflected in society's value judgment and, thus, also in current land prices.

The two sample areas are unaffected by suburbanization processes. No signs of the so-called gentrification process can be detected. The number of permanent residents is the lowest in the Ötfa area affected by hobby farms, considering the whole of Kiskunmajsa. The farm owners use their property periodically, typically for recreational purposes.

With the help of the freely available CORINE files, the surface cover changes are quantifiable. However, the files' resolution (1:100,000 or 1:50,000) and the six-year update time must be considered. An alternative option is the freely available multispectral satellite images, which have high geometry resolution (up to 10 m) and a frequent return time (up to 10 days). The ESA's Copernicus program should be highlighted, which provides free access to the Sentinel satellites' images and ensures the possibility of processing them with the SNAP software. At the current level of satellite technology, images with a resolution of 40 cm/pixel are commercially available (this resolution is the same as that of the national orthophotos prepared every third year). Launching the new EnMAP hyperspectral sensor will significantly improve the spectral resolution.

Based on my results and the literature, the land cover of Kiskunmajsa has changed significantly between 1990 and 2018, but at the same time, it has retained its mosaic of landscape use. This allows the creation of land use that better matches the ecological features, which also ensures a sustainable farm management system. At the same time, targeted measures are justified to deal with unique problems, such as eliminating goose farming, which puts a heavy burden on the environment.

Between 1961 and 2019, 29% of the area of Felsőlajos has seen a change in land cover, with decreasing mosaicism. It can be concluded that the time-dependent changes in the number of farms and their management conditions are dissimilar in different areas of the Great Plain. While on the Tiszántúl, the farms lost the land needed for farming due to the development of large-field arable crops, on the Homokhátság, the different land use slowed down the process. One of the tools for this was the cooperative functioning typical of Felsölajos, where the holding became a member farm, sometimes creating an integrated backyard farm of considerable size.

The permanent water surfaces and swampy areas previously characteristic of the sample area in Felsőlajos have been significantly reduced. The preservation of the current environmental conditions – significant from a nature conservation point of view – is ensured by the parts of the ecological network classified as core areas and corridors. If the goal is a detailed description of such wetlands, the resolution of the available CORINE files is insufficient.

Using the possibilities of drone technology, I created an orthomosaic of a part of Felsőlajos settlement with a field resolution of 4 cm/pixel, which is an order of magnitude better than the state orthophotos. This richness of detail is also sufficient for precision agricultural applications. In addition, the surface cover values calculated from the orthomosaics can be considered a benchmark compared to those determined by my visual interpretation of the orthophotos and those calculated from Sentinel-2 satellite images and CORINE files.

In the last decade, the number of freely available digitized data files related to the subject of the thesis has continuously increased, and their information content has expanded. During the compilation of my thesis, among others, I used the Mapire, CORINE, Land Parcel Identification System, National Regional Development and Spatial Planning Information System, Inspire, KÜVET, National Ecological Network files, archival aerial photographs, topographic maps, orthophotos, and Sentinel-2 satellite images. Similarly, the available open-source, often platform-independent GIS software is also expanding. Based on the latter, regional community projects can also be implemented cost-effectively. At the same time, such initiatives should be supported by a circle of experts with specific knowledge. It would also be helpful to provide targeted training to the affected group, including the public service staff.

Based on my own experience in the sample area of Kiskunmajsa and Felsőlajos, the integrated use of available data files, remote sensing methods, and GIS software open up new opportunities for detailed analysis of farmstead settlements. In my opinion, my results can contribute to creating surveys with an uniform methodology, and through this, to creating databases for farmsteads. Furthermore, adequately structured databases are equally helpful for government agencies that call for tenders, local governments, and owners of individual farms.

5. NEW SCIENTIFIC RESULTS

I proved that the available public databases for farmsteads could not be compared; they need significant additions and corrections. In addition, due to the lack of a uniform farmstead definition and data on population, the number of farmsteads within a given county or settlement can differ by order of magnitude from database to database.

I processed in detail the answers to the 2016 Great Plain farmstead survey questions, which can be classified into eight thematic units. Based on these, nearly 80% of the farmsteads are permanently inhabited, 12% are uninhabited, and a significant part of the latter have some economic function. Most farms (58%) produce exclusively for their consumption; that is, they do not sell their products on the market. However, 23% of the farms sell the surplus above their consumption, and 19% produce primarily for sales purposes.

I created an index value based on the farmstead's infrastructural supply (electricity, water, gas), which proved suitable for presenting regional differences. For Bács-Kiskun county, the proportion of farmsteads classified as unfavorable, average, and favorable: is 2.4, 72.3, and 25.3%, respectively.

I developed a method to correct the geographical coordinates inaccurately recorded in the 2016 farmstead survey in the case of Kiskunmajsa as a sample settlement. Based on the visual interpretation of topographic maps, orthophotos, and data from the Kiskunmajsa micro-regional farm development program, I created a reference data file containing 1,138 farms with corrected GPS coordinates. The procedure is also suitable for the correction of other public databases.

Using the combined use of remote sensing and geospatial information methods, I presented the geographical arrangement and temporal changes of the farmsteads of Kiskunmajsa and Felsőlajos based on the file geodatabase type databases I compiled. In the case of Kiskunmajsa, I identified 131, 602, 1,554, 1,353, and 1,138 farmsteads based on the I. and II. military survey, the military topographic map of 1950, the 1989-1994 map, and the reference data. I also identified the hobby farms (n=77) that appeared in close connection with the change of function of the farmsteads, which are typically located in the vicinity of the Ötfa thermal bath.

Based on the infrastructural characteristics, I arranged the farms of Kiskunmajsa into groups. As a result of the cluster analysis, the commodity-producing farms representing 2.7% of the total sample proved easily distinguishable. They produce most local agricultural products by cultivating 35% of the area under investigation.

I described the changes in the land cover of the two sample areas using remote sensing and GIS methods. In the case of Felsőlajos, compared to the available CORINE files, I achieved a significantly more detailed resolution based on the aerial photographs, orthophotos, and topographic maps I digitized and visually interpreted at a scale of 1:1,000 between 1961 and 2019. In the six decades examined, I found that the proportion of artificial surfaces and forest areas increased continuously (from 1.5% to 7.5% and from 6.5% to 33%, respectively). The size of orchards decreased from 419.5 ha to 19.7 ha.

6. PUBLICATIONS CONNECTED WITH THE SUBJECT OF DISSERTATION

Articles published in scientific journals in foreign language

- Szabó M., Pap-Szuromi O., Romvári R. (2018): Preliminary results of a farmstead survey of the Great Hungarian Plain, Regional Statistics 8 (2), pp. 92-108.
- Romvári R., Szakáli I. L., Nyárai O. (2017): Development possibilities as part of the Farmstead Development Program, Hungarian Agricultural Research, 26 (4), pp. 5-9.
- Romvári R. (2017): Applicability of drones in agriculture and farmstead management, Hungarian Agricultural Research, 26 (1), pp. 20-24.

Articles published in scientific journals in Hungarian language

- Romvári R. (2019): A drón- és a GIS technológia településmorfológiai alkalmazása az Abaúji térségben, Észak-Magyarországi Stratégiai Füzetek 16 (2), pp. 51-61.
- Dobai R., Fokti K., Kontur T., Matus L., Pap-Szuromi O., Romvári R. (2018): A magyar tanyák és a Tanyafejlesztési Program 2011-2016, Földművelésügyi Minisztérium Budapest, p. 90.
- Romvári R., Szikora A., Pap-Szuromi O. (2018): Nemzeti vidékfejlesztési programok eredményei és aktualitásai - a Tanyafejlesztési Program és a Zártkerti Program, Falu Város Régió, pp. 156-194.
- Romvári R., Pap-Szuromi O. (2018): Tanyafelmérések tanulságai, A Falu XXXIII. évf. 3. sz., pp. 9-20.
- Romvári R. (2017): Változások a tanyák szerepében, A Falu, XXXII. évf. 2. sz., pp. 67-76.
- Romvári R. (2016): A Tanyafejlesztési Program nyertes tanyagazdaságai, A Falu, XXXI. évf. 1. sz., pp. 29-36.
- Romvári R. (2014): A magyar tanyavilág villamosítása, A Falu, XXIX. évf. 4. sz., pp. 77-86.
- Romvári R. (2014): A Tanyafejlesztési Programok eredményei, A Falu, XXIX. évf. 1. sz., pp. 51-59.

Presentations held at scientific conferences in foreign language and published in conference proceedings

- Romvári R. (2018): Analysis of the surface coverage of a settlement in the Great Plain using the GIS methodology, VII. Interdiszciplináris Doktorandusz Konferencia, Pécs, p. 183.
- Romvári R. (2018): Investigating the transformation of traditional farmstead functions, VII. Interdiszciplináris Doktorandusz Konferencia, Pécs, p. 184.
- Romvári R. (2017): The use of drone technology in farmstead management, VI. Interdiszciplináris Doktorandusz Konferencia, Pécs, p. 175.

Presentations held at scientific conferences in Hungarian language and published in conference proceedings

- Romvári R. (2017): Távérzékelési- és térinformatikai módszerek alkalmazása a kiskunmajsai szórványok térbeli elrendeződésének vizsgálatára, VI. Interdiszciplináris Doktorandusz Konferencia, Pécs, p. 163.
- Romvári R. (2016): Tanyasi gazdaságok szerepének változása Bács-Kiskun megye példáján, In: Pajtókné Tari, Ilona; Tóth, Antal (szerk.) Magyar Földrajzi Napok 2016 konferenciakötet: VIII. Magyar Földrajzi Konferencia, XVI. Geográfus Doktoranduszok Országos Konferenciája, Oktatás-módszertani és Földrajztanári Konferencia, Eger, pp. 775-780.
- Romvári R. (2015): A Tanyafejlesztési Programok infrastruktúra fejlesztésre gyakorolt hatásainak vizsgálata, IV. Interdiszciplináris Doktorandusz Konferencia, Pécs, p. 76.

Chapter in scientific book in Hungarian language

- Romvári R. (2016): Az Alföld tanyás térségeinek fejlődése 1960 és 2011 között, In: Tájak, régiók, települések térben és időben, Dialóg Campus Kiadó, Budapest, pp. 365-374.