

Historical land use changes between 1848 and 2016: Case study of two selected villages in Małopolska

Barbara PRUS¹, Kinga ULICKA², Stanisław BACIOR³

¹ University of Agriculture in Krakow, Faculty of Environmental Engineering and Land Surveying, Department of Spatial Management and Landscape Architecture; email: barbara.prus@urk.edu.pl

² Graduate of Faculty of Environmental Engineering and Land Surveying, course of Geodesy and Cartography

³ University of Agriculture in Krakow, Faculty of Environmental Engineering and Land Surveying, Department of Agricultural Land Surveying, Cadastre and Photogrammetry

1. Introduction

Land uses change as a result of consecutive reorganization of the land in order to adapt it to the changing social demands (Antrop 2005). In some places urban function was preferred and in the other locations the attention was drawn to the agriculture (Kabrda 2004). Changes in land use in selected countries, regions and localities are the subject of numerous studies and analyses carried out in Poland (Bielecka 1969; Poławski 2009; Ciołkosz, Poławski 2006), Central Europe (Bičík et al. 2001; Bičík, Jeleček 2003; Bičík et al. 2012; Gabrovec et al. 2001; Krausmann 2006) and also in the world (Agbola et al. 2014).

At the area of Europe, historical surveys of use changes are based, among other things, on the cartographic part of so called Franciscan Cadastre (Harvey et al. 2014) created in the first half of the 19th century for the area of the Austrian Monarchy and then the Austro-Hungarian Empire (Lisek, Navratil 2014).

Archival maps of the Austrian cadastre are the valuable source of information about land use. Nevertheless, it is important to remember that information read from cartographic elaborations are secondary data which means that they are not an ideal reflection of the existing state but only the interpretation of a cartographer who was preparing a map. So the image of reality would be the model adapted for obligatory mapping within a specific time, map's purpose and also the one which considers the reference system used in a specific place and time. The measurement method was a key element in the range of maps' accuracy as well (Affek 2012).

The land tax cadastre accomplished in the territory of the Austro-Hungarian Empire on Polish grounds as well as in Galicia has extensive use in equipment and agricultural works, scientific surveys (Wolski 2000) and also as the source of economic history of Galicia (Styś 1932/33; Wydro 1967; Wolski 2001). Galicia was the region where in mid-19th century Austrian authorities granted property rights of all previous land users which resulted in visible structure fragmentation of plots and farms (Poławski 2009). This state was intensified by traditional land distribution between all children and chronic over-population (Baran-Zgłobicka, Zgłobicki 2012). In the whole area of Galicia the number of population increased from 4.8 mln in 1822 to 7.8 mln in 1900 (Davies 2010).

Studies and analyses of the way of land use in the first half of the 19th century point out that Galicia is mostly an agricultural region as the arable lands which in 1842 composed 43.1% of all farmlands held the greatest share. In the next seven decades, proportion of arable lands increased by 5.4% at the expense of forests the share of which decreased from 31.5% in 1842 to 25.7% in 1913 (Poławski 2009). Małopolska is a region where

in last decades diverse spatial structure of rural areas (Janus et al. 2016; Woch, Borek 2015; Baran-Zgłobicka, Zgłobicki 2012), dynamic changes in land use (Poławski 2009) especially within farmlands, forests, urbanised areas and wastelands (Noszczyk et al. 2017) and also spatial differentiation of anthropogenic impact can be observed (Cegielska et al. 2017).

2. Objectives

The analysis of land use change was performed in two places located at the area that belongs to the historical region of Galicia and Lodomeria Kingdom. The objects accepted for research – Kryspinów and Kaszów – are two locations situated in close proximity of Krakow on its western side and situated in Krakow district, the commune of Liszki. The locations were chosen so as to be situated in more and more distant zones from Krakow city (Fig. 1). The analysis of two objects located peripherally to Krakow allowed to research the change rate of land cover over 168 years as well as test evaluation of distance to Krakow at the direction and dynamics of changes of land use at agricultural areas. The first of analysed objects included the cadastral commune of Kryspinów.

At present, this place adjoins directly to Krakow. The distance of the second research object – Kaszów location – is 6 km counting from the current western administrative borders of Krakow city. Until recently, agricultural crops produced at the area of the two mentioned places were satisfying the needs of not only local communities but they were also transported to Krakow and sold there on market places. The technical progress, possibilities to gain goods from distant place and, from the other hand, the increase of demand for building space influenced the changes in land use in the vicinity of city agglomerations (Gonda-Soroczyńska 2009) and also in peripheral zones of Krakow.



Fig. 1 – Location of research objects in relation to Krakow.

3. Methodology

The typical mosaic landscape of Polish areas which were used agriculturally at the area of former Galicia is difficult to be analysed in case of tools and techniques based on the analytical methods which are subject to considerable generalisations. It happens, for example, in case of the analysis of land cover on the basis of Corine Land Cover data that take 100 meter pixel raster images as the basis for surveys (Ciołkosz, Bielecka 2005). More detailed although time-consuming analyses provide better results (Sauer 1941; Tuan 1976). Historical cadastral materials can provide the means to study land use changes (Harvey et al. 2014).

The analysis of changes in land use consisted in comparing the area occupied by particular farmlands noted in historical cartographic materials elaborated within the Franciscan Cadastre at the area of the former Austro-Hungarian Empire and current area of farmlands provided by Databases of Topographic Objects, so called BDOT10k. It was possible because the Austro-Hungarian cadastral maps are similar or comparable to newer sources (Harvey et al. 2014).

Information about the historical way of land use were collected on the basis of chromatic maps of the Austrian cadastre, so called Viennese gained from the National Archive in Krakow. Franciscan cadastral maps remain a detailed source of historical information about landscape structure in 19th and 20th centuries (Harvey et al. 2014). They covered the entire Austro-Hungarian Empire (Kain, Baigent 1992) which was an area of more than 500,000 square kilometers (Krausmann 2003). When not destroyed, the cadastral maps provide opportunities for historical and geographical analysis of land use change in many countries including Poland, the Czech Republic, Slovakia, Austria, Hungary, Ukraine, Romania, Slovenia, Croatia or Serbia (Heine et al. 2002; Gabrovec, Petek 2003).

The obtained scans of cadastral maps for the places were calibrated and then target coordinate system was specified and lots' vectorization was performed determining their number and the kind of land use for each of them. 4,400 objects (plots) for Kaszów and 1,335 objects (plots) for Kryspinów were obtained during vectorization. Definitions of farmlands (with the key) were accepted according to the guidelines of the Instruction prepared to perform cadastral maps at the area of Austro-Hungary (Instrukcja 1824). The layers from vectorization were checked in terms of topology correctness. The prepared layers served for realization of analyses and spatial questions. Both the calibration and spatial analyses were performed in QGIS 2.14.3 Essen programme. The state of land use in 2016 was obtained from the Databases of Topographic Objects on the basis of farmlands classification according to the Regulation on lands and buildings register (Rozporządzenie 2001). The layers downloaded to QGIS programme also served as the basis for spatial questions and matrix products.

Geographic Information System allows to collect, keep and analyse and manage data together with their spatial reference. More broadly, GIS can be understood as the research method where the computer system is only a tool. More narrowly, GIS can be considered as a tool which allows to enter data, to browse them and also a spatial analysis (Wnęk 2010). Spatial analyses performed in the paper consisted in transforming output data sets i.e. summation, subtraction, multiplication, data aggregation, multi-thematic analyses as well as creating questions that allow to choose areas of interacting fields (Prus 2014). Nowadays, GIS is applicable in various fields of science (Gotlib et al. 2007) including geographic and historical analyses (Leszczyńska 2010). Distinguished Historical GIS (in short: HGIS) as the

interdisciplinary research approach includes issues from the range of geo-information, historical geography and geo-ecology. The research subject of HGIS are, among other things changes of land use or problems of spatial economy (Kuraś 2007), reconstructing historical administrative borders and landscape studies (Affek 2012).

4. Results of the analysis and discussion

4.1 Cadastral municipality of Kaszów

Kaszów is a village located in the southern part of Poland in Krakow district, Liszki commune. The beginnings of its establishing trace back to the 12th century. This village is situated in the basin of Sanka river on the southern edge of the Jurassic National Park. The hill in the northern part of the village reaches 263 m a.s.l. Till now, the place is characterized by the linear settlement type whereas the main road coincides historically with the road from Krakow to Silesia. At the end of the 19th century, there were 922 Austrian morgens of the arable land, 227 morgens of grasslands and orchards, 277 morgens of pastures and 20 morgens of forest in the village. In 1869, there were 250 cottages in Kaszów inhabited by 1,401 people. During the following years, the number of people was rising systematically achieving 1,523 inhabitants already in 1880 (Słownik, Tom III, s. 902).

Comparing the course of borders as well as the area of Kaszów in 1848 and today, it is apparent that place decreased by about 23 ha. The grounds that belonged yet in the mid-19th century to Kaszów were attached to Liszki place. This area was described questionable while preparing the map of Franciscan cadastre.

Kaszów is a typical agricultural place as evidenced both by historical surveys and the analysis of current structure of land use (Tab. 1). In 1848, the area of arable lands was 529.2575 ha which was 61.77% of the place's area. At present, the arable lands constitute 62.45% of the analysed area which means the increase of the agricultural area. An unfavourable phenomenon from the agricultural point of view is a very fragmented structure of ground plots. This situation took place already in mid-19th century. The relation of lengths and widths of plots' sides was unfavourable and amounted to 1:30. As can be seen, this state lasted until present times. The analysis of green spaces revealed slight decrease of their area in relation to the state from before 168 years, mainly in the range of grasslands. In 1848, pastures

Tab. 1 – Land use in Kaszów in 1848 and 2016.

	1848		2016	
	ha	percentage	ha	percentage
Built-up areas	6.5485	0.76	116.8615	13.67
Sports facilities	–	–	0.8794	0.10
Forests	11.5912	1.35	16.0736	1.18
Wooded and shrubby lands	–	–	57.5175	6.72
Pastures	160.1183	18.69	110.5464	12.91
Grasslands	129.6899	15.13	3.1572	0.37
Arable lands	529.2575	61.77	535.0058	62.45
Wastelands	0.0534	0.01	1.2393	0.14
Roads	18.5185	2.16	14.4041	1.70
Floating waters	0.0844	0.01	0.5528	0.06
Still waters	0.5907	0.07	–	–
Orchards	0.4468	0.05	–	–
Total	856.8992	100%	856.2376	100%

Data source: Maps of Franciscan cadastre for the cadastral commune of Kaszów prepared in 1848; for 2016, the Database of Topographic Objects (BDOT10k) was the source of data.



Fig.2 – Contemporary orthophoto of Kaszów settlement from 2016.
Source: Own study based on Geoportal (www.geoportal.stat.gov.pl).

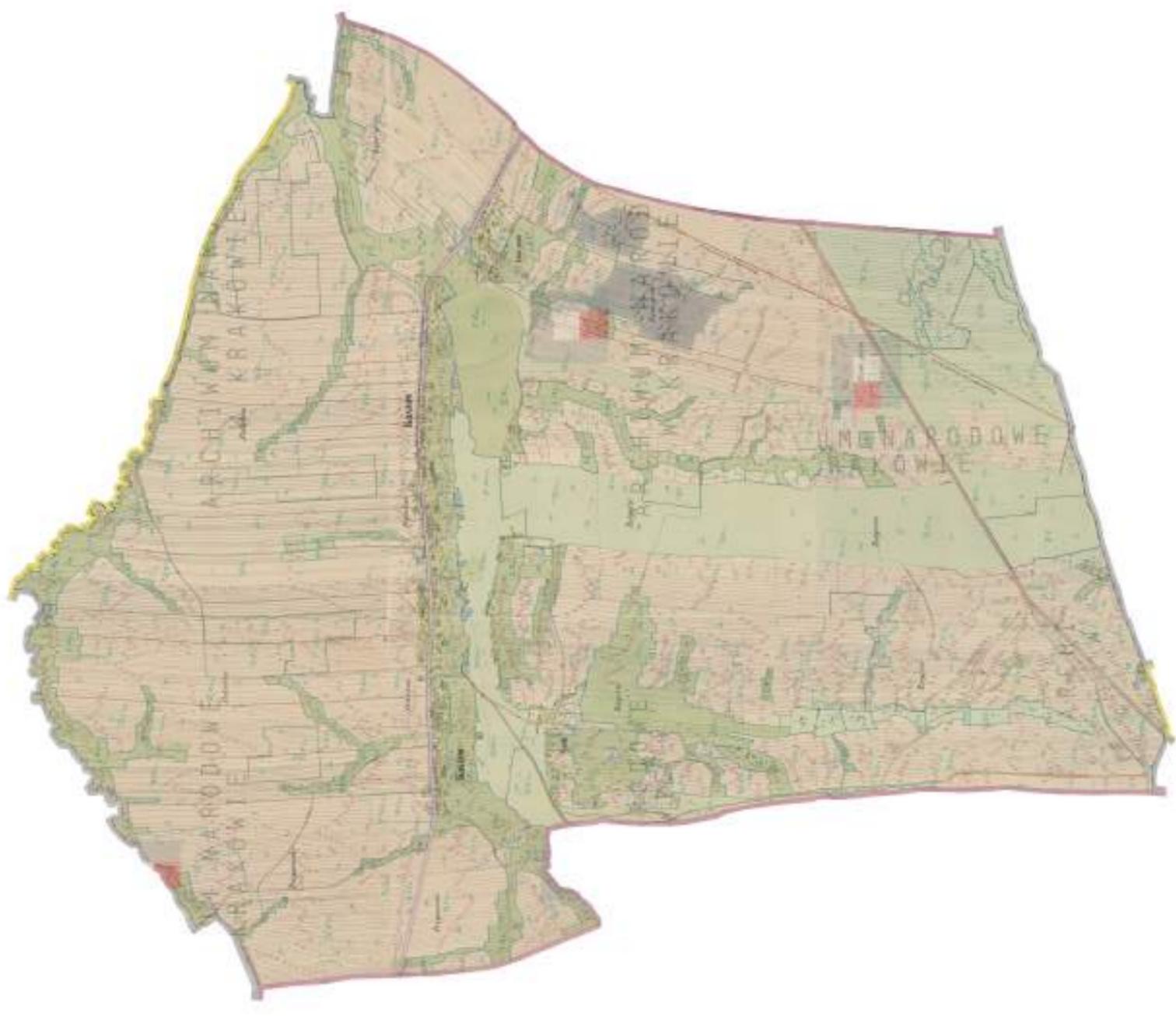


Fig. 3 – Franciscan cadastre (1848) of Kaszów settlement.
Source: Own study based on the maps provided by the National Archive in Krakow.



Fig.4 – Contemporary orthophoto of Kaszów settlement from 2016 with marked areas with unchanged way of land use.

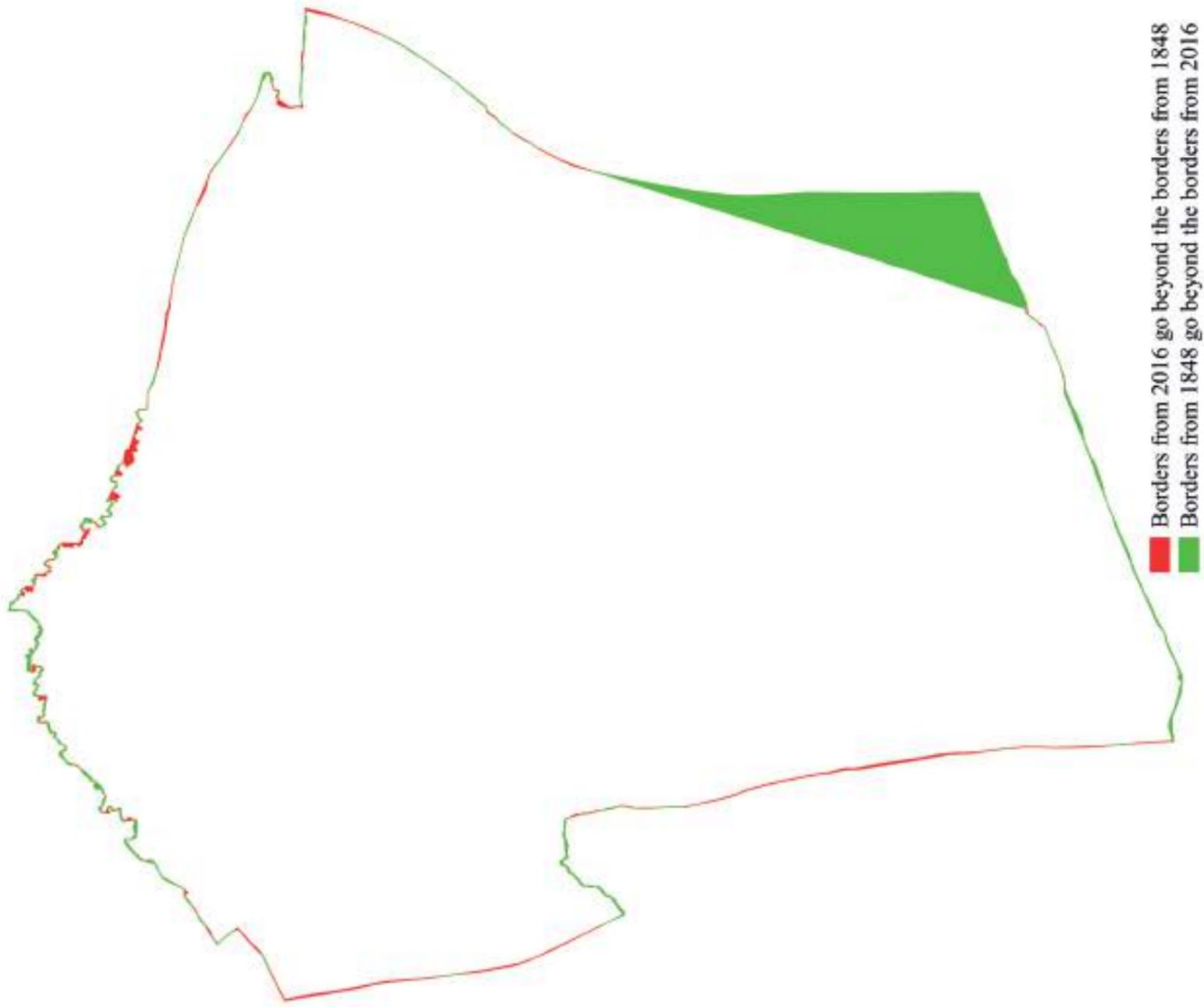


Fig. 5 – Comparing of Kaszów borders from the years 1848 and 2016.

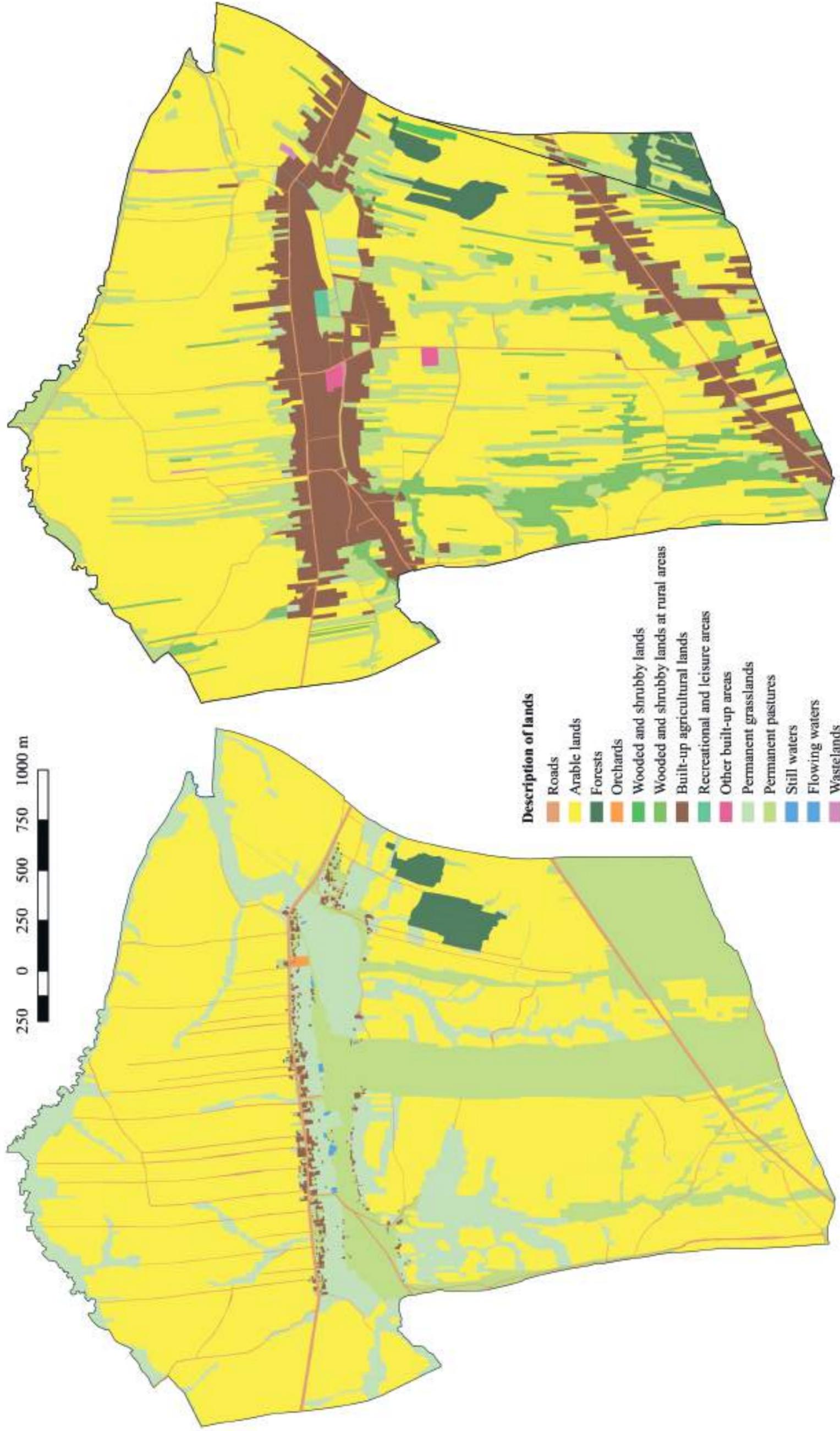


Fig. 6 – Land use in Kaszów settlement according to the Franciscan cadastre from 1848.

Fig. 7 – Contemporary land use in Kaszów settlement from 2016.

were occupying the area of 160.1183 ha, i.e. 18.69% of the area of the surveyed place, whereas in 2016 this area decreased to 110.5464 ha i.e. to 12.91% of total land. In mid-19th century, there were 129.6899 ha of grasslands which occupied 15.13% of the contemporary area of Kaszów. At present, the area of grasslands is small and amounts to 3.1572 ha which is only 0.37% of the place's area.

Built-up areas of Kaszów are the grounds the positive balance of which in regard to 2016 can be noticed over the centuries. Their area increased from 6.5485 ha i.e. 0,76% in 1848 to 116.8615 ha i.e. 13.67% in 2016. Therefore, it can be concluded that this area increased at the expense of green lands. The structure and arrangement of road network were significantly affected as well. Only two main roads crossing the place in the directions: west-east were left. The road located along the western border of Kaszów and some minor access roads did not change their position.

As mentioned previously, significantly elongated plots dominate at the area of Kaszów. In the 19th century, there were access roads to plots in the northern part of the location. At present, most of them disappeared in favour of not-hardened inner roads which are seasonal access roads to cultivated fields. After the season, these roads are subjected to usual cultivation so they are not a permanent element of communication system.

In the 19th century, road plots occupied the area of 18.5185 ha i.e. 2.16% of Kaszów area. Nowadays, the plots under the roads amount to 14.4041 ha i.e. 1.70% of the place's area. Therefore it can be noticed that the communication system in the surveyed period was reduced. The area covered with trees was in Kaszów in 1848 only 11.5912 ha i.e. 1.35% of the place's area. Currently, altogether 73.5911 ha i.e. 8.60% of area was classified as a forest as well as wooded and shrubby land. So, the significant growth of forest areas over years is visible. Minimal areas of orchards, wastelands and lands occupied by floating and still waters can be distinguished both now and in mid-19th century (Tab. 1).

4.2 Cadastral municipality of Kryspinów

The second research object is currently adjacent straight to administrative borders of Krakow city. It is a place with the area of 488.7779 ha (at present).

As late as the 19th century, the village was called Stinky (in Polish: Śmierdząca) which was caused by the stink from the surrounding marshes. The village is located at the left bank of the Vistula river near the mouth of Sanka to Vistula at the level of about 212 m a.s.l. At the end of 19th century, it numbered 73 homesteads including 3 ones at the manorial area where 471 inhabitants were living. At that time, the area of fields was 444 Austrian morgens, 144 morgens of grassland, 165 morgens of pastures and 22 morgens of forest. The soil was described as fertile (Słownik, Tom X, s. 876).

The southern Kryspinów border of rather irregular shape is determined by the Vistula river. One of the ways to designate a border which goes along the river is mathematical designation of its bed's axis on the basis of bank lines' course (Ustawa 2001; Bieda 2012). The border called mobile is displaced together with moving of bank lines of the river bed which determine it. In practice, such a border is not usually marked, however, its course is put on a map. On the basis of the cadastral map from 1848, it can be stated that the border between Kryspinów and Tyniec was situated in the axis of the Vistula river bed. Gradual changes of the Vistula bed within Kryspinów are visible on the maps created already after 1900 that considered progressive separation of

Tab. 2 – Land use at Kryspinów in 1848 and 2016.

	1848		2016	
	ha	percentage	ha	percentage
Built-up areas	3.9594	0.82	93.6393	19.16
Manorial parks	1.2474	0.26	–	–
Sports facilities	–	–	2.2749	0.47
Forests	12.7924	2.64	29.4024	6.02
Wooded and shrubby lands	0.0648	0.01	61.5993	12.60
Pastures	93.8749	19.36	130.0336	26.60
Grasslands	62.3372	12.86	24.1366	4.94
Arable lands	255.0060	52.60	90.9083	18.60
Wastelands	5.1548	1.06	7.2911	1.49
Roads	9.6974	2.00	24.4068	4.99
Flowing waters	21.6046	4.46	14.6050	2.99
Still waters	17.4688	3.60	7.6853	1.57
Fossil lands	0.7360	0.15	–	–
Orchards	0.8624	0.18	2.7953	0.57
Total	484.8061	100%	488.7779	100%

Data source: Maps of Franciscan cadastre for the cadastral commune of Kaszów prepared in 1848; for 2016, the database of topographic objects provided by the Office of Geodesy and Cartography was the source of data.

the southern most fragment of the bend by the rubble deposited by the river in that place.

In 1830, after the big flood in 1813, the process of cleaning of the Vistula river in its Cracovian part was started (Pociask-Karteczka 1994). Regulation of the Upper Vistula began in 1884 and was conducted till the outbreak of the first world war. The works were restarted in the 1920. They mainly consisted in embanking of Vistula banks and over time adaptation of Vistula to inland navigation was started mostly in order to transport black coal from Silesia (Matakiewicz 1929). Assumptions of development of Upper Vistula from 1974 were aimed at building the "Kościuszko" barrage and also performing a dike as well as regulation of Vistula bed as a result of which this bed was straightened and shortened. However, the old river bed which now marks the southern border of Kryspinów was left.

In mid-19th century, Kryspinów was a typically agricultural area. The area of arable lands in that period amounted to about 255 ha (Tab. 2) which is 52.6% of the total area. In 2016, the area of these lands is less than 91 ha i.e. 18.6% of the place's area.

Such a great decrease of agricultural lands over the centuries can be explained, among other things, by regress of profitability of agricultural production, inconstant conditions on the selling markets and also growing demand for building plots in the vicinity of Krakow. One of the reasons of regress of profitability of agricultural production in Poland was introducing the free market economy as well as importing food from the countries of Western Europe (Poławski 2009).

In 19th-century structure of land uses, the areas of land communities which were characteristic for that period appeared in Kryspinów in the form of pastures. Grasslands and pastures altogether covered in 1848 the area slightly over 156 ha i.e. total 32.22% of the place's area. The area of built-up land was changed significantly. Few parcels with wooden houses in the middle of the 19th century were replaced 16 decades later by the compact settlement including the one of industrial character. Growth of built-up areas is in case of Kryspinów almost 90 ha i.e. from the level of 0.82% of grounds occupied by buildings in 1848 to 19.16% of the built-up land in 2016.

Changes in land use are also visible in case of roads. The area of land occupied by communication system of Kryspinów in 2016 increased by 14.7094 ha in relation to 1848.



Fig. 8 – Contemporary orthophoto of the Kryspinów settlement from 2016.
Source: Own study based on Geoportal (www.geoportal.stat.gov.pl).



Fig. 9 – Franciscan cadastre (1848) of the Kryspinów settlement. Source: Own study based on the maps provided by the National Archive in Krakow.



Fig. 10 – Contemporary orthophoto of the Kryspinów settlement from 2016 marked areas with unchanged way of land use since 1848.

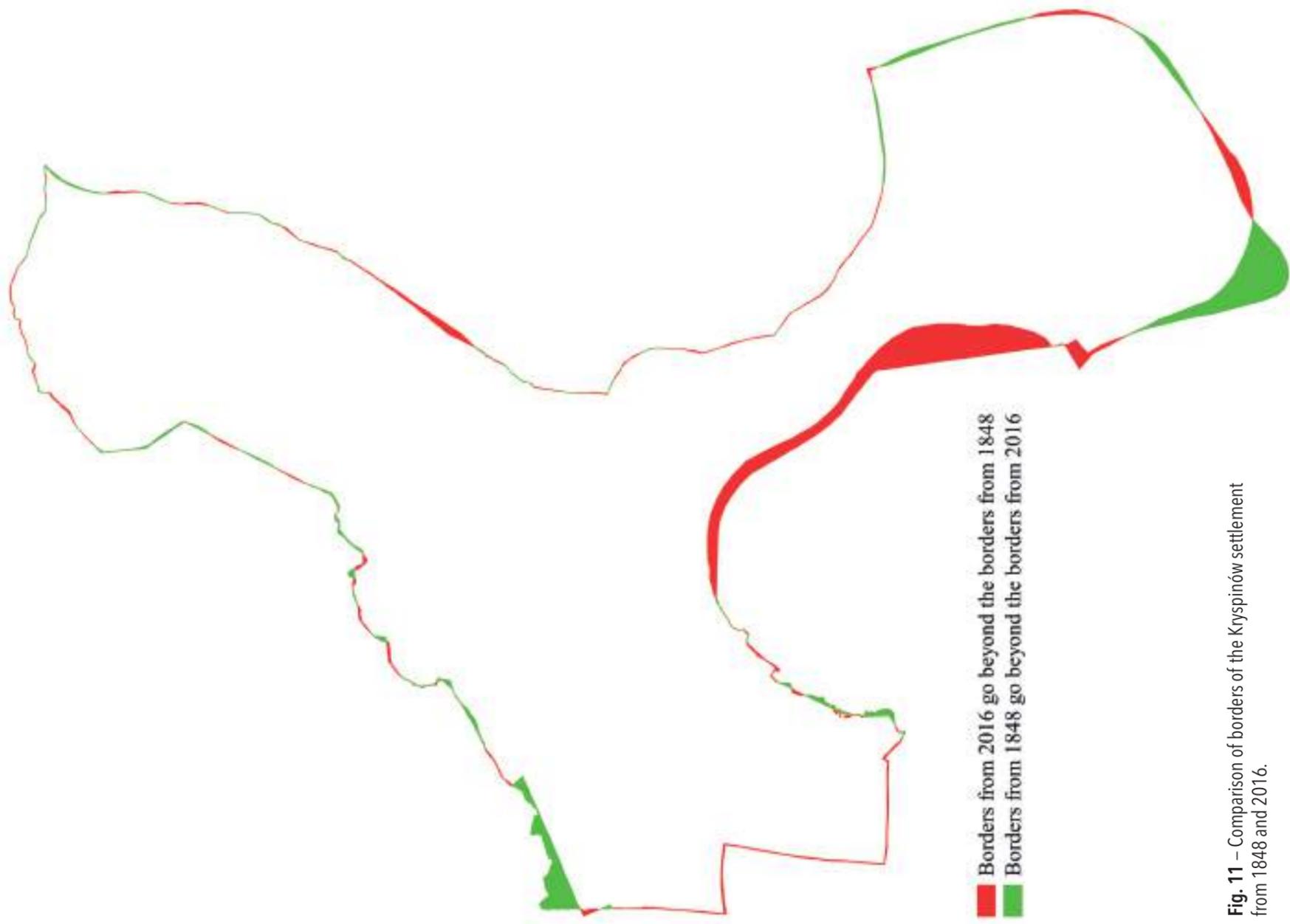


Fig. 11 – Comparison of borders of the Kryspinów settlement from 1848 and 2016.

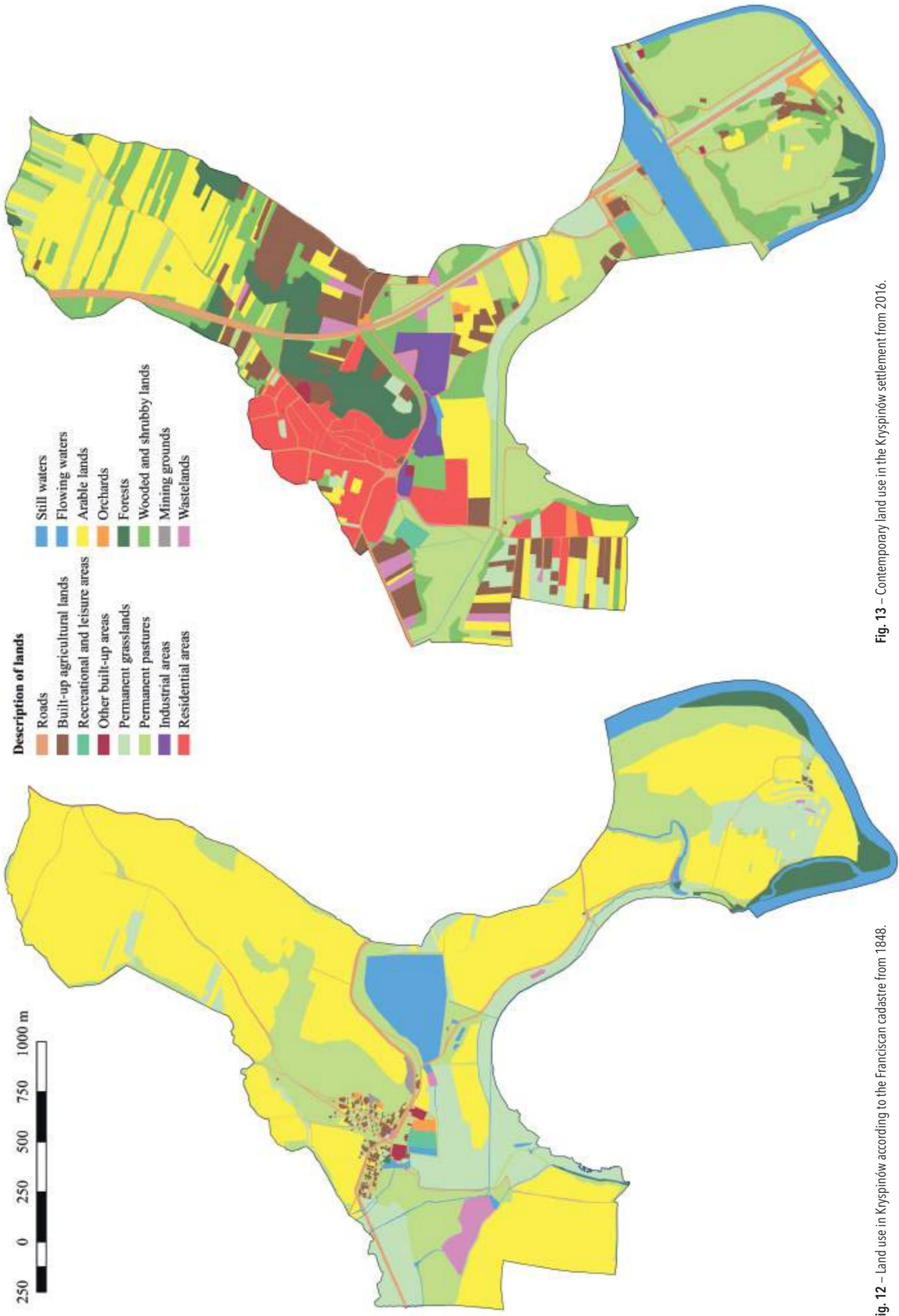


Fig. 12 – land use in Kryspinów according to the Franciscan cadastre from 1848.

Fig. 13 – Contemporary land use in the Kryspinów settlement from 2016.

Over the centuries, the change in the range of forestry use in Kryspinów took place as well. They currently occupy the area of 61.5993 ha, i.e. 12.6% of total area of the place. At the time of performing the cadastral map, forests did not occur in Kryspinów. The area of orchards and wastelands also increased. In mid-19th century, there was a quarry in Kryspinów without any evidence remained at the moment. Great changes took place in case of still and flowing waters. In 1848, there was a large pond in the centre of the place where the residential building is located at present. In spite of performing the dike of the Vistula river at the area of Kryspinów the area occupied by the flowing waters decreased from 21.6046 ha to 14.6050 ha, which is by more than half.

The direction of changes in land use observed in tested localities corresponds to the general trend of decreasing the areas used agriculturally at the area of Małopolska (Noszczyk et al. 2017), in Poland (Poławski 2009; Łowicki 2008) and also in the world (Meiyappan et al. 2015). The growth of forested areas and also built-up and urbanized ones is the next observed change at the area of surveyed objects. The increase of afforestation index can result from the general tendency of abandonment of agricultural use at the area of Małopolska (Noszczyk et al. 2017), whereas the growth of built-up lands especially at the area of Kryspinów which is located in the vicinity of Krakow can be caused by observed in the last decade an “urban sprawl” which can be seen especially at the areas that directly border cities (Springer 2013).

5. Conclusions

There are numerous factors that influence land use changes in rural areas including socio-economic development, the state policy and legal conditions in the range of property rights that result from it, technical progress as well as position of agriculture in the state economy. Suburban processes have a great impact on the directions of changes in land use structure, especially in case of places located in close vicinity of fast-growing city centres. Such situation can be observed in case of two analysed locations: Kryspinów and Kaszów situated in close vicinity of Krakow. Smaller changes were noted in the following distance zone the area of which was not under direct urban pressure of Krakow. Observed historical changes of land use copy the general tendency of increase of built-up and urban areas as well as wastelands and wooded areas at the expense of the areas used agriculturally.

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